Warrenpoint Port

Maintenance Dredging 2024-2027

Information to Inform a Habitats Regulations Screening Assessment

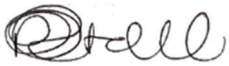
November 2023

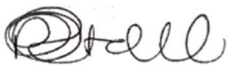
Project Nr
642

Anthony D Bates Partnership LLP
7 Hen Parc Lane
Upper Killay
Swansea
SA27EY

info@anthonybates.co.uk
www.anthonybates.co.uk

Client:	Warrenpoint Harbour Authority
Project:	Warrenpoint Port - Maintenance Dredging 2024-2027
Title:	Information to Inform a Habitats Regulations Screening Assessment

	Prepared by:	**Reviewed by:**
DRAFT	**NAME**	**NAME**
	S Challinor	Paul Mitchell
DATE	**SIGNATURE**	**SIGNATURE**
16/11/2023		

	Prepared by:	**Reviewed by:**
Final	**NAME**	**NAME**
	S Challinor	P Mitchell
DATE	**SIGNATURE**	**SIGNATURE**
30/11/2023		

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1 Introduction

1.1.1 Warrenpoint Harbour Authority, the operators of Warrenpoint Port, are seeking a new marine licence to dispose of dredged material arising from maintenance dredging in the period 2024-2027. Maintenance dredging is required to conserve safe water depths for navigation and berthing in the port and its approaches.

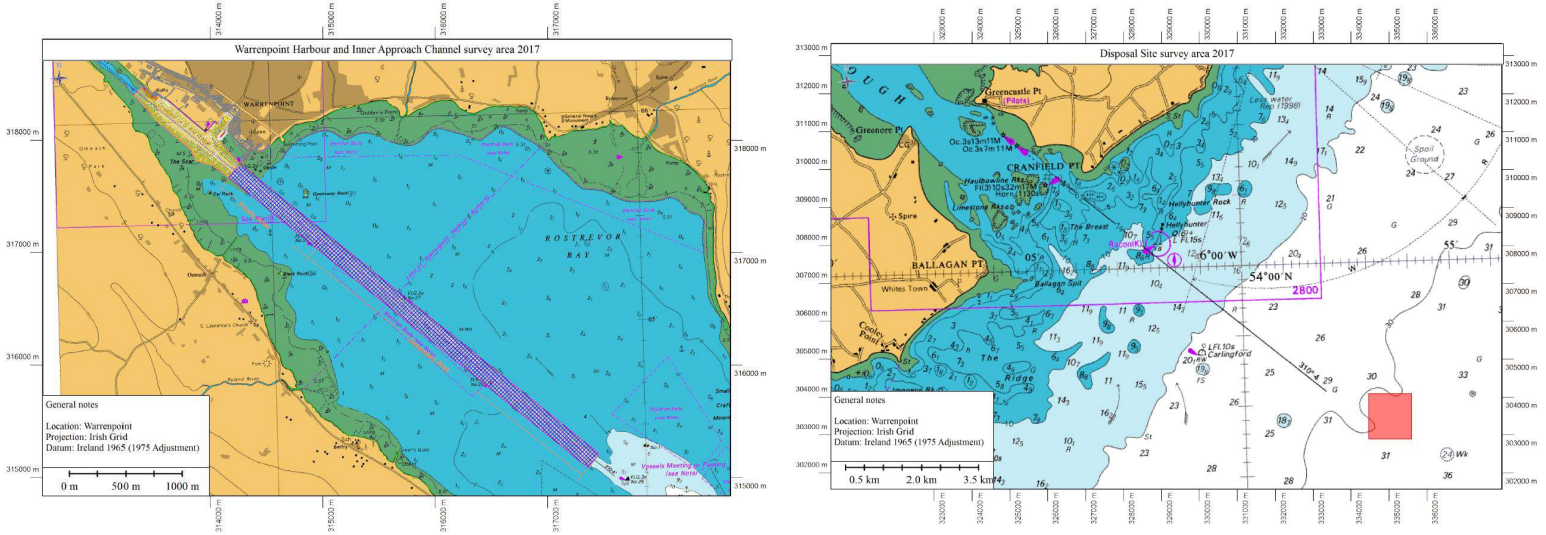
1.1.2 The scope of the future maintenance dredging and disposal of dredged material in the period 2024-2027 is expected to be similar to that in the period 2020-2023. Accordingly, maintenance dredging is likely to be undertaken using a trailing suction hopper dredger (TSHD) supported by a bed leveller / plough dredger, and potentially a backhoe or grab hopper dredger, and is likely to result in a maximum 805,000 tonnes of dredged material (including gravel, sand, silt and clay) being deposited in the sea at the Warrenpoint B disposal site.

2 Habitats Regulations Screening Assessment

2.1.1 In accordance with Regulation 43(1) of the Conservation (Natural Habitats, etc) Regulations (Northern Ireland) 1995 (as amended) and the changes made under the Conservation (Natural Habitats, etc) (Amendment) (Northern Ireland) (EU Exit) Regulations 2019, in determining an application for a marine licence, DAERA (as the competent authority) must make an assessment of the proposed maintenance dredging and disposal of dredged material, either alone or in combination with other plans and projects, is likely to have a significant effect on a European site (i.e., Special Areas of Conservation (SACs) and/or Special Protection Areas (SPAs)). The principal purpose of this assessment is to ensure that a marine licence is granted only if the proposed maintenance dredging and disposal of dredged material would not adversely affect the features of a European site or the integrity of the site network (i.e., UK's national site network and/or the Republic of Ireland's Natura 2000 site network).

2.1.2 The assessment – known as the Habitats Regulations Assessment - comprises up to four stages. The first stage is a 'screening assessment' which is an initial test of whether a plan or project is likely is likely to have a significant effect on a European site without the incorporation of measures that are considered to be necessary and specifically intended to avoid or reduce adverse effects on a European site.

2.1.3 This report provides information to inform a screening assessment by DAERA. It provides an update of the information provided to inform the screening assessments that were was undertaken in 2015 and 2018 to support the previous marine licence applications associated with maintenance dredging at Warrenpoint Port. Minor changes have been made to incorporate new legislation and information, but the conclusions of this information to inform a screening assessment are unchanged; that is, the proposed maintenance dredging and disposal of dredged material is not likely to have a significant effect on the European sites within and beyond Carlingford Lough and, therefore, there is no need to undertake the next stage of the Habitats Regulations Assessment (i.e., 'appropriate assessment').

Test for Likely Significant Effects	
Name of project or plan	Warrenpoint Port maintenance dredging 2024-2027
Brief description of the project or plan	**Scope of Work** Warrenpoint Port is situated at the north-west end of Carlingford Lough where the River Newry enters the Lough. It is one of the major ports serving Northern Ireland and is an essential component in the local economy. Access to the port, particularly for deep draught vessels, is via an approach channel. Water depths along the approach channel and within the port itself are maintained by periodic dredging campaigns to achieve the following water depths below Chart Datum (BCD): Town Dock: 2.35mBCD, Customs House Quay: 3.0mBCD, Deep Water Pocket: 7.5mBCD, Berth Nos. 1 and 2: 5.4mBCD, Return Berth: 5.4mBCD, Ro-Ro Berth: 6.5mBCD, Turning Basin: 5.4mBCD, Main Basin: 5.4mBCD and Inner Approach Channel: 5.4mBCD. Dredged material arising from the maintenance dredging campaigns is deposited at the Warrenpoint B disposal site. **Figure 1 Warrenpoint Harbour and Inner Approach Channel (left) and Warrenpoint B Disposal Site (right)**  **Method Statement for Maintenance Dredging** Maintenance dredging has been undertaken at Warrenpoint Port for several decades and covers the time prior to and since the designation of the SACs and/or SPAs that contribute to the UK's national site network and/or the EU's Natura 2000 network. The majority of maintenance dredging activity carried out in Warrenpoint Port has been undertaken using a TSHD supported by plough dredgers and, in particular instances, a mechanical

Test for Likely Significant Effects	
	dredger (e.g., backhoe dredger or grab dredger). The dredging methods outlined below are expected to be used for maintenance dredging from 2024 and 2027. Trailing Suction Hopper Dredger (TSHD) A TSHD is a self-propelled vessel that is equipped with hydraulic suction system comprising an impeller pumping system (potentially including submerged and onboard pumps), a trailer arm with a suction pipe and drag-head, and an in-built hopper with hydraulically operated watertight bottom doors. It operates independently of other plant or equipment and can sail over long distances to transport and dispose of dredged material. To commence the dredging process, the TSHD sails under its own propulsion to the dredging area within Warrenpoint Port. Once in position over the dredging area, the TSHD lowers its trailer arm to the bed and sails slowly forwards in a straight line at speeds of typically less than 2 knots. The drag-head dislodges and collects a mixture of the bed sediment and surrounding water. The sediment and water are pumped through the suction pipe and into the hopper. Excess water flows out of the hopper leaving the sediment inside the hopper. Successive passes of the TSHD over the dredging area result in the removal of sediment until the required bed level and associated water depth is achieved. The TSHD's dredge master monitors the depth and position of the drag-head at all times to ensure that the required bed level is not unduly exceeded. Dredging continues until the hopper is filled by a mixture of sediment and water. However, dredging may continue in order to increase the sediment to water ratio in the hopper by allowing the water in the hopper to overflow through a dedicated weir system built into the hopper. The optimum period of overflow depends on the particle size and density of the sediment. When dredging fine-grained sediment (i.e., soft mud and silt) - as is often the case for Warrenpoint Port - there is usually very little benefit to be gained from extended periods of overflowing water from the hopper because the fine-grained sediment particles do not settle out of suspension sufficiently, which means the density of the material being overflowed is similar to the density of the material being dredged from the seabed. This is not the case when dredging medium- and/or coarse-grained sediment (i.e., sand and gravel). The use of overflowing when dredging medium- and/or course-grained sediment can safely be undertaken for some considerable time without causing significant impact on the receiving water's turbidity levels, as the sediment settles to the bottom of the hopper and only the supernatant water is overflowed out of the hopper. The use of overflowing when dredging medium- and/or course-grained sediment can result in a more economic and efficient dredging operation as the hopper's load is maximised prior to the TSHD sailing to the disposal site. This is a very important consideration for dredging at Warrenpoint Port as the disposal site is a significant distance from the port (approximately 24km). To transport a hopper load that contains a high proportion of water is very inefficient, both environmentally and economically. By maximising the hopper's load, the CO_2 emissions associated with each m^3 of dredged material can be minimised. The trade-off between turbidity levels, CO_2 emissions and financial cost need to be considered when formulating a 'best practice' approach to dredging at Warrenpoint Port. To date, dredging activities at Warrenpoint Port have been restricted contractually such that overflowing can be undertaken for 15 minutes only providing always that turbidity/suspended solids and dissolved oxygen levels in the water column are monitored and do not exceed prescribed limits; however, typically, this timeframe is not utilised as there is very limited benefit for overflowing due to the fine-grained nature of sediment at Warrenpoint Port. When the hopper is filled, the TSHD raises the trailer arm and sails to the Warrenpoint B disposal site (Figure 3). When the TSHD reaches the disposal site, doors at the bottom of the TSHD's hopper are opened and the dredged material is discharged. The discharge takes place at the keel at the TSHD.

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	The TSHDs typically used at Warrenpoint Port have keels more than 6m below the water surface. Once the hopper is empty, and flushed clean, the TSHD's bottom doors are closed and the TSHD sails on a reciprocal course back to the dredging area, lowers the trailer arm, and recommences dredging. Plough Dredger To assist the TSHD, the reduction of elevated 'high spots' is undertaken by the use of a plough dredger (also known as a bed leveller). A plough dredger is not a dredger per se but is a bottomless, rectangular box-shaped fabricated steel implement that is towed behind a small workboat or tug using a deck-mounted hoist winch. It is used to move accumulated sediment over a short distance to level an irregular bed in order to move sediment from a location where it causes a restriction or obstruction, or to move sediment from an inaccessible location to an accessible location so that it can be removed by other dredging plant, such as a TSHD. To commence the dredging process, the workboat sails under its own propulsion to the dredging area. Once in position over the dredging area, the plough is lowered and suspended at the required bed level, and is then towed behind the workboat. The sediment is sliced by the cutting blade at the plough's leading edge and contained within the rest of the plough's structure until the plough reaches an area where the bed level is lower than the plough level, whereupon the contained sediment drops through the bottom of the plough. At this point, the plough is raised above the bed and the workboat sails back to the dredging area where the plough is lowered to the required bed level and recommences dredging. Unlike the other dredging methods, plough dredging does not involve the disposal of the dredged material; rather, it redistributes material locally on the seabed. Mechanical Dredger (Backhoe Dredger or Grab Hopper Dredger) The combination of a TSHD and plough dredger is the most commonly used for maintenance dredging internationally. However, they are limited in the type of sediment they can dredge and, therefore a mechanical dredger (e.g., a backhoe dredger or a grab hopper dredger) may be required to dredge coarse-grained sediment (e.g., sediment with particles more than 150mm) that cannot be recovered using the hydraulic suction processes used by a TSHD or relocated by a plough dredger. The excavating module of a backhoe dredger is almost identical to a tracked hydraulic excavators used on land. The main differences, apart from being mounted on a pontoon, are that they are usually relatively large machines often with the boom and stick extended to cope with the greater digging depth as required in many maritime applications. The dredged material is loaded, by the excavator, into dedicated barges. The barges can be either self-propelled or 'dumb'. In the latter case a tug is required to tow the barge to the disposal site. Once the material is loaded into the hopper the disposal process is the same as for the TSHD. A grab hopper dredger is a mechanical dredging method that is similar to a backhoe dredger; however, it has a self-contained hopper to store and transport the dredged material. This allows all dredged material to be managed by a single item of plant. Grab hopper dredgers are generally smaller than TSHDs and the loading and disposal operations are time consuming. For this reason, grab hopper dredgers are generally only used to dredge relatively small volumes of material or to dredge material that is either inaccessible to larger plant or unsuitable for removal by hydraulic means.

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	To commence dredging, a grab hopper dredger is positioned either under its own propulsion. Once in position, dredging commences with the clamshell grab is lowered to and lifted from the seabed by a crane on wire ropes or by an excavator, and then is rotated such that it is positioned over the hopper. The dredged material is then placed into the hopper. Dredging continues until the hopper is filled. When the hopper is filled, the grab hopper dredger sails to another location so that the dredged material can be unloaded or discharged (e.g., by depositing the dredged material through hatches in the barge's hull, or by mechanically removing the material using an excavator working from the quayside). As required, the grab hopper dredger is repositioned as per the procedure described above and recommences dredging. <u>Environmental Monitoring of Maintenance Dredging</u> As for previous maintenance dredging campaigns at Warrenpoint Port, will be undertaken to check that the maintenance dredging and disposal of dredged material do not have a significant effect on the SACs and/or SPAs within the UK's national site network and/or the EU's Natura 2000 network European sites. Monitoring requirements are set out in a dedicated Dredging and Disposal Monitoring Plan and summarised below, and are a direct repeat of the monitoring required under the existing marine licence. Monitoring of dredging during a maintenance dredging campaign: • Bathymetric surveys will be undertaken of the area to be dredged before, during and after the dredging works. • Sediment samples will be acquired upstream and downstream before and after the dredging works, and will be retained for a minimum of 3 months and made available for testing if required. • Blue mussel, *Mytilus edulis,* samples will be acquired upstream and downstream, before, during and after the dredging works, and will be analysed for the following PAHs: benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene and chrysene. • Total Suspended Solids (TSS) concentrations will be monitored in real-time (using a turbidity correlation) at an agreed location within the Inner Harbour, and the concentrations recorded shall not exceed 300mg/l for durations longer than 6 hours, and/or shall not exceed 600mg/l at any time. TSS concentrations shall also be compared to the permanent AFBI monitoring buoy as a reference and levels exceeding 10% of the 90 percentile of background (71mg/l) for greater than 6 hours shall not be permitted. • Dissolved oxygen (DO) concentrations will be monitored in real-time at an agreed location within the Inner Harbour, and dredging works shall cease if DO concentrations fall below 4mg/l and shall not commence again until DO concentrations have increased to 5mg/l if dredging works are identified as the cause for DO reductions. Monitoring of the Warrenpoint B disposal site before commencement and on completion of disposal operations: • A bathymetric survey will be undertaken to monitor the bed level within the disposal site. • A photography/video survey and grab sample of the benthos will be undertaken and reported.
Project reference (Planning ref. etc.)	TBC

Test for Likely Significant Effects	
File number	TBC
Name and location of European site	The following European sites are screened into the test for likely significant effect: • Carlingford Lough SPA including its proposed marine extension, Northern Ireland. • Carlingford Shore SAC, Republic of Ireland. • Carlingford Lough SPA, Republic of Ireland. • Murlough SAC, Northern Ireland. Location plans for the European sites are provided in **Appendix 1**.
European site features	**Carlingford Lough SPA including proposed marine extension, Northern Ireland** Current area: 827.12 hectares. Proposed area of marine extension: 11,405 hectares. Site code: UK9020161. Date classified: March 1998. Boundary: the current site extends between Killowen Point and Soldiers Point on the northern shores of Carlingford Lough and includes all lands and intertidal areas seawards to the limits of territorial waters (marine areas below mean low water are not included), and contains sections of Carlingford Lough ASSI and is entirely coincident with the Carlingford Lough Ramsar site (**Appendix 1**), the proposed marine extension includes the open water marine area adjoining the existing SPA within Carlingford Lough and the area of the Lough's mouth seawards to the limits of territorial waters, as well as coastal waters northwards to the Bloody Bridge area on the Mournes Coast (**Appendix 1**). Qualifying features: the site qualifies under EC Directive 79/409 on the Conservation of Wild Birds by regularly supporting important numbers of breeding common tern (*Sterna hirundo*) and sandwich tern (*Sterna sandvicensis*), and by regularly supporting important numbers of over wintering (non-breeding) light bellied brent goose (*Branta bernicla hrota*); the proposed marine extension provides foraging habitat for both sandwich tern and common tern originating from the breeding colony at this site. Conservation objectives: the conservation objectives for this site are to maintain each qualifying feature in favourable condition, which is related to the following site objectives: • To maintain or enhance the population of the qualifying species. • Fledging success sufficient to maintain or enhance population. • To maintain or enhance the range of habitats utilised by the qualifying species. • To ensure that the integrity of the site is maintained.

Test for Likely Significant Effects	

	• To ensure there is no significant disturbance of the species.
	• To ensure that the following are maintained in the long term:
	  ○ Population of the species as a viable component of the site;
	  ○ Distribution of the species within site;
	  ○ Distribution and extent of habitats supporting the species; and
	  ○ Structure, function and supporting processes of habitats supporting the species.
	
	Further information: Carlingford Lough SPA Guidance and Literature | Department of Agriculture, Environment and Rural Affairs (daera-ni.gov.uk)
	
	Carlingford Shore SAC, Republic of Ireland
	
	Area: 526.27 hectares.
	
	Site code: 002306.
	
	Date Classified: first proposed as eligible as a Site of Community Importance (SCI) in June 2001.
	
	Boundary: the site comprises the entire southern shoreline of Carlingford Lough and continues round the tip of the Cooley Peninsula to just west of Cooley Point (**Appendix 1**) and overlaps with Carlingford Lough SPA (**Appendix 1**).
	
	Qualifying features: the site is designated under the EC Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora by hosting the following habitats: annual vegetation of drift lines and perennial vegetation of stony banks.
	
	Conservation objectives (annual vegetation of drift lines): the conservation objectives for this site are to maintain the favourable conservation condition of annual vegetation of drift lines in relation to the following list of attributes and targets:
	
	• Habitat area – area stable or increasing, subject to natural processes, including erosion and succession.
	• Habitat distribution - no decline, or change in habitat distribution, subject to natural processes.
	• Physical structure: functionality and sediment supply - maintain the natural circulation of sediment and organic matter, without any physical obstructions.
	• Vegetation structure - zonation - maintain range of coastal habitats including transitional zones, subject to natural processes including erosion and succession.
	• Vegetation composition - typical species and sub-communities: maintain the presence of species-poor communities with typical species: sea rocket (*Cakile maritima*), sea sandwort (*Honckenya peploides*), prickly saltwort (*Salsola kali*) and orache (*Atriplex spp*.).
	• Vegetation composition: negative indicator species - negative indicator species (including non-natives) to represent less than 5% cover.
	
	Conservation objectives (perennial vegetation of stony banks): the conservation objectives for this site are to maintain the favourable conservation condition of perennial vegetation of stony banks in relation to the following list of attributes and targets:

Test for Likely Significant Effects	
	• Habitat area – area stable or increasing, subject to natural processes, including erosion and succession. • Habitat distribution - no decline, or change in habitat distribution, subject to natural processes. • Physical structure: functionality and sediment supply - maintain the natural circulation of sediment and organic matter, without any physical obstructions. • Vegetation structure - zonation - maintain range of coastal habitats including transitional zones, subject to natural processes including erosion and succession. • Vegetation composition - typical species and sub-communities: maintain the typical vegetated shingle flora including the range of sub-communities within the different zones. • Vegetation composition: negative indicator species - negative indicator species (including non-natives) to represent less than 5% cover. Further information: Carlingford Shore SAC | National Parks & Wildlife Service (npws.ie) **Carlingford Lough SPA, Republic of Ireland** Area: 171.99 hectares Site code: 004078 Date classified: October 1996 Boundary: the site comprises parts of the south side of Carlingford Lough, County Louth, between Carlingford Harbour and Ballagan Point (**Appendix 1**) and overlaps with Carlingford Shore SAC (**Appendix 1**). Qualifying features: the site qualifies under EC Directive 79/409 on the Conservation of Wild Birds by regularly supporting important numbers of over wintering (non-breeding) light bellied brent goose (*Branta bernicla hrota*), and by hosting wetland habitat as a resource for the regularly occurring migratory waterbirds that utilise it. Conservation objectives (light-bellied brent goose): the conservation objectives for this site are to maintain the favourable conservation condition of light-bellied brent goose in relation to the following list of attributes and targets: • Population trend - long term population trend stable or increasing. • Distribution - no significant decrease in the range, timing or intensity of use of areas by light-bellied brent goose, other than that occurring from natural patterns of variation. Conservation objectives (wetlands): the conservation objectives for this site are to maintain the favourable conservation condition of wetland habitat as a resource for the regularly occurring migratory waterbirds that utilise it in relation to the following list of attributes and targets:

Test for Likely Significant Effects	
	• Habitat area - the permanent area occupied by the wetland habitat should be stable and not significantly less than the area of 595 hectares, other than that occurring from natural patterns of variation. Further information: Carlingford Lough SPA | National Parks & Wildlife Service (npws.ie) **Murlough SAC, Northern Ireland** Area: 11,903.9 hectares Site code: UK0016612 Date classified: May 2005 Boundary: the site comprises Dundrum Bay including the supratidal major dune systems of Murlough and Ballykinler, and the intertidal and shallow subtidal waters of Dundrum Bay (**Appendix 1**). Qualifying features: the site is designated under the EC Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora by hosting the following habitats and species: Atlantic decalcified fixed dunes, fixed dunes with herbaceous vegetation, Atlantic salt meadows, dunes with creeping willow, embryonic shifting dunes, marsh fritillary butterfly (*Euphydryas (Eurodryas, Hypodryas) aurinia*), mudflats and sandflats not covered by seawater at low tide, harbour seal / common seal (*Phoca vitulina*), sandbanks which are slightly covered by sea water all the time, and shifting dunes with marram. Conservation objectives: the conservation objectives for this site are to maintain (or restore where appropriate) the qualifying features. Further information: Murlough SAC | Department of Agriculture, Environment and Rural Affairs (daera-ni.gov.uk)
Description of the project or plan	Size and scale The maximum area of the maintenance dredging areas within Warrenpoint Harbour and its Inner Approach Channel totals approximately 650 hectares. The maximum area of the Warrenpoint B disposal site is 68 hectares. Since maintenance dredging campaigns do not always cover the full maintenance dredging areas within Warrenpoint Harbour and its Inner Approach Channel, the actual dredging and disposal areas are typically smaller in size and scale than the maximum areas. Maintenance dredging frequency is irregular; historically a main campaign has been undertaken every 5-6 years which involves the removal of approximately 350,000m^3, while smaller campaigns of the turning basin and the deep-water pocket have been undertaken every 1-2 years (**Table 1**).

Test for Likely Significant Effects

Table 1 Previous Dredging Campaigns at Warrenpoint Harbour and in the Approach Channel

Year	Dredging Works	Dredging Methodology	Approx. Dredged Material Volume
2022	Inner Harbour Area (maintenance works)	TSHD	62,300m^3
2020	Turning Circle (maintenance works)	TSHD	54,000m^3
2019	Inner Harbour Area (maintenance works)	TSHD	34,000m^3
2018	Deep Water Berth Pocket (maintenance works)	TSHD	20,300m^3
2017	Entire Harbour Area and Approaches (maintenance works)	TSHD	393,000m^3
2016	Deep Water Berth Pocket and Approaches (maintenance works)	TSHD	50,000m^3
2015	Turning Circle (maintenance works)	GHD	5,800m^3
2014	Deep Water Berth Pocket (maintenance works)	TSHD	30,000m^3
2011-2012	Entire Harbour Area and Approaches (maintenance works)	TSHD	390,000m^3
2008	Turning Circle (maintenance works)	TSHD	25,000m^3
2009	Breakwater, Container Ship Berths Pocket, Turning Circle (capital works)	Backhoe	127,000m^3
2006-2007	Ro-Ro Berth (capital works)	Backhoe	20,000m^3
2005	Town Dock Phase 2 (capital works)	Backhoe	41,000m^3
2005	Turning Circle and Approach Channel (maintenance works)	TSHD	268,000m^3
2004	Town Dock Phase 1 (capital works)	Backhoe	13,000m^3

<u>Land-take</u>

The proposed maintenance dredging will not involve any land take. The dredging areas within Warrenpoint Harbour and its Inner Approach Channel and the Warrenpoint B disposal site are subject to maintenance dredging and disposal activities on an annual basis, and are also subject to disturbance from port activities and/or vessel movements. The Warrenpoint B disposal site has been receiving dredged material for many years.

Test for Likely Significant Effects	
	Distance from the European site(s) or key features of the site(s) The dredging areas within Warrenpoint Harbour and its Inner Approach Channel are situated: • Approximately 1.5km from the closest boundary of the Carlingford Lough SPA and the proposed marine extension area (Northern Ireland). • Approximately 3.5km from the closest boundary of the Carlingford Lough SPA (Republic of Ireland). • Within and adjacent to the boundary of the Carlingford Shore SAC, notably where the southern areas of the Main Basin and Turning Basin overlap with the boundary. • Approximately 22km from the closest boundary of the Murlough SAC. The Warrenpoint B disposal site is situated: • Approximately 10km from the closest boundary of the Carlingford Lough SPA (Northern Ireland), and approximately 2.8km from the closest boundary of the SPA's proposed marine extension area. • Approximately 10km from the closest boundary of Carlingford Lough SPA (Republic of Ireland). • Approximately 10km from the closest boundary of the Carlingford Shore SAC (Republic of Ireland). • Approximately 18km from the closest boundary of the Murlough SAC (Northern Ireland). Resource requirements Maintenance dredging will not require any resource requirements apart from the use of seawater as a hydraulic medium to raise sediments into the hopper of the TSHD. Emissions Maintenance dredging will generate temporary exhaust emissions and noise emissions associated with the operating of dredging plant (e.g., TSHD, plough dredger, backhoe dredger, barge); however, these emissions are not expected to be any greater than emissions associated with other vessels transiting to and from Warrenpoint Port. Excavation requirements Maintenance dredging will remove accreted sediment within Warrenpoint Harbour and its Inner Approach Channel to reinstate the bed to the levels required to provide safe navigation and berthing. Transportation requirements Dredged material will be transported from the dredging areas within Warrenpoint Harbour and its Inner Approach Channel to the Warrenpoint B disposal site by sea within the hoppers of a TSHD and/or a barge(s). Dredged material will not be transported by road.

Test for Likely Significant Effects	
	Duration Maintenance dredging will take place, as required, on an intermittent basis over a 3-year period between 2024 and 2027. Other Maintenance dredging will take place within the sub-tidal navigable channels and berths within the boundary of Warrenpoint Harbour and its Inner Approach Channel, and the disposal of dredged material will take place within the boundary of the Warrenpoint B disposal site. Maintenance dredging and disposal activities have taken place at these locations for many years and, therefore, have taken place prior to the designation of the European sites and have taken place alongside the conservation and management of the European sites.
Is the proposal directly connected with or necessary to management of the site for conservation of N2K features? **If yes proceed no further.**	No.
Describe the individual elements of the project (either alone or in combination with other plans or projects) likely to give rise to impacts on the European site(s)	Maintenance dredging and disposal of dredged material is expected to give rise to the following impacts which, in turn, may have the potential for likely significant effects on the European sites: • Sediment dispersion leading to an adverse impact on qualifying species and/or the supporting habitats of qualifying species due to exposure to increased suspended sediment concentrations, decreases in dissolved oxygen concentrations, and/or increases in contaminant concentrations. • Sediment deposition leading to an adverse impact on the supporting habitats of qualifying species due to exposure to changes to seabed substrate and/or benthic communities. • Underwater noise generation and propagation leading to an adverse impact on qualifying species and/or the supporting habitats of qualifying species due to auditory injury and/or disturbance. The evidence base for these impacts is provided in **Appendices 2.1, 2.2 and 2.3**.
Describe any potential effects on the European	The potential effects on the European sites are screened for likely significant effects in the table below.

Test for Likely Significant Effects				
sites in terms of interference with the key relationships that define the structure or function of the sites	Screening is based on a source-pathway-receptor approach to identify whether there is the potential (i.e., likelihood) for an effect. This approach identifies whether an effect can be realised because a potential pathway can be established that links a receptor (i.e., the habitats and species that are the qualifying features of European sites) to a source of a potential impact (e.g., impacts arising from dredging and disposal activities). If there is no pathway between a source and a receptor, then there is no potential for a receptor to be exposed to an impact and, therefore, there is no potential for a likely significant effect. If there is a potential pathway between a source and a receptor, then there is the potential for a receptor to be exposed to an impact and, therefore, a screening assessment has been undertaken to consider the potential for a likely significant effect. Where relevant, the screening assessments make reference to the evidence base in **Appendices 2.1, 2.2 and 2.3**.			
Source	**Pathway**	**European Site Receptor**	**Qualifying Feature Receptor**	**Screening Assessment for Likely Significant Effect**
Sediment disturbed by dredging within Warrenpoint Harbour and the Inner Approach Channel	Sediment dispersion in the estuarine / marine water column leading to exposure of receptors in the intertidal and/or subtidal zones to increased suspended sediment concentrations, decreases in dissolved oxygen concentrations, and/or increases in contaminant concentrations	Carlingford Lough SPA (Northern Ireland)	Common tern Sandwich tern	There is considered to be negligible potential for a significant effect on these qualifying features. Although there is a potential pathway for sediment dispersion (and effects associated with suspended sediment increases / dissolved oxygen decreases / contaminant increases), it is not expected to extend as far as the SPA and the qualifying features and their supporting habitat. Previous monitoring of sediment dispersion during maintenance dredging within Warrenpoint Harbour and the Inner Approach Channel (**Appendix 2.1**) indicates that the extent of sediment dispersion could be expected to occur at a distance of approximately 2km to the closest boundary of Carlingford Lough SPA, approximately 2km from the closest boundary of the Carlingford Lough SPA extension area, and approximately 8km from the principal breeding areas for the terns within Carlingford Lough SPA, which are situated at the islands near the mouth of the lough.
			Light bellied brent goose	There is considered to be negligible potential for a significant effect on this qualifying feature. Although there is a potential pathway for sediment dispersion (and effects associated with suspended sediment increases / dissolved oxygen decreases / contaminant increases), it is not expected to extend as far as the SPA and the qualifying feature and its supporting habitat. Previous monitoring of sediment dispersion during maintenance dredging within Warrenpoint Harbour and the Inner Approach Channel (**Appendix 2.1**) indicates that the extent of sediment dispersion could be expected to occur at a distance of approximately 2km from the closest boundary of Carlingford Lough SPA, approximately 2km from the closest boundary of the

Test for Likely Significant Effects				
	(see **Appendix A2.1** in **Appendix 2** for further information about the nature of this impact and its pathway)			Carlingford Lough SPA extension area, approximately 8km from the closest principal inter-tidal eel grass[1] feeding area for the light bellied brent goose, which is situated within the SPA along the shore of Mill Bay, and approximately 28km from the closest principal roosting area for the light bellied brent goose, which is situated beyond the SPA along the coast in Dundalk Bay[2].
		Carlingford Lough SPA (Republic of Ireland)	Light bellied brent goose	There is considered to be <u>negligible potential for a significant effect</u> on this qualifying feature. Although there is a potential pathway for sediment dispersion (and effects associated with suspended sediment increases / dissolved oxygen decreases / contaminant increases), it is not expected to extend as far as the SPA and the qualifying feature and its supporting habitat. Previous monitoring of sediment dispersion during maintenance dredging within Warrenpoint Harbour and the Inner Approach Channel (**Appendix 2.1**) indicates that the extent of sediment dispersion could be expected to occur at a distance of approximately 2km from the closest boundary of Carlingford Lough SPA, approximately 8km from the closest principal inter-tidal eel grass feeding area for the light bellied brent goose, which is situated within the SPA along the shore of Mill Bay, and approximately 28km from the closest principal roosting area for the light bellied brent goose, which is situated beyond the SPA along the coast in Dundalk Bay.
		Carlingford Shore SAC (Republic of Ireland)	Annual vegetation of drift lines	There is considered to be <u>negligible potential for a significant effect</u> on these qualifying features. Although there is a potential pathway for sediment dispersion (and effects associated with suspended sediment increases / dissolved oxygen decreases / contaminant increases), it is expected to extend as far as the SAC but not as far as the qualifying features. Previous monitoring of sediment dispersion during maintenance dredging within Warrenpoint Harbour and the Inner Approach Channel (**Appendix 2.1**) indicates that the extent of sediment dispersion could be expected to occur at a distance of approximately 0km from the closest boundary of Carlingford Shore SAC, but approximately 7km from the closest point of these qualifying features, which are present in the intertidal zone from Greenore to west of Cooley Point.
			Perennial vegetation of stony banks	
		Murlough SAC	Fixed dunes with	There is considered to be <u>no potential for a significant effect</u> on these qualifying features. There is no potential pathway for sediment dispersion (and effects associated with suspended

[1] Eel grass is the preferred food resource for brent goose, based on Owen and Black 1990, Hassall and Lane 2005 and NPWS et al., 2006.
[2] Based on Martin 2013, unpublished data

Test for Likely Significant Effects				
		(Northern Ireland)	herbaceous vegetation	sediment increases / dissolved oxygen decreases / contaminant increases) to extend as far as these qualifying features in Dundrum Bay because they are present within the supratidal zone.
			Atlantic de-calcified fixed dunes	
			Dunes with creeping willow	
			Shifting dunes with marram	
			Embryonic shifting dunes	
			Atlantic salt meadows	There is considered to be negligible potential for a significant effect on these qualifying features. Although there is a potential pathway for sediment dispersion (and effects associated with suspended sediment increases / dissolved oxygen decreases / contaminant increases), it is not expected to extend as far as the SAC and the qualifying features. Previous monitoring of sediment dispersion during maintenance dredging within Warrenpoint Harbour and the Inner Approach Channel (**Appendix 2.1**) indicates that the extent of sediment dispersion could be expected to occur at a distance of approximately 22km from the closest boundary of Murlough SAC and these qualifying features in Dundrum Bay, which are present within the intertidal and/or subtidal zones.
			Mudflats and sandflats not covered by seawater at low tide	
			Sandbanks which are slightly covered by sea water all the time	
			Marsh fritillary butterfly	There is considered to be no potential for a significant effect on this qualifying feature. There is no potential pathway for sediment dispersion (and effects associated with suspended sediment increases / dissolved oxygen decreases / contaminant increases) to extend as far as

Test for Likely Significant Effects				
				this qualifying feature in Dundrum Bay because it and its supporting habitat are present within the supratidal zone.
			Harbour seal	There is considered to be negligible potential for a significant effect on this qualifying feature. Although there is a potential pathway for sediment dispersion (and effects associated with suspended sediment increases / dissolved oxygen decreases / contaminant increases), it is not expected to extend as far as the SAC and the qualifying feature and its supporting habitat. Previous monitoring of sediment dispersion during maintenance dredging within Warrenpoint Harbour and the Inner Approach Channel (**Appendix 2.1**) indicates that the extent of sediment dispersion could be expected to occur at a distance of approximately 22km from the closest boundary of Murlough SAC, and approximately 4km from the closest haul out site for harbour seal within Carlingford Lough, which is at Ballyedmond.
Sediment released by disposal within Warrenpoint B disposal site	Sediment deposition on the seabed leading to exposure of receptors in the intertidal and/or subtidal zones to increased smothering (see **Appendix A2.2** in **Appendix 2** for further information about the nature of this impact and its pathway)	Carlingford Lough SPA (Northern Ireland)	Common tern Sandwich tern	There is considered to be negligible potential for a significant effect on these qualifying features. Although there is a potential pathway for sediment deposition, it is not expected to extend as far as the SPA and the qualifying features and their supporting habitat. Previous monitoring of sediment deposition associated with the disposal of dredged material at Warrenpoint B disposal site (**Appendix 2.2**) indicates that the extent of sediment deposition could be expected to occur at a distance of approximately 10km from the closest boundary of Carlingford Lough SPA, and approximately 2.8km from the closest boundary of the Carlingford Lough SPA extension area.
			Light bellied brent goose	There is considered to be negligible potential for a significant effect on this qualifying feature. Although there is a potential pathway for sediment deposition, it is not expected to extend as far as the SPA and the qualifying feature and its supporting habitat. Previous monitoring of sediment deposition associated with the disposal of dredged material at Warrenpoint B disposal site (**Appendix 2.2**) indicates that the extent of sediment deposition could be expected to occur at a distance of approximately 10km from the closest boundary of Carlingford Lough SPA, approximately 2.8km from the closest boundary of the Carlingford Lough SPA extension area, approximately 14km from the closest principal inter-tidal eel grass feeding area for the light bellied brent goose, which is situated within the SPA along the shore of Mill Bay, and approximately 24km from the closest principal roosting area for the light bellied brent goose, which is situated beyond the SPA along the coast in Dundalk Bay.

Test for Likely Significant Effects				
		Carlingford Lough SPA (Republic of Ireland)	Light bellied brent goose	There is considered to be negligible potential for a significant effect on this qualifying feature. Although there is a potential pathway for sediment deposition, it is not expected to extend as far as the SPA and the qualifying feature and its supporting habitat. Previous monitoring of sediment deposition associated with the disposal of dredged material at Warrenpoint B disposal site (**Appendix 2.2**) indicates that the extent of sediment deposition could be expected to occur at a distance of approximately 10km from the closest boundary of Carlingford Lough SPA, approximately 2.8km from the closest boundary of the Carlingford Lough SPA extension area, approximately 14km from the closest principal inter-tidal eel grass feeding area for the light bellied brent goose, which is situated within the SPA along the shore of Mill Bay, and approximately 24km from the closest principal roosting area for the light bellied brent goose, which is situated beyond the SPA along the coast in Dundalk Bay.
		Carlingford Shore SAC (Republic of Ireland)	Annual vegetation of drift lines	There is considered to be negligible potential for a significant effect on these qualifying features. Although there is a potential pathway for sediment deposition, it is not expected to extend as far as the SAC and the qualifying features. Previous monitoring of sediment deposition associated with the disposal of dredged material at Warrenpoint B disposal site (**Appendix 2.2**) indicates that the extent of sediment deposition could be expected to occur at a distance of approximately 10km from the closest boundary of Carlingford Shore SAC and the qualifying features, which are present in the intertidal zone from Greenore to west of Cooley Point.
			Perennial vegetation of stony banks	
		Murlough SAC (Northern Ireland)	Fixed dunes with herbaceous vegetation	There is considered to be no potential for a significant effect on these qualifying features. There is no potential pathway for sediment deposition to extend as far as these qualifying features in Dundrum Bay because they are present within the supratidal zone.
			Atlantic de-calcified fixed dunes	
			Dunes with creeping willow	

Test for Likely Significant Effects				
			Shifting dunes with marram	
			Embryonic shifting dunes	
			Atlantic salt meadows	There is considered to be negligible potential for a significant effect on these qualifying features. Although there is a potential pathway for sediment deposition, it is not expected to extend as far as the SAC and the qualifying features. Previous monitoring of sediment deposition associated with the disposal of dredged material at Warrenpoint B disposal site (**Appendix 2.2**) indicates that the extent of sediment deposition could be expected to occur at a distance of approximately 18km from the closest boundary of Murlough SAC and these qualifying features in Dundrum Bay, which are present within the intertidal and/or subtidal zones.
			Mudflats and sandflats not covered by seawater at low tide	
			Sandbanks which are slightly covered by sea water all the time	
			Marsh fritillary butterfly	There is considered to be no potential for a significant effect on this qualifying feature. There is no potential pathway for sediment deposition to extend as far as this qualifying feature in Dundrum Bay because it and its supporting habitat are present within the supratidal zone.
			Harbour seal	There is considered to be negligible potential for a significant effect on this qualifying feature. Although there is a potential pathway for sediment deposition, it is not expected to extend as far as the SAC and the qualifying feature and its supporting habitat. Previous monitoring of sediment deposition associated with the disposal of dredged material at Warrenpoint B disposal site (**Appendix 2.2**) indicates that the extent of sediment deposition could be expected to occur at a distance of approximately 18km from the closest boundary of Murlough SAC, and approximately 10km from the closest haul out site for harbour seal within Carlingford Lough, which is at a reef around Blockhouse Island.

Test for Likely Significant Effects				
Under noise released by dredger operations including dredging activity and vessel transits between the dredging areas within Warrenpoint Harbour and the Inner Approach Chanel and the Warrenpoint B disposal site	Underwater noise propagation leading to exposure of receptors in the intertidal and/or subtidal zones to increased sound levels (see **Appendix A2.3** in **Appendix 2** for further information about the nature of this impact and its pathway)	Murlough SAC (Northern Ireland)	Harbour seal	There is considered to be negligible potential for a significant effect on this qualifying feature during dredging activities. Although there is a potential pathway for underwater noise propagation, it is not expected to extend as far as the SAC and the qualifying feature and its supporting habitat. Research into underwater noise impacts on pinnipeds including harbour seal (**Appendix 2.3**) indicates that the extent of auditory injury could be expected to occur at a distance of approximately 18km from the closest boundary of Murlough SAC, and approximately 5km from the closest haul out site for harbour seal within Carlingford Lough, which is at a reef around Blockhouse Island. In addition, research into underwater noise impacts on pinnipeds including harbour seal (**Appendix 2.3**) indicates that the extent of disturbance could be expected to occur at a distance of approximately 13km from the closest boundary of Murlough SAC, and approximately 0km from the closest haul out site for harbour seal within Carlingford Lough, which is at a reef around Blockhouse Island.
Provide details of any other projects or plans that together with the project or plan being assessed could (directly or indirectly) affect the site	Existing projects and plans include ongoing activities associated with commercial and recreational vessel activities (including ferries and yachts), commercial and recreational fishing (including bait digging and seaweed collecting), shoreside recreational activities (including recreational walking, dog walking), sewage discharges, scientific research, etc. These activities are integrated into the test for likely significant effects as they form part of the baseline environmental conditions. No ongoing or reasonably foreseeable projects and plans were identified and, therefore, no in-combination effects were considered.			

Is the potential scale or magnitude of any effect likely to be significant?	
Alone?	**Yes** ☐ **No** ☒
In-combination with other projects of plans?	**Yes** ☐ **No** ☒

Consultation	
List of agencies consulted: provide contact name and telephone or email address	None to date
Above consultee response	

Conclusion	
Is the proposal likely to have a significant effect on an N2K site?	**Yes☐ No☒**
IF IT HAS BEEN DETERMINED THAT THE PROPOSAL WILL NOT HAVE A SIGNIFICANT EFFECT, THEN THE ASSESSMENT IS COMPLETED. IF ANY PART OF THE PROPOSAL IS LIKELY TO HAVE A SIGNIFICANT EFFECT AN APPROPRIATE ASSESSMENT WILL BE REQUIRED – STAGE 2 APPROPRIATE ASSESSMENT.	

Assessor and Data Sources	
Who carried out the assessment?	Anthony D Bates Partnership LLP
Sources of data	AFBI (2009). Warrenpoint B Disposal Site Survey. AFBI (2016). Warrenpoint Harbour Environmental Monitoring. AFBI (2017). Warrenpoint Harbour Environmental Monitoring. De Jong, C., Ainslie, M., Dreschler, J., Jansen, E., Heemskerk, E. and Groen, W. (2010). Underwater Noise of Trailing Suction Hopper Dredgers at Maasvlakte 2: Analysis of Source Levels and Background Noise. TNO-DV 2010 C335. November 2010. Geomara (2016). Multibeam Echosounder and Drop Down Camera Survey Warrenpoint Harbour Dump Site on Behalf of Warrenpoint Harbour Authority. June 2016. Hassall, M. and Lane, S.J. (2005). Partial feeding preferences and the profitability of winter-feeding sites for Brent Geese. Basic and Applied Ecology 6: 559-570. Nachtsheim, D.A., Johnson, M., Schaffeld, T. (2023). Vessel Noise Exposures of Harbour Seals from the Wadden Sea. Sci. Rep. 13, 6187 (2023). NOAA (2023). Summary of Marine Mammal Protection Act Acoustic Thresholds. National Marine Fisheries Service. February 2023. Owen, M. and Black, J.M. (1990). Waterfowl Ecology. Blackie and Son Ltd, Glasgow and London pp194 Southall, B.L., Bowles, A.E., Ellison, W.T., Finneran, J.J., Gentry, R.L., Greene Jr, C.R. and Tyack, P.L. (2007). Marine mammal noise-exposure criteria: initial scientific recommendations. Aquatic Mammals, 33(4), 411–521. Wilson S., O'Malley D., Cassidy D., and Clarke D. (2012). Surveying the Seals of Carlingford Lough, Loughs Agency. Xodus (2015). Technical Note on Underwater Noise. Document no. A-100142-S20-TECH-001. April 2015.
Level of assessment completed	Stage 1 Screening Assessment
Where can the full results of the	All documents can be viewed the consultants offices: 7 Hen Parc Lane, Upper Killay, Swansea, SA27EY

assessment be accessed and viewed?	

APPENDIX 1: EUROPEAN SITE BOUNDARIES

Figure A1.1 Carlingford Lough SPA (Northern Ireland)

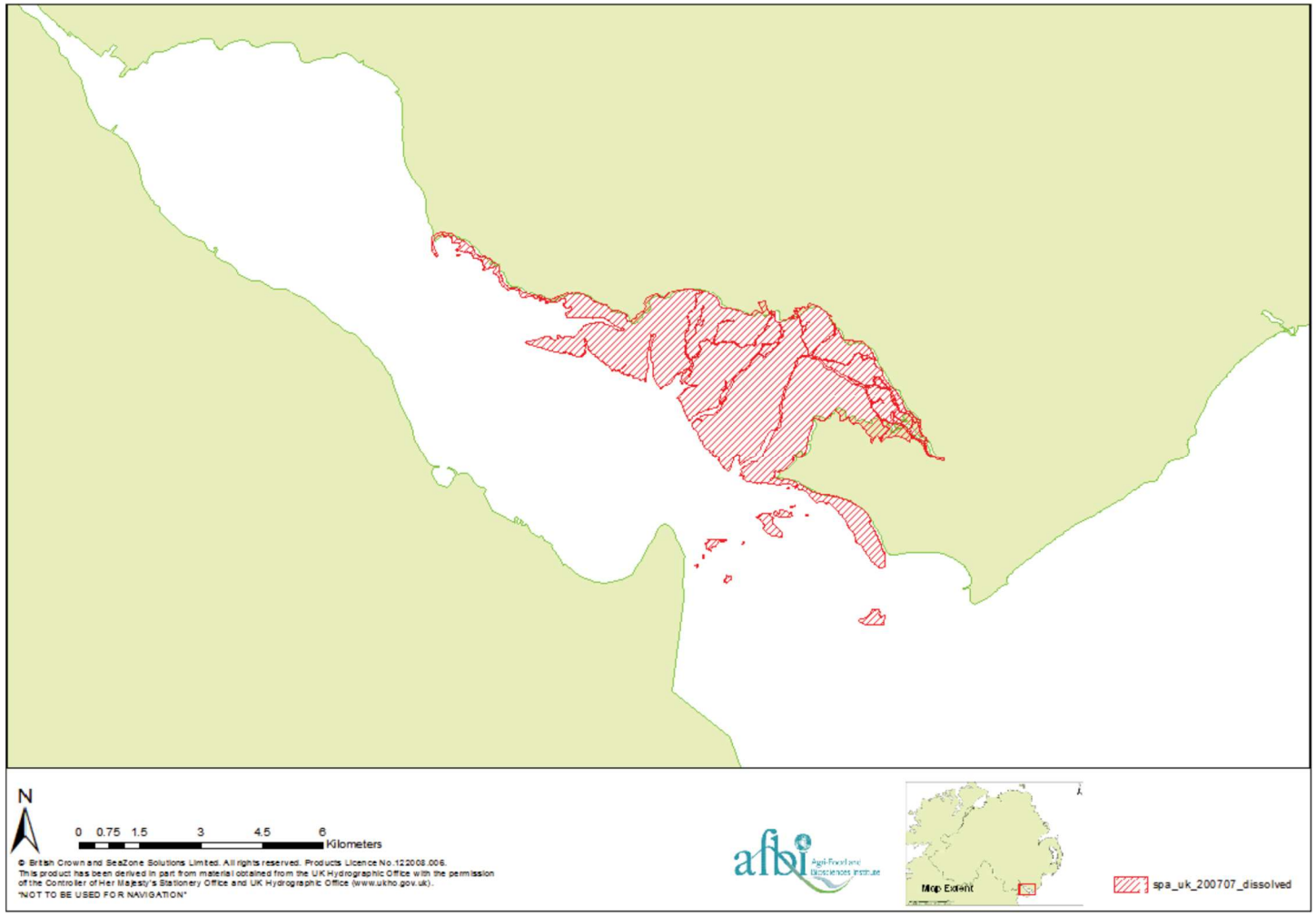


Figure A1.2 Carlingford Lough SPA proposed marine extension (Northern Ireland)

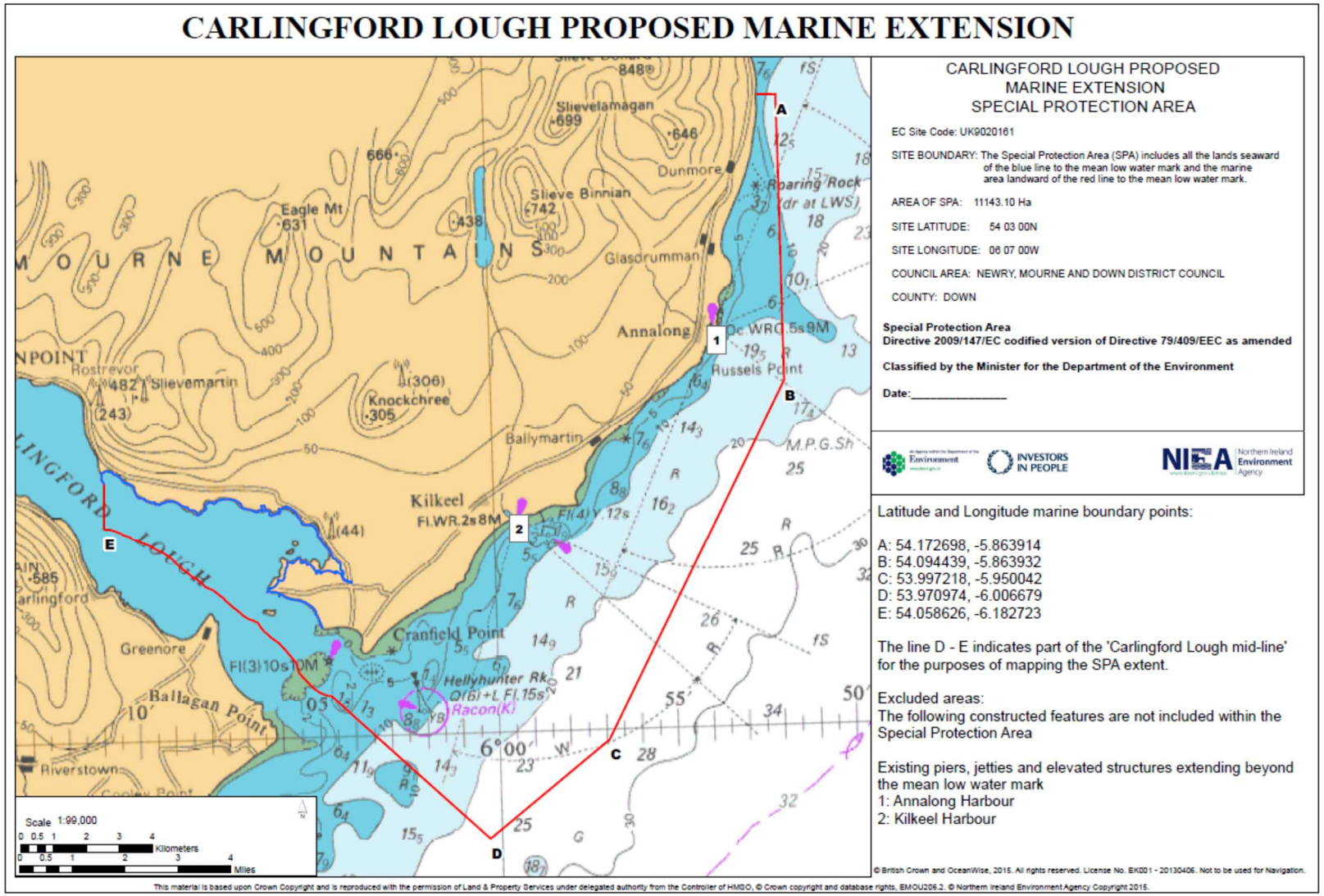


Figure A1.3 Carlingford Shore SPA (Republic of Ireland)

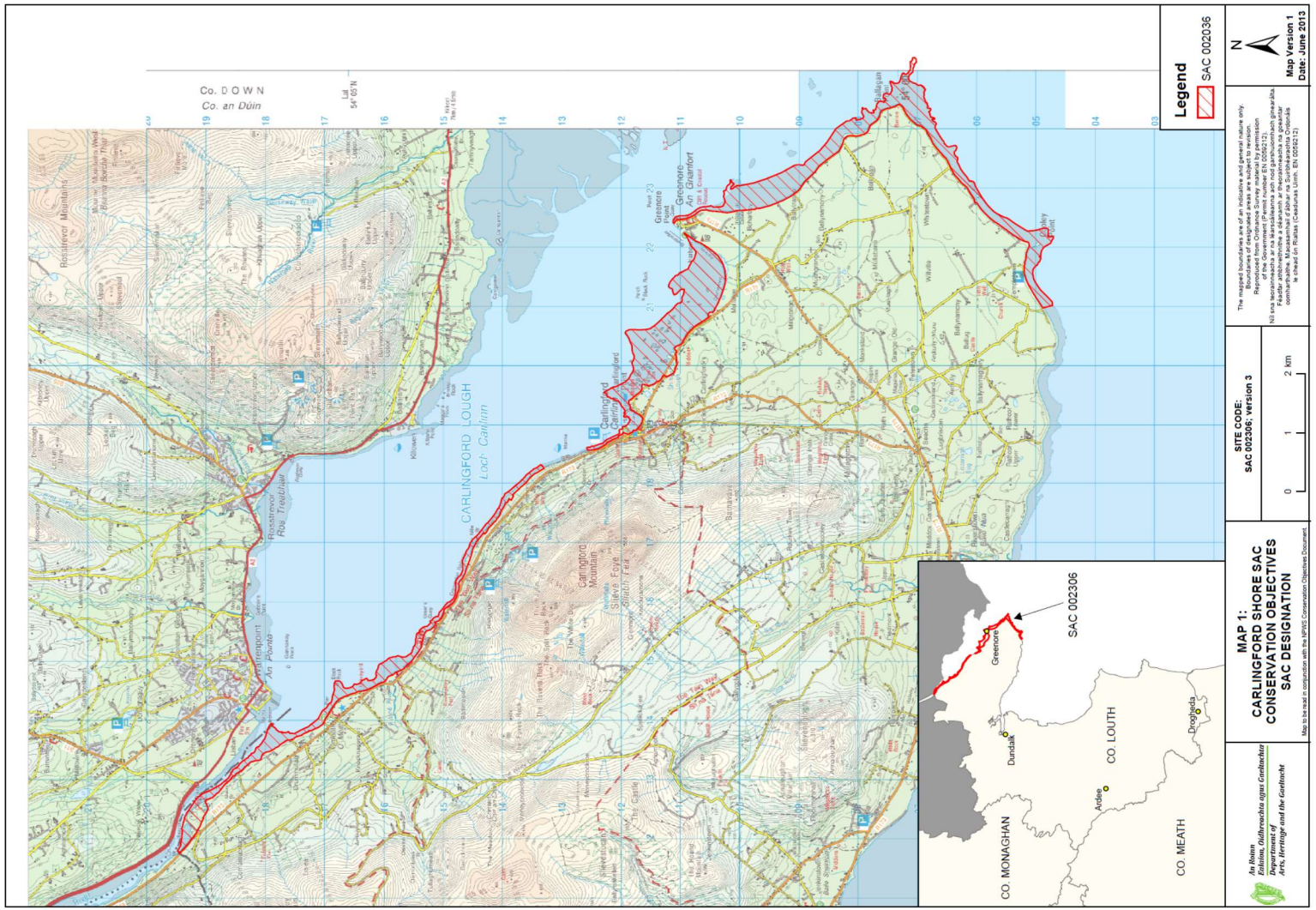


Figure A1.4 Carlingford Lough SPA (Republic of Ireland)

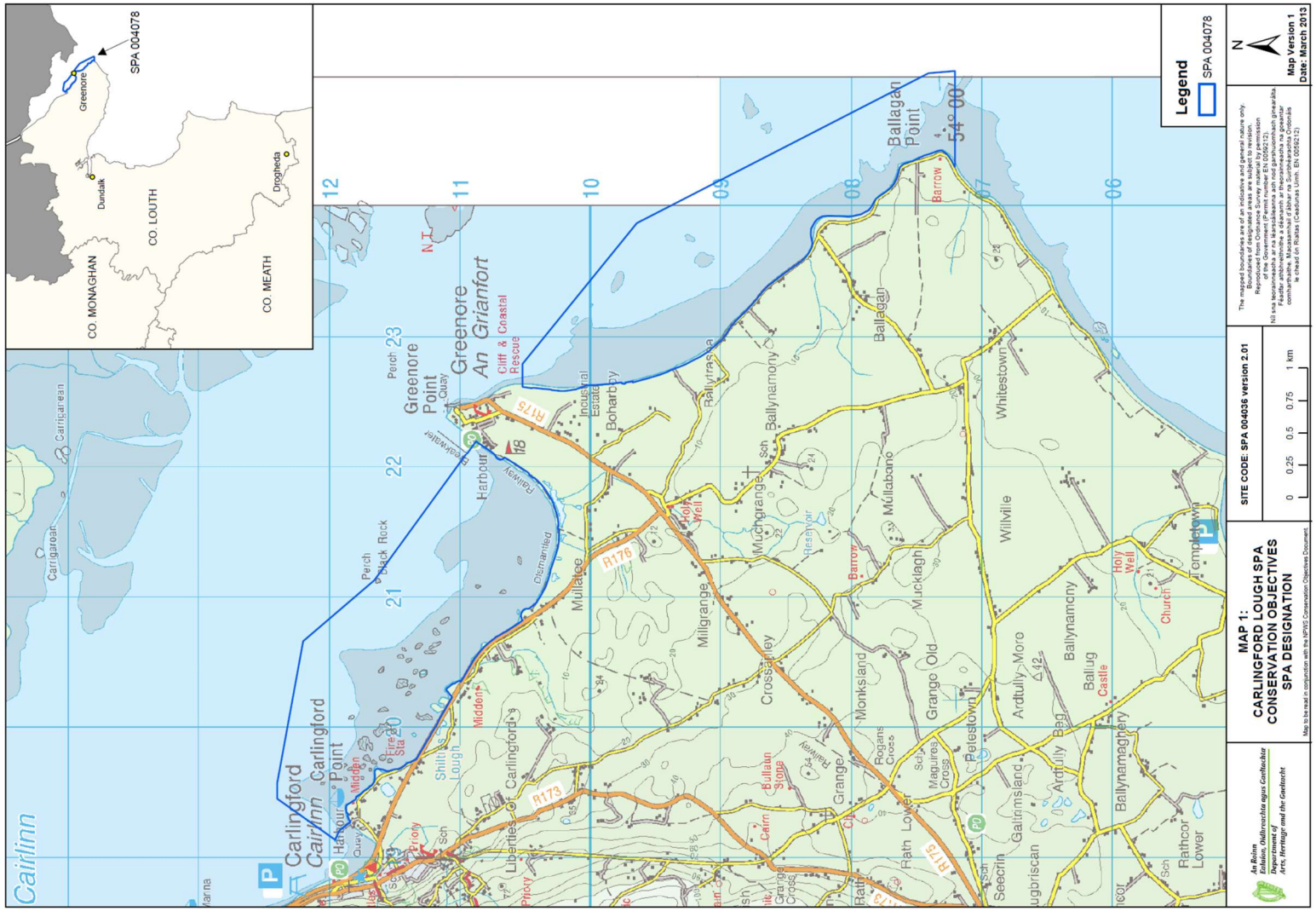


Figure A1.5 Overlapping Carlingford Shore SAC and Carlingford Lough SPA (Republic of Ireland)

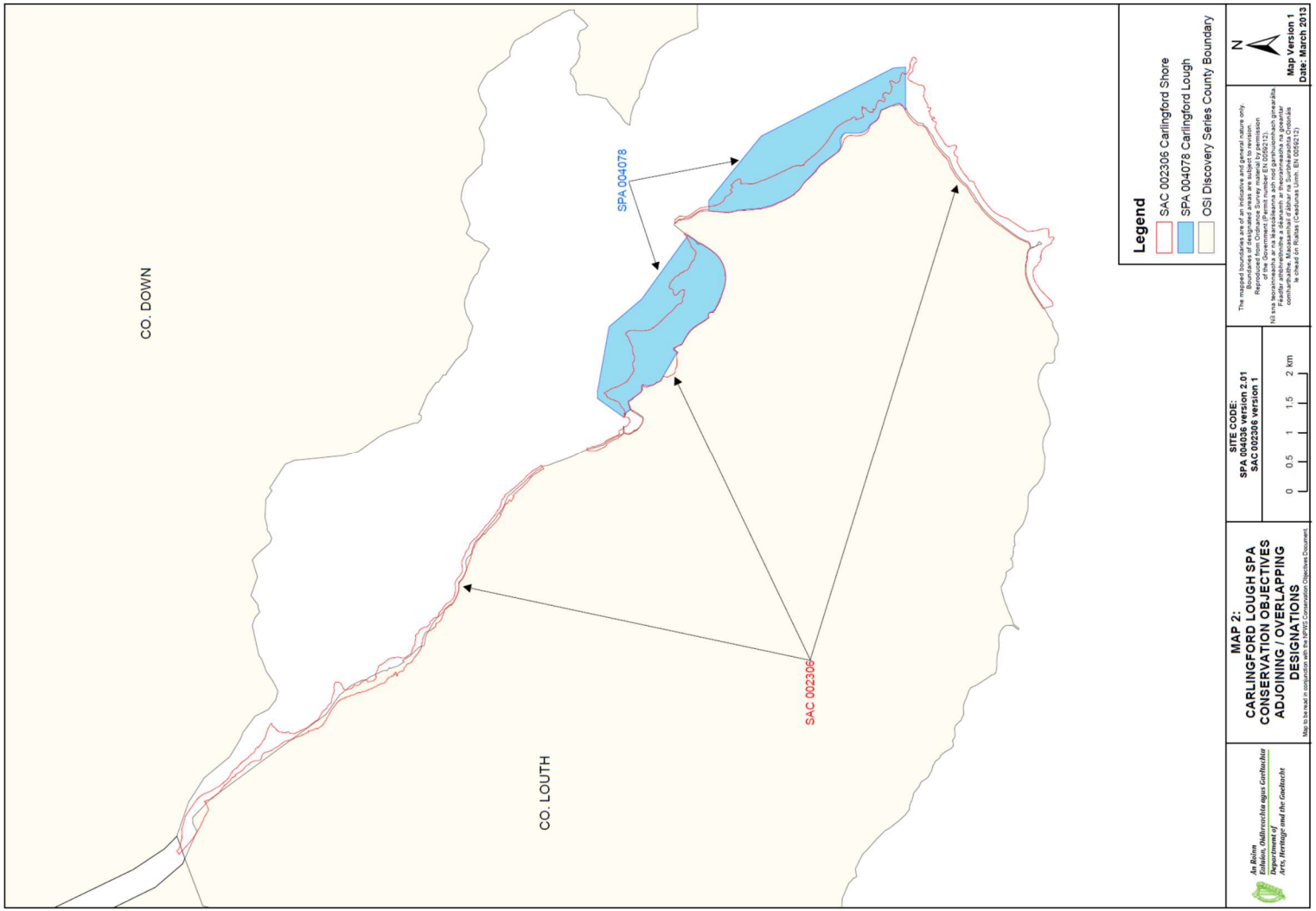
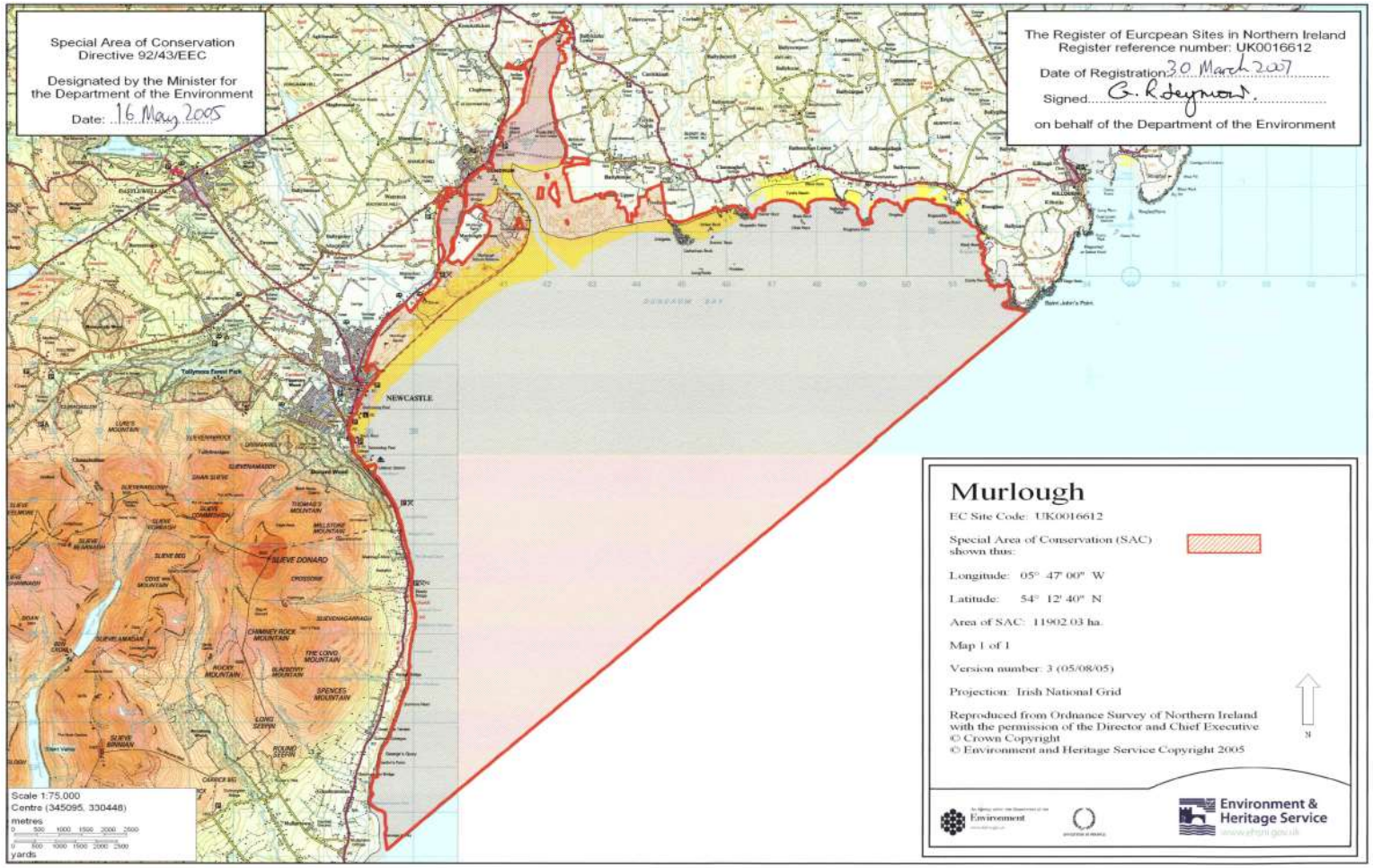


Figure A1.6 Murlough SAC (Northern Ireland)



APPENDIX 2: SUPPORTING EVIDENCE FOR THE SCREENING ASSESSMENT

Appendix A2.1 Narrative on the Potential Impact due to Sediment Dispersion

The potential impact on due to sediment dispersion can be considered in relation to the temporal and spatial extents of the following water quality parameters:

- Suspended sediment concentrations (and corresponding turbidity levels).
- Dissolved oxygen concentrations.
- Contaminant concentrations.

Baseline Conditions: Water Quality

Background water quality monitoring outside of dredging and disposal activities indicated that, in general, the baseline conditions for suspended sediment concentrations and turbidity levels within Warrenpoint Harbour and the Inner Approach Channel were highly variable and, at times, were characterised by high suspended sediment concentrations and turbidity levels, particularly around spring tides when low waters are at their lowest (AFBI, 2016).

Similarly, background water quality monitoring outside of dredging and disposal activities indicated that, in general, the baseline conditions for dissolved oxygen within Warrenpoint Harbour and the Inner Approach Channel were characterised by low dissolved oxygen concentrations, particularly around spring tides when low waters are at their lowest) (AFBI, 2016).

Baseline Conditions: Sediment Quality

In June 2023, the sediment within Warrenpoint Harbour and the Inner Approach Channel was sampled and subject to a range of tests to characterise its physical and chemical contents. Samples were taken from a range of locations within Warrenpoint Harbour and its Inner Approach Channel (see samples stations S1 to S19 in **Figure A3.1** in **Appendix 3**). The results of the tests are presented in **Appendix 3** and are summarised below.

Physically, the sediment within Warrenpoint Harbour and its Inner Approach Channel was tested to determine its principal particle sizes and its organic matter content. The results indicate that the sediment is typically composed of organic silty clay comprising silt (typically >75 per cent), sand (typically <20 per cent) and, occasionally, gravel (typically <5 per cent), and organic matter (typically 1 to 3 per cent), as shown in **Table A3.1** in **Appendix 3**.

Chemically, the sediment within Warrenpoint Harbour and the Inner Approach Channel was tested to determine the concentrations of contaminants of concern (i.e., metals, organotin compounds, polyaromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PBCs)). The results indicate that the sediment contains negligible and low levels of these contaminants.

Potential Impact on Water Quality: Suspended Sediment Concentrations

The potential impact on suspended sediment concentrations can be informed by the water quality monitoring undertaken for the maintenance dredging campaigns in 2016 and 2017 by the Agri-Food and Biosciences Institute (AFBI) on behalf of Warrenpoint Port. The purpose of the monitoring was to provide a warning system for the potential onset of environmental risks from dredging to the shellfish industry, the passage of migratory fish, and the qualifying habitats and species associated with the nearby SACs and SPAs. The water quality monitoring included real time monitoring of suspended sediment concentrations (correlated to turbidity levels) in the water column close to and

upstream of the dredging areas in Warrenpoint Harbour. Water quality monitoring of the maintenance dredging campaigns in 2016 and 2017 recorded that dredging activities did not cause a significant increase in suspended sediment concentrations (or corresponding turbidity levels). Generally, suspended sediment concentrations at the monitoring station were well below 100mg/l for most of the time during dredging; for example, during maintenance dredging in 2017, suspended sediment concentrations at the monitoring station were below 25 mg/l for 70 per cent of the time (AFBI, 2017). Occasionally, suspended sediment concentrations at the monitoring station exceeded the 218mg/l alarm threshold (correlated to 150 NTU) and the 600mg/l alert threshold (correlated to 410 NTU), but they did not exceed the 600mg/l alert threshold for a duration longer than 6 hours and, therefore, no intervention measures were deemed necessary (AFBI, 2016; AFBI, 2017).

The temporal magnitude of this impact is expected to last for the duration of an individual maintenance dredging campaign plus up to one week for residual sediment dispersion on cessation of dredging and disposal activities. The durations of individual maintenance dredging campaigns can be informed by previous campaigns: for example, maintenance dredging in 2016 lasted for approximately 5 weeks (from 03-06-2016 to 07-07-2016) and removed c.50,000m^3 sediment from the Deep Berth Pocket in Warrenpoint Harbour and the Inner Approach Channel, while maintenance dredging in 2017 lasted for approximately 7 weeks (from 30-05-2017 to 12-07-2017) and removed c.393,000m^3 sediment from the entire extent of Warrenpoint Harbour and Inner Approach Channel. In summary, the temporal magnitude of one maintenance dredging campaign is expected to be limited to a duration of up to 10 weeks.

The spatial magnitude of this impact for dredging activities is expected to be confined largely within the areas of Carlingford Lough that align with the dredging areas within Warrenpoint Harbour and the Inner Approach Channel. However, this impact is expected to extend upstream and, potentially, downstream of Warrenpoint Harbour and the Inner Approach Channel due to sediment dispersion driven by tidal currents. The spatial magnitude of this impact is informed by water quality monitoring undertaken for the previous maintenance dredging undertaken in 2016 and 2017 (AFBI, 2016; AFBI, 2017), which was based on a monitoring station being positioned immediately upstream of Warrenpoint Harbour so that it would capture sediment plumes dispersing upstream from the dredging areas in Warrenpoint Harbour, which was the most likely scenario for sediment dispersion given the flood dominant tide in Carlingford Lough and the lower reach of the Clanrye River. The water quality monitoring recorded that dredging activities did not lead to significant dispersion of sediment beyond the boundary of the dredging areas within Warrenpoint Harbour and Inner Approach Channel.

The spatial magnitude of this impact for disposal activities is expected to be confined largely within the area of the Warrenpoint B disposal site. However, this impact is expected to extend slightly beyond the boundary of the disposal site due to sediment dispersion driven by tidal currents. The spatial magnitude of this impact is informed by bathymetry monitoring undertaken for the previous maintenance dredging campaign undertaken in 2016 (Geomara, 2016). The bathymetry monitoring recorded that disposal activities did not lead to the significant dispersion of sediment beyond the boundary of the Warrenpoint B disposal site (**Figure A2.1**).

Given the above findings, the potential impact on water quality is considered to be generally negligible and occasionally low in terms of increased suspended sediment concentrations (and corresponding turbidity), temporally limited to the duration of a maintenance dredging campaign (i.e., up to c.10 weeks), and spatially limited to within and a little distance beyond the maintenance dredging areas within Warrenpoint Harbour and Inner Approach Channel, and within and a little distance beyond the Warrenpoint B disposal site.

<u>Potential Impact on Water Quality: Dissolved Oxygen Concentrations</u>

The potential impact on dissolved oxygen concentrations can be informed by the water quality monitoring undertaken for the maintenance dredging campaigns in 2016 and 2017 by the AFBI on behalf of Warrenpoint Port. The purpose of the monitoring was to provide a warning system for the potential onset of environmental risks from dredging to the shellfish industry, the passage of migratory fish, and the qualifying habitats and species associated with the nearby SACs and SPAs. The water quality monitoring included real time monitoring of dissolved oxygen concentrations (correlated to turbidity levels) in the water column close to and upstream of the dredging areas in

Warrenpoint Harbour. Water quality monitoring during maintenance dredging included real time monitoring of dissolved oxygen concentrations in the water column close to and upstream of the dredging areas in Warrenpoint Harbour. Water quality monitoring of the maintenance dredging campaigns in 2016 and 2017 recorded that the dredging did not cause a significant decrease in dissolved oxygen concentrations; although dissolved concentrations at the monitoring station fell below the 6mg/l alert threshold on a number of occasions, they did not fall below the 4mg/l alarm threshold on any occasion and, therefore, no intervention measures were deemed necessary (AFBI, 2016; AFBI, 2017).

The temporal magnitude of this impact is expected to be similar to that described above for suspended sediment (i.e., up to c. 10 weeks) because of the oxygen demand associated with the sediment dispersed during dredging and disposal activities (i.e., the majority of the oxygen demanding materials within the sediment are likely to associated with the sediment's particles (i.e., the organic matter).

The spatial magnitude of this impact for dredging activities is expected to be similar to that described above for suspended sediment (i.e., limited to within and a little distance beyond the maintenance dredging areas within Warrenpoint Harbour and Inner Approach Channel) because of the oxygen demand associated with the sediment dispersed during dredging activities.

The spatial magnitude of this impact for disposal activities is expected to be similar to that described above for suspended sediment (i.e., limited to within and a little distance beyond the Warrenpoint B disposal site) because of the oxygen demand associated with the sediment dispersed during disposal activities.

Given the above findings, the potential impact on water quality is considered to be generally negligible in terms of reduced dissolved oxygen concentrations, temporally limited to the duration of a maintenance dredging campaign (i.e., up to c.10 weeks), and spatially limited to within and a little distance beyond the maintenance dredging areas within Warrenpoint Harbour and Inner Approach Channel, and within and a little distance beyond the Warrenpoint B disposal site.

Potential Impact on Water Quality: Contaminant Concentrations

The potential impact on contaminant concentrations can be informed by the sediment quality monitoring undertaken for the maintenance dredging campaigns in 2023 by Warrenpoint Port. The purpose of the monitoring was to characterise the sediment quality in relation to sediment quality standards; namely, the Action Levels used to characterise dredged material in Northern Ireland and the Republic of Ireland, and the Gorham-Test Effects Ranges used to characterise the potential for toxic effects on benthic ecological receptors (**Table A3.2** in **Appendix 3**). The Action Levels are used in Northern Ireland and the Republic of Ireland to determine the contaminant loading of dredged material and its suitability for disposal at sea (i.e., disposal onto the seabed of open water, marine environments). Sediment with contaminant loads below Action Level 1 is generally considered suitable for disposal at sea, while sediment with contaminant loads above Action Level 2 is generally considered unsuitable and precluded from disposal at sea. The Gorham-Test Effects Ranges are used to determine the contaminant loading of sediment in relation to toxic effects on benthic communities. Sediment with contaminant loads around Effects Range Low (ERL) is generally considered to have a low potential for toxic effects (10^{th} percentile), while sediment with contaminant loads around Effects Range Median (ERM) is generally considered to have a moderate potential for toxic effects (50^{th} percentile). In summary, the sediment is believed to contain negligible and low levels of contamination because:

- The sediment within Warrenpoint Harbour and its Inner Approach Channel is characterised by contaminants generally present at concentrations that are below and slightly above the Action Level 1 used in Northern Ireland, as shown in **Tables A3.3, A3.4 and A3.5** in **Appendix 3**.
- The sediment within Warrenpoint Harbour and its Inner Approach Channel is characterised by contaminants generally present at concentrations that are below and slightly above the Action Level 1 used in the Republic of Ireland, as shown in **Tables A3.6, A3.7 and A3.8** in **Appendix 3**.

- The sediment within Warrenpoint Harbour and its Inner Approach Channel is characterised by contaminants generally present at concentrations that are below and slightly above the ERL used to indicate the potential for toxic effects on benthic ecological receptors, as shown in **Table A3.9** in **Appendix 3**.

The temporal magnitude of this impact is expected to be similar to that described above for suspended sediment (i.e., up to c. 10 weeks) because of the partitioning behaviour of the contaminants associated with the sediment dispersed during dredging and disposal activities (i.e., the majority of the contaminants within the sediment are likely to associated with the sediment's particles (i.e., contaminants attached or absorbed to the sediment's particle surfaces).

The spatial magnitude of this impact for dredging activities is expected to be similar to that described above for suspended sediment (i.e., limited to within and a little distance beyond the maintenance dredging areas within Warrenpoint Harbour and Inner Approach Channel) because of the partitioning behaviour of the contaminants associated with the sediment dispersed during dredging activities.

The spatial magnitude of this impact for disposal activities is expected to be similar to that described above for suspended sediment (i.e., limited to within and a little distance beyond the Warrenpoint B disposal site) because of the partitioning behaviour of the contaminants associated with the sediment dispersed during disposal activities.

Given the above findings, the potential impact on water quality is considered to be generally negligible in terms of increased contaminant concentrations, temporally limited to the duration of a maintenance dredging campaign (i.e., up to c.10 weeks), and spatially limited to within and a little distance beyond the maintenance dredging areas within Warrenpoint Harbour and Inner Approach Channel, and within and a little distance beyond the Warrenpoint B disposal site.

Conclusion

Given the above findings, the potential impact due to sediment dispersion is considered to be:

- Negligible (occasionally low) in terms of increased suspended sediment concentrations.
- Negligible in terms of decreased dissolved oxygen concentrations.
- Negligible in terms of increased contaminant concentrations.
- Temporally limited to the duration of a maintenance dredging campaign (i.e., up to c.10 weeks).
- Spatially limited to within and a little distance beyond Warrenpoint Harbour and Inner Approach Channel.

Appendix A2.2 Narrative on the Potential Impact due to Sediment Deposition

The potential impact on due to sediment deposition can be considered in relation to the temporal and spatial extents of the following benthic smothering parameters:

- Changes to seabed substrate and benthic faunal communities within the Warrenpoint B disposal site.
- Potential for changes to seabed substrate and benthic faunal communities beyond the Warrenpoint B disposal site.

Potential Impact on Benthic Habitat and Communities: Warrenpoint B Disposal Site

Monitoring surveys have been undertaken at the Warrenpoint B disposal site to determine the nature of the seabed substrate and its faunal communities prior to and after sediment deposition associated with capital and maintenance dredging campaigns within Warrenpoint Harbour and its Inner Approach Channel.

AFBI (2009) conducted surveys in early 2009 before and after the deposition of c.127,000m^3 of sediment. The findings of these surveys are described below.

The pre-dredge survey of the disposal site was undertaken on 9 January 2009 and involved four independent video transects covering a total of approximately 1990m of the seafloor. The survey found that the seabed was characterised by a significant covering of silt type material over rocks and boulders and some limited areas of shell material. The faunal community included mobile species such as crustaceans (*Cancer pagurus*, *Pagurus bernhardus*, and *Nephrops norvegicus*), echinoderms (*Asterias rubens*), anemone (*Metridium senile*) and fish (which could not be identified to species level), as well as some barnacle encrusted material. Nephrops were observed in their burrows.

The post-dredge survey of the disposal site was undertaken on 27 April 2009 and involved five independent video transects covering a total of approximately 2030m of the seafloor. The survey found that the seabed was characterised by a sediment type was similar to what was observed prior to sediment deposition with a significant silt component covering rocks and boulders. The fauna community was also very similar to what was observed prior to sediment deposition, with more Nephrops in burrows and the addition of, echinoderms (*Crossaster papposus*, *Henricia purpureum*), tunicates (*Ascidiella*), and the Cnidarian (*Alcyonium digitatum*). The deposited sediment was observed at disposal site and was noted to have been either quickly colonised by Nephrops or to have not completely smothered existing benthic communities.

Overall, AFBI (2009) concluded that there was no obvious difference in the characteristics of the seabed habitat between the two surveys, with both mobile and sedentary faunal species noted on both survey occasions.

Potential Impact on Benthic Habitat and Communities: Beyond the Warrenpoint B Disposal Site

Monitoring surveys have been undertaken at the Warrenpoint B disposal site to determine the bathymetry of the seabed prior to and after sediment deposition associated with capital and maintenance dredging campaigns within Warrenpoint Harbour and its Inner Approach Channel.

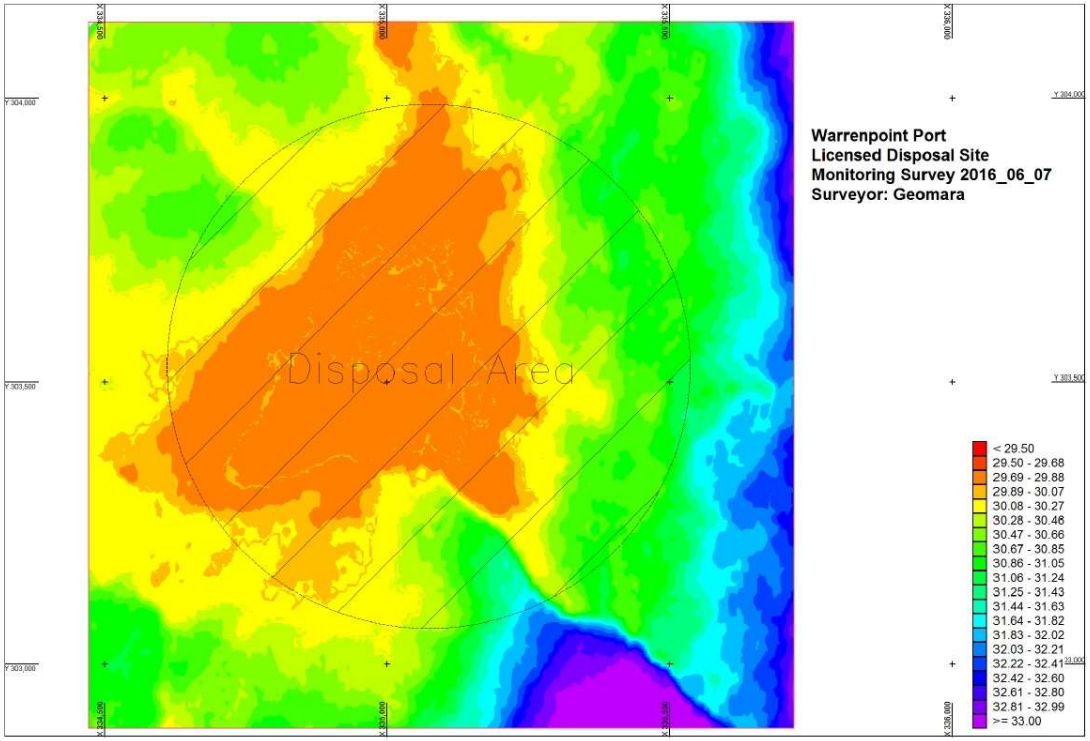
Geomara (2016) conducted a survey in 2016 after the deposition of c.50,000m^3 of sediment. The bathymetry of the seabed indicates that the extent of sediment deposition and dispersion on the seabed and, therefore, the extent of a potential impact on benthic habitat and communities (e.g., a smothering impact) is likely to be spatially limited beyond the boundary of the disposal site (**Figure A2.1**).

Conclusion

Given the above findings, the potential impact due to sediment deposition is considered to be:

- Negligible in terms of changes to seabed substrate.
- Negligible in terms of changes to benthic faunal communities.
- Spatially limited to within and a little distance beyond the Warrenpoint B disposal site.

Figure A2.1 Bathymetry Monitoring to Determine the Spatial Extent of Sediment Deposition at and around the Warrenpoint B Disposal Site as a result of the Maintenance Dredging Campaign undertaken in 2016 (source: Geomara, 2016)



Appendix A2.3 Narrative on the Potential Impact on Harbour Seal due to Underwater Noise associated with Trailing Suction Hopper Dredgers

The potential impact on harbour seal due to underwater noise from TSHDs can be considered in relation to the following parameters:

- Auditory injury as a permanent threshold shift (PTS) (i.e., permanent hearing loss) or a temporary threshold shift (TTS) (i.e., temporary hearing loss).
- Disturbance as a chronic disruption of behaviour or a displacement from an area with subsequent redistribution being significantly different from that occurring due to natural variation.

Different types of marine mammals have different hearing ranges. The National Oceanic and Atmospheric Administration (NOAA) (2023) identify the general hearing range of phocid pinnipeds (i.e., true seals, including harbour seal) to be between 50Hz to 86kHz. Nachtsheim et al. (2023) identify the most sensitive hearing range for harbour seal to be between 0.2kHz and 40kHz.

Impact Criteria: Onset Thresholds

Different types of marine mammals have different onset thresholds for auditory injury and behavioural disturbance. Onset thresholds for auditory injury are presented as sound exposure levels (SELs) that accumulate over a 24-hour period, and are measured in units of dB re 1µPa^{2}s and are defined at a distance of 1m from the source. Onset thresholds for behavioural disturbance are presented as root mean square (RMS) sound pressure levels (i.e., the average of variations in sound pressure over a specific time period), and are measured in units of dB re 1µPa and are defined at a distance of 1m from the source.

The onset thresholds auditory injury and disturbance to pinnipeds are identified in the tables below (**Tables A2.1 and A2.2**, respectively). The onset thresholds for auditory injury (**Table A2.1**) are weighted to represent the hearing ranges across which acoustic exposures can have auditory effects on pinnipeds. It is important to note that the onset thresholds for auditory injury can be considered very precautionary because they do not take into account the potential for hearing recovery in between subsequent exposure intervals and, therefore, they are likely to overestimate hearing damage caused by time varying exposure, and because they use hearing range weightings for marine mammal groups which are considerably wider than the best hearing ranges for individual marine mammal species (Xodus, 2015).

Table A.2.1 Auditory Injury Onset Thresholds for Pinnipeds (sources: Southall et al., 2007; NOAA, 2023)

Sound Source	Onset Thresholds (Southall et al. 2007)	Onset Thresholds (NOAA, 2023)
	Sound Exposure Level (dB re 1 µPa^{2}s)	Sound Exposure Level (dB re 1 µPa^{2}s)
Intermittent impulsive	186	185
Continuous, non-impulsive	203	201

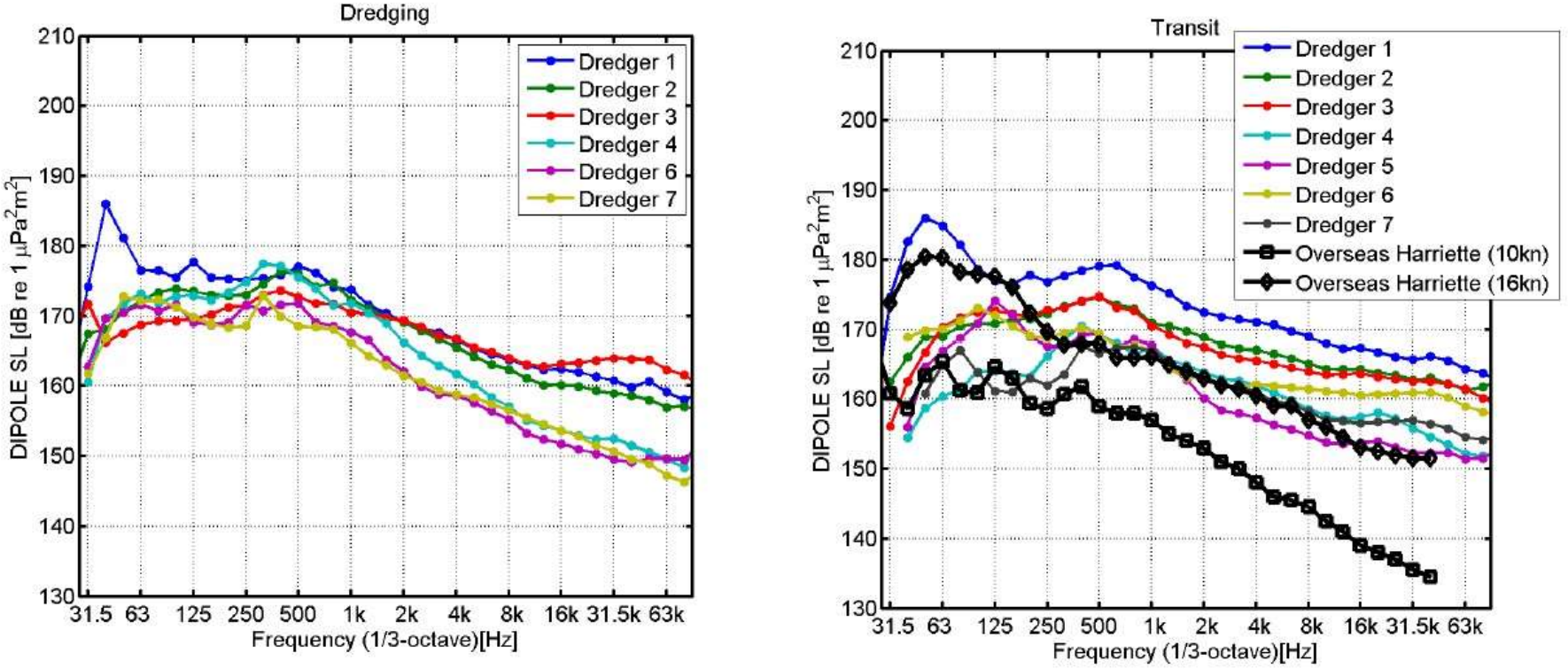
Table A.2.2 Behavioural Disturbance Onset Thresholds for Pinnipeds (sources: Southall et al., 2007; NOAA, 2023)

Sound Source	Onset Thresholds (Southall et al. 2007)	Onset Thresholds (NOAA, 2023)
	RMS Sound Pressure Level (dB re 1 µPa)	RMS Sound Pressure Level (dB re 1 µPa)
Intermittent impulsive	160	160
Continuous, non-impulsive	120	120

Indicative Sound Pressure Levels from Dredging Operations

De Jong et al. (2010) recorded and reported on the underwater sound levels generated by seven TSHDs working on the construction of a port development in the Netherlands, including the noise source levels generated during dredging and transiting activities. For both dredging activity (**Figure A2.2 left**) and transiting activity (**Figure A2.2 right**), the average noise source levels from the seven THSDs were generally below 180dB in the most sensitive hearing range for harbour seal (i.e., between 0.2kHz and 40kHz). For transiting activity (**Figure A2.2 right**), the average noise source levels from the seven THSDs were generally similar to or higher than the average noise sources from a transiting cargo vessel (*Overseas Hariette*) in the most sensitive hearing range for harbour seal (i.e., between 0.2kHz and 40kHz). Propeller cavitation was believed to be the principal noise source from TSHDs during both dredging and transiting activity and from cargo vessel transiting activity, albeit subject to transiting speed.

Figure A2.2 Noise Source Levels from Seven TSHDs during Construction of Massvlakte 2: Dredging Activity (left) and Transiting Activity (right) (source: de Jong et al., 2010)



Indicative Impact Zones from Dredging Operations

Xodus (2015) derived indicative impact zones for auditory injury and disturbance based on the underwater sound levels generated by a TSHD working on the construction of an offshore windfarm in the UK, and generating the following sound levels at a distance of 1m:

- SEL over a 24-hour period of 237dB re 1 μPa^2s.
- RMS sound pressure level of 188dB re 1 µPa.

It should be noted that the TSHD in this study was using dynamic positioning thrusters and, therefore, was believed to have generated higher sound levels than would be typically expected for TSHDs where the principal sound source relates to propeller cavitation.

The indicative impact zones are:

- Radius of potential auditory injury zone for pinnipeds assuming continuous exposure over a 24-hour period of 50m.
- Radius of potential disturbance zone for all marine mammals including pinnipeds: 5km.

Potential for an Auditory Injury Impact on Harbour Seal due to Dredging and Transiting Activities

On the basis of the sound exposure levels and sound pressure levels generated by a TSHD, both dredging and transiting activities are unlikely to exceed the onset thresholds for auditory injury to pinnipeds including harbour seal, even in close proximity to the TSHD. Given the narrow 50m radius of the impact zone identified by Xodus (2015), a harbour seal would have to remain within 50m of a TSHD and continuous dredging activity and/or transiting activity for a 24-hour period to experience an auditory injury. Given the high mobility of harbour seal and given the distribution and location of the various harbour seal haul out sites within Carlingford Lough (**Table A2.3**), it is extremely unlikely that a harbour seal would be sufficiently exposed to sound levels to cause the onset of auditory injury.

Table A2.3 Harbour Seal Haul Out Sites in Carlingford Lough (source: Wilson et al., 2012)

Site Location	Distance from Dredging Areas within Warrenpoint Harbour and the Inner Approach Channel	Distance from Disposal Area at Warrenpoint B Disposal Site
Ballyedmond	4km	16.8km
Carlingford Island	5.2km	15.5km
Carriganean	5.3km	15.4km
Mill Bay	7.2km	13.5km
Green Island (North)	8.1km	12.4km
Green Island (South)	8.2km	12.3km
Blockhouse Island	9.7km	10.9km
Blockhouse Island Reef 1	10.2km	10.5km
Blockhouse Island Reef 2	10.1km	10.5km
Greenore	10km	10.8km

Potential for a Disturbance Impact on Harbour Seal due to Dredging and Transiting Activities

On the basis of the sound exposure levels and sound pressure levels generated by a TSHD, both dredging and transiting activities are unlikely to exceed the onset thresholds for disturbance to pinnipeds including harbour seal. Despite the wide 5km radius of the impact zone identified by Xodus (2015), a harbour seal would have to remain within 5km of a TSHD and dredging activity and/or transiting activity to experience a disturbance impact. Given the high mobility of harbour seal and given the distribution and location of the various harbour seal haul out sites within Carlingford Lough (**Table A2.3**), it is extremely unlikely that a harbour seal would be sufficiently exposed to sound levels to cause a chronic disruption of behaviour or a displacement from a haul out with subsequent redistribution being significantly different from that occurring due to natural variation. Notably, Wilson et al. (2012) identified that the sites used by the largest numbers of adult and sub-adult harbour seal in both June to July and August to September seasons were at Green Island, followed by Blockhouse Island (shingle beach), Carlingford Island, Carriganean and Mill Bay, which are all situated more than 5km from the dredging areas within Warrenport Harbour and the Inner Approach Channel. Also, given the existing level of cargo vessels transiting along Carlingford Lough to access Warrenpoint Port, it is likely that harbour seal have adapted their behaviour in relation to exposure to the underwater noise associated with cargo vessel transits.

APPENDIX 3: SEDIMENT CONTAMINATION DATA AND COMPARISON TO QUALITY STANDARDS

Figure A3.1 Sample Identification: Sampling Station Location

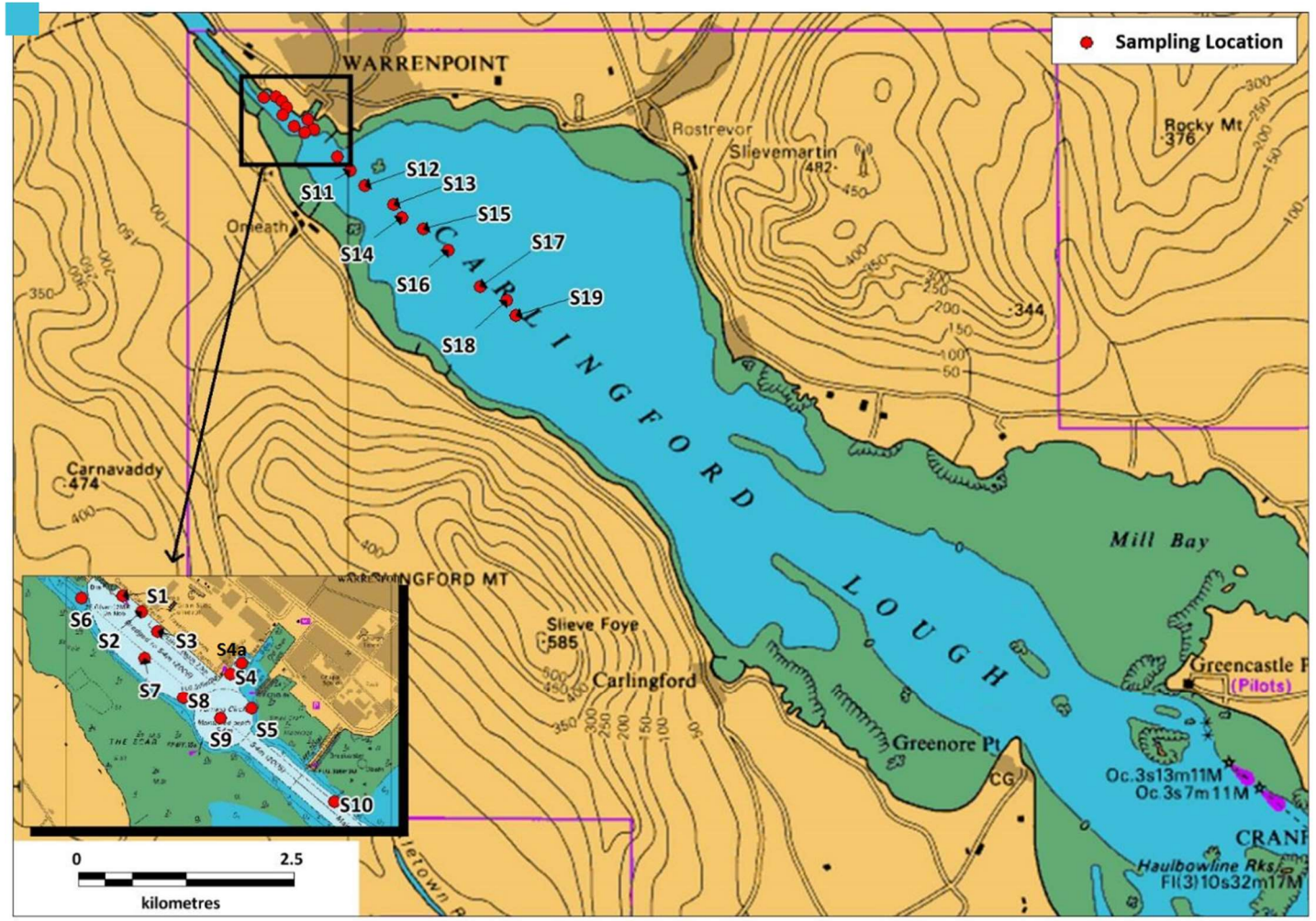


Table A.3.1 Sediment Composition

Sample ID	% Total Moisture	% Total Solids	% Gravel (>2mm)	% Sand (0.063-2mm)	% Silt (<0.063mm)	% Total Organic Carbon
S1 0.0m	67.8	32.2	0.00	11.92	88.08	1.70
S2 0.0m	68.4	31.6	2.96	13.96	83.07	2.42
S3 0.0m	66.7	33.3	0.00	13.96	86.04	2.50
S4 0.0m	66.9	33.1	0.00	12.76	87.24	2.42
S4a 0.0m	66.6	33.4	0.00	10.79	89.21	2.39
S5 0.0m	62.3	37.7	11.62	13.56	74.82	2.46
S6 0.0m	67.1	32.9	0.00	14.10	85.90	2.83
S7 0.0m	69.9	30.1	0.00	12.08	87.92	2.42
S8 0.0m	53.0	47.0	0.77	13.86	85.37	1.60
S9 0.0m	66.4	33.6	2.88	14.70	82.42	2.48
S10 0.0m	62.2	37.8	0.00	22.86	77.14	1.74
S11 0.0m	60.2	39.8	0.00	35.17	64.83	1.85
S12 0.0m	58.1	41.9	0.00	27.14	72.86	1.65
S13 0.0m	61.6	38.4	1.12	13.27	85.61	1.96
S14 0.0m	63.1	36.9	0.00	17.79	82.21	1.73
S15 0.0m	60.5	39.5	0.00	34.26	65.74	1.52
S16 0.0m	61.0	39.0	0.05	17.63	82.32	1.63
S17 0.0m	50.1	49.9	0.00	27.10	72.90	1.52
S18 0.0m	60.6	39.4	0.00	43.73	56.27	0.97
S19 0.0m	44.8	55.2	0.00	45.81	54.19	0.91
S4a 2.2m	61.3	38.7	0.00	12.75	87.25	2.44
S4a-1.2m	68.0	32.0	0.00	14.23	85.77	2.59
S4 2.2m	58.6	41.4	0.00	15.26	84.74	2.37
S4 1.2m	61.6	38.4	0.00	14.38	85.62	2.80
S3 1.7m	58.0	42.0	0.00	18.24	81.76	2.78
S1 1.8m	57.8	42.2	0.00	13.51	86.49	2.29
S10 1.3m	46.6	53.4	2.64	24.83	72.54	1.99
S12 1.6m	49.2	50.8	0.00	15.24	84.76	2.26
S13 1.0m	48.8	51.2	0.00	17.56	82.44	1.98
S14 1.4m	44.6	55.4	0.00	18.83	81.17	2.19

Table A3.2 Sediment Quality Standards

Contaminant	Units	Northern Ireland		Republic of Ireland		Gorham-Test Effects Range	
		Acton Level 1	Action Level 2	Acton Level 1	Action Level 2	Low	Medium
Arsenic	$mg.kg^{-1}$ dry weight	20	100	20	70		
Cadmium	$mg.kg^{-1}$ dry weight	0.4	5	0.7	4.2		
Chromium	$mg.kg^{-1}$ dry weight	40	400	120	370		
Copper	$mg.kg^{-1}$ dry weight	40	400	40	110		
Mercury	$mg.kg^{-1}$ dry weight	0.3	3	0.2	0.7		
Nickel	$mg.kg^{-1}$ dry weight	20	200	40	60		
Lead	$mg.kg^{-1}$ dry weight	50	500	60	218		
Zinc	$mg.kg^{-1}$ dry weight	130	800	160	410		
Organo-tins: TBT and DBT	$mg.kg^{-1}$ dry weight	0.1	1	0.1	0.5		
PCBs: sum ICES 7	$\mu g.kg^{-1}$ dry weight	10		7	1,260		
PCBs: sum 25 congeners	$\mu g.kg^{-1}$ dry weight	20	200				
PAHs: individual	$\mu g.kg^{-1}$ dry weight	100					
PAHs: acenaphthene	$\mu g.kg^{-1}$ dry weight					44	640
PAHs: acenaphthylene	$\mu g.kg^{-1}$ dry weight					16	500
PAHs: anthracene	$\mu g.kg^{-1}$ dry weight					85	1,100
PAHs: benz[a]anthracene	$\mu g.kg^{-1}$ dry weight					261	1,600
PAHs: chrysene	$\mu g.kg^{-1}$ dry weight					384	2,800
PAHs: dibenz[a,h]anthracene	$\mu g.kg^{-1}$ dry weight					63	260
PAHs: fluoranthene	$\mu g.kg^{-1}$ dry weight					600	5,100
PAHs: fluorene	$\mu g.kg^{-1}$ dry weight					19	540
PAHs: naphthalene	$\mu g.kg^{-1}$ dry weight					160	2,100
PAHs: phenanthrene	$\mu g.kg^{-1}$ dry weight					240	1,500
PAHs: pyrene	$\mu g.kg^{-1}$ dry weight					665	2,600
PAHs: sum USEPA 16	$\mu g.kg^{-1}$ dry weight			4,000			
DDT	$\mu g.kg^{-1}$ dry weight	1					
Dieldrin	$\mu g.kg^{-1}$ dry weight	5					
TEH	$g.kg^{-1}$ dry weight			1			
γHCH	$\mu g.kg^{-1}$ dry weight			0.3	1		
HCB	$\mu g.kg^{-1}$ dry weight			0.3	1		

Key to Sediment Contaminant Data Comparison to Sediment Quality Standards

Indicator	Data Comparison to Sediment Quality Standards
	Data is below Action Level 1 / Gorham-Test Effects Range Low
	Data is above Action level 1 and below Action Level 2 / above Gorham-Test Effects Range Low and below Gorham-Test Effects Range Median
	Data is above Action Level 2 / above Gorham-Test Effects Range Median
	Not applicable as there is no Action Level / Gorham-Test Effects Range

Table A3.3 Sediment Contamination: Metals and Organo-tins (mg.kg^{-1} dry weight) compared to Northern Ireland Action Levels

Sample ID	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc	Dibutyltin	Tributyltin
S1 0.0m	11.7	0.26	69.8	21.6	27.6	<0.01	30.6	91.3	<0.005	<0.005
S2 0.0m	16.9	0.39	99.2	37.2	45.5	<0.01	47.5	187	<0.005	<0.005
S3 0.0m	18.4	0.51	102	35.8	47.4	<0.01	45.0	173	<0.005	<0.005
S4 0.0m	19.9	0.48	107	36.2	50.3	<0.01	47.3	176	<0.005	<0.005
S4a 0.0m	20.2	0.48	105	36.1	49.8	<0.01	48.0	177	<0.005	<0.005
S5 0.0m	16.0	0.39	92.5	30.1	42.6	<0.01	42.1	151	<0.005	<0.005
S6 0.0m	18.1	0.51	98.2	38.7	49.7	<0.01	44.6	185	<0.005	<0.005
S7 0.0m	25.6	0.65	140	51.2	69.1	0.03	62.8	243	<0.005	<0.005
S8 0.0m	14.8	0.39	90.5	28.6	42.5	<0.01	38.4	141	<0.005	<0.005
S9 0.0m	17.4	0.45	96.4	32.0	46.4	<0.01	43.1	160	<0.005	<0.005
S10 0.0m	15.2	0.38	86.2	26.0	41.2	<0.01	37.8	132	<0.005	<0.005
S11 0.0m	15.1	0.31	85.0	24.6	38.9	<0.01	37.4	127	<0.005	<0.005
S12 0.0m	14.9	0.30	87.9	24.8	37.0	<0.01	36.6	120	<0.005	<0.005
S13 0.0m	15.7	0.30	88.1	23.7	39.4	<0.01	37.6	128	<0.005	<0.005
S14 0.0m	16.0	0.30	86.6	24.8	39.0	<0.01	38.3	128	<0.005	<0.005
S15 0.0m	15.1	0.28	85.7	22.1	35.2	<0.01	38	114	<0.005	<0.005
S16 0.0m	16.5	0.28	89.9	23.7	39.2	<0.01	39.4	124	<0.005	<0.005
S17 0.0m	13.6	0.22	83.4	19.7	34.7	<0.01	35.7	109	<0.005	<0.005
S18 0.0m	11.1	0.15	65.7	13.9	27.2	<0.01	29.6	75.7	<0.005	<0.005
S19 0.0m	8.6	0.15	66.2	16.2	26.2	<0.01	25.3	64.8	<0.005	<0.005
S4a 2.2m	16.1	0.29	89.6	36.4	52.7	0.21	43.3	169	<0.005	<0.005
S4a-1.2m	17.8	0.33	87.2	36.6	54.8	0.20	42.0	177	<0.005	<0.005
S4 2.2m	18.6	0.27	81.6	33.0	52.9	0.22	39.2	159	<0.005	<0.005
S4 1.2m	18.5	0.36	82.9	35.7	54.4	0.17	41.6	168	<0.005	<0.005
S3 1.7m	18.5	0.33	81.6	34.3	54.0	0.17	40.1	164	<0.005	<0.005
S1 1.8m	15.9	0.35	80.0	37.4	51.0	0.15	41.8	156	<0.005	<0.005
S10 1.3m	14.0	0.29	71.1	25.8	43.9	0.12	34.4	133	<0.005	0.0165
S12 1.6m	16.5	0.26	78.4	27.9	49.2	0.14	37.8	144	<0.005	<0.005
S13 1.0m	16.2	0.30	81.7	29.0	56.5	0.21	38.9	155	<0.005	<0.005
S14 1.4m	17.9	0.29	85.1	28.8	52.0	0.13	41.3	153	<0.005	<0.005

Table A3.4 Sediment Contamination: PAHs (µg.kg^{-1} dry weight) compared to Northern Ireland Action Levels

Sample ID	Acenaphthene	Acenaphthylene	Anthracene	Benz[a]anthracene	Benzo[a]pyrene	Benzo[b]fluoranthene	Benzo[g,h,i]perylene	Benzo[k]fluoranthene
S1 0.0m	<5	<5	20.0	68.9	99.8	101	92.5	110
S2 0.0m	<5	<5	23.6	60.8	79.5	101	86.0	117
S3 0.0m	28.1	<5	29.4	57.7	77.5	109	81.7	101
S4 0.0m	<5	<5	19.8	73.6	88.6	124	97.8	107
S4a 0.0m	<5	<5	<5	57.3	76.6	102	75.5	86.1
S5 0.0m	<5	<5	19.2	66.6	91.0	108	89.5	104
S6 0.0m	<5	<5	26.2	105	140	159	135	164
S7 0.0m	<5	<5	21.4	84.4	95.4	116	98.2	108
S8 0.0m	<5	<5	14.6	45.2	51.4	79.6	60.5	66.4
S9 0.0m	<5	<5	15.0	88.7	138	148	132	141
S10 0.0m	<5	<5	22.2	90.3	89.5	113	89.4	105
S11 0.0m	<5	16.2	42.9	151	139	146	117	153
S12 0.0m	<5	<5	<5	48.3	58.3	67.1	55.4	66.1
S13 0.0m	<5	<5	<5	44.6	56.3	69.3	56.3	70.4
S14 0.0m	<5	<5	15.2	74.0	82.4	83.2	79.7	111
S15 0.0m	<5	<5	35.0	40.7	52.9	61.5	53.3	66.9
S16 0.0m	<5	<5	14.8	60.1	65.3	118	69.9	85.3
S17 0.0m	<5	<5	10.6	32.6	40.1	61.1	42.4	47.0
S18 0.0m	<5	<5	13.7	54.6	72.3	123	84.0	80.3
S19 0.0m	<5	<5	9.17	21.7	27.5	35.1	27.8	24.2
S4a 2.2m	9.17	11.6	35.9	124	155	170	143	204
S4a-1.2m	9.31	9.22	22.0	70.8	87.6	137	114	141
S4 2.2m	8.24	11.4	33.8	111	152	166	130	158
S4 1.2m	18.0	11.0	26.5	78.8	121	113	112	173
S3 1.7m	6.73	8.07	20.9	62.1	89.9	115	96.6	107
S1 1.8m	8.44	12.7	26.5	89.6	129	159	131	165
S10 1.3m	2.03	2.88	7.85	22.2	29.5	33.2	24.0	26.7
S12 1.6m	5.53	7.58	20.4	66.4	93.6	146	105	123
S13 1.0m	8.60	15.2	34.3	105	157	206	168	182
S14 1.4m	8.13	22.4	46.0	179	204	205	150	218

Table A3.4 continued Sediment Contamination: PAHs (µg.kg^{-1} dry weight) compared to Northern Ireland Action Levels

Sample ID	Chrysene	Dibenz[a,h]anthracene	Fluoranthene	Fluorene	Indeno[1,2,3-c,d]pyrene	Naphthalene	Phenanthrene	Pyrene	Sum of USEPA 16
S1 0.0m	87.3	16.6	136	24.2	113	44.1	73.6	114	1,111.00
S2 0.0m	79.6	<5	143	26.2	94.9	34.1	68.2	121	<1,049.90
S3 0.0m	77.8	18.2	375	60.2	103	39.0	298	243	1,703.6
S4 0.0m	90.6	17.3	145	25.9	108	38.1	81.6	124	1,151.3
S4a 0.0m	72.0	13.1	101	15.1	91.6	28.1	57.1	97.9	888.40
S5 0.0m	84.2	18.1	120	22.4	93.0	34.1	64.0	113	1,037.10
S6 0.0m	120	19.2	167	27.6	147	42.2	73.8	167	1,503.0
S7 0.0m	106	18.5	154	26.4	117	35.2	87.7	139	1,217.2
S8 0.0m	51.5	<5	78.0	14.9	62.6	50.8	43.6	76.0	<710.10
S9 0.0m	105	17.7	143	23.5	147	40.5	69.4	136	1,354.80
S10 0.0m	98.6	14.6	169	23.6	98.3	32.0	77.6	147	1,180.1
S11 0.0m	159	24.1	339	21.8	136	41.2	117	267	1,875.2
S12 0.0m	56.8	<5	86.2	15.6	64.2	28.3	45.9	74.6	<686.80
S13 0.0m	53.0	<5	89.1	17.7	65.3	26.8	49.9	77.0	<695.70
S14 0.0m	84.8	<5	112	21.8	84.2	37.6	60.4	107	<968.3
S15 0.0m	52.4	<5	72.1	15.6	53.7	23.9	50.9	65.1	<281.3
S16 0.0m	74.1	<5	102	19.1	85.0	27.1	60.3	87.4	<381
S17 0.0m	37.2	<5	59.2	13.3	45.7	22.0	40.9	53.0	<520.1
S18 0.0m	69.2	13.5	97.7	16.7	81.9	30.3	53.4	95.7	896.3
S19 0.0m	28.3	<5	42.4	<5	29.8	16.1	32.8	39.8	<354.7
S4a 2.2m	144	30.1	240	33.2	160	48.2	121	211	1,840.17
S4a-1.2m	88.3	22.3	141	25.8	127	44.5	75.9	135	1,250.73
S4 2.2m	142	28.3	224	30.1	158	48.6	117	193	1,711.44
S4 1.2m	107	23.5	162	30.2	134	46.4	85.8	152	1,394.2
S3 1.7m	87.2	19.9	128	24.0	117	38.8	78.5	114	1,113.70
S1 1.8m	119	27.0	176	30.5	158	48.2	100	160	1,539.94
S10 1.3m	26.9	5.15	44.4	5.92	26.8	7.88	26.1	40.8	332.31
S12 1.6m	89.3	22.0	127	21.1	122	38.9	75.8	115	1,178.61
S13 1.0m	129	34.1	190	30.6	190	53.2	99.1	186	1,788.10
S14 1.4m	207	33.3	375	40.4	171	34.1	239	332	2,464.33

Table A3.5 Sediment Contamination: PCBs (µg.kg^{-1} dry weight) compared to Northern Ireland Action Levels

Sample ID	PCB28	PCB52	PCB101	PCB118	PCB138	PCB153	PCB180	Sum of ICES 7
S1 0.0m	0.20	0.25	0.15	0.29	0.10	0.23	0.10	1.32
S2 0.0m	0.30	0.33	0.13	0.24	0.17	0.19	0.11	1.47
S3 0.0m	0.18	0.22	0.14	0.30	0.09	0.18	<0.08	<1.19
S4 0.0m	0.36	0.65	0.71	1.00	0.62	0.76	0.53	4.63
S4a 0.0m	0.17	0.19	0.10	0.32	0.16	0.18	<0.08	1.20
S5 0.0m	0.16	0.14	0.09	0.18	0.15	0.14	0.09	0.95
S6 0.0m	0.19	0.22	<0.08	0.21	0.14	0.21	0.14	1.19
S7 0.0m	0.34	0.70	0.55	0.79	0.55	0.57	0.60	4.10
S8 0.0m	0.13	0.15	0.10	0.15	0.12	0.18	0.11	0.94
S9 0.0m	0.15	0.11	<0.08	0.28	0.21	0.19	<0.08	<1.10
S10 0.0m	0.10	0.09	<0.08	0.18	<0.08	0.11	<0.08	<0.72
S11 0.0m	0.11	0.10	<0.08	0.18	0.12	0.14	<0.08	<0.81
S12 0.0m	0.09	0.09	<0.08	0.08	0.08	0.12	<0.08	<0.62
S13 0.0m	0.15	0.13	<0.08	0.22	0.17	0.12	<0.08	<0.95
S14 0.0m	0.12	0.12	0.12	0.12	<0.08	0.15	0.08	<0.79
S15 0.0m	0.09	0.10	<0.08	0.09	0.10	0.11	<0.08	<0.65
S16 0.0m	0.10	0.11	0.16	0.31	0.24	0.23	0.08	<1.23
S17 0.0m	0.19	0.23	0.10	0.19	0.14	0.20	<0.08	<1.13
S18 0.0m	<0.08	<0.08	<0.08	0.09	<0.08	<0.08	<0.08	<0.49
S19 0.0m	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.56
S4a 2.2m	0.23	0.13	0.14	0.22	0.15	0.21	0.11	1.19
S4a-1.2m	0.21	0.10	0.12	0.21	0.20	0.17	<0.08	<1.09
S4 2.2m	0.18	0.12	0.15	0.15	0.26	0.29	0.15	1.30
S4 1.2m	0.19	0.10	0.10	0.23	0.21	0.30	<0.08	<1.21
S3 1.7m	0.23	0.11	0.13	0.22	0.15	0.19	0.09	1.12
S1 1.8m	0.58	0.44	0.38	0.44	0.33	0.54	0.35	3.06
S10 1.3m	0.17	0.09	0.10	0.14	0.19	0.25	<0.08	<1.02
S12 1.6m	0.22	0.15	0.12	0.19	0.25	0.30	0.08	1.31
S13 1.0m	0.21	0.14	0.19	0.22	0.19	0.31	<0.08	<1.34
S14 1.4m	0.21	0.12	0.13	0.22	0.22	0.26	<0.08	<1.24

Table A3.6 Sediment Contamination: Metals and Organo-tins (mg.kg^{-1} dry weight) compared to Republic of Ireland Action Levels

Sample ID	Arsenic	Cadmium	Chromium	Copper	Lead	Mercury	Nickel	Zinc	Dibutyltin	Tributyltin
S1 0.0m	11.7	0.26	69.8	21.6	27.6	<0.01	30.6	91.3	<0.005	<0.005
S2 0.0m	16.9	0.39	99.2	37.2	45.5	<0.01	47.5	187	<0.005	<0.005
S3 0.0m	18.4	0.51	102	35.8	47.4	<0.01	45.0	173	<0.005	<0.005
S4 0.0m	19.9	0.48	107	36.2	50.3	<0.01	47.3	176	<0.005	<0.005
S4a 0.0m	20.2	0.48	105	36.1	49.8	<0.01	48.0	177	<0.005	<0.005
S5 0.0m	16.0	0.39	92.5	30.1	42.6	<0.01	42.1	151	<0.005	<0.005
S6 0.0m	18.1	0.51	98.2	38.7	49.7	<0.01	44.6	185	<0.005	<0.005
S7 0.0m	25.6	0.65	140	51.2	69.1	0.03	62.8	243	<0.005	<0.005
S8 0.0m	14.8	0.39	90.5	28.6	42.5	<0.01	38.4	141	<0.005	<0.005
S9 0.0m	17.4	0.45	96.4	32.0	46.4	<0.01	43.1	160	<0.005	<0.005
S10 0.0m	15.2	0.38	86.2	26.0	41.2	<0.01	37.8	132	<0.005	<0.005
S11 0.0m	15.1	0.31	85.0	24.6	38.9	<0.01	37.4	127	<0.005	<0.005
S12 0.0m	14.9	0.30	87.9	24.8	37.0	<0.01	36.6	120	<0.005	<0.005
S13 0.0m	15.7	0.30	88.1	23.7	39.4	<0.01	37.6	128	<0.005	<0.005
S14 0.0m	16.0	0.30	86.6	24.8	39.0	<0.01	38.3	128	<0.005	<0.005
S15 0.0m	15.1	0.28	85.7	22.1	35.2	<0.01	38	114	<0.005	<0.005
S16 0.0m	16.5	0.28	89.9	23.7	39.2	<0.01	39.4	124	<0.005	<0.005
S17 0.0m	13.6	0.22	83.4	19.7	34.7	<0.01	35.7	109	<0.005	<0.005
S18 0.0m	11.1	0.15	65.7	13.9	27.2	<0.01	29.6	75.7	<0.005	<0.005
S19 0.0m	8.6	0.15	66.2	16.2	26.2	<0.01	25.3	64.8	<0.005	<0.005
S4a 2.2m	16.1	0.29	89.6	36.4	52.7	0.21	43.3	169	<0.005	<0.005
S4a-1.2m	17.8	0.33	87.2	36.6	54.8	0.20	42.0	177	<0.005	<0.005
S4 2.2m	18.6	0.27	81.6	33.0	52.9	0.22	39.2	159	<0.005	<0.005
S4 1.2m	18.5	0.36	82.9	35.7	54.4	0.17	41.6	168	<0.005	<0.005
S3 1.7m	18.5	0.33	81.6	34.3	54.0	0.17	40.1	164	<0.005	<0.005
S1 1.8m	15.9	0.35	80.0	37.4	51.0	0.15	41.8	156	<0.005	<0.005
S10 1.3m	14.0	0.29	71.1	25.8	43.9	0.12	34.4	133	<0.005	0.0165
S12 1.6m	16.5	0.26	78.4	27.9	49.2	0.14	37.8	144	<0.005	<0.005
S13 1.0m	16.2	0.30	81.7	29.0	56.5	0.21	38.9	155	<0.005	<0.005
S14 1.4m	17.9	0.29	85.1	28.8	52.0	0.13	41.3	153	<0.005	<0.005

Table A3.7 Sediment Contamination: PAHs (µg.kg^{-1} dry weight) compared to Republic of Ireland Action Levels

Sample ID	Acenaphthene	Acenaphthylene	Anthracene	Benz[a]anthracene	Benzo[a]pyrene	Benzo[b]fluoranthene	Benzo[g,h,i]perylene	Benzo[k]fluoranthene
S1 0.0m	<5	<5	20.0	68.9	99.8	101	92.5	110
S2 0.0m	<5	<5	23.6	60.8	79.5	101	86.0	117
S3 0.0m	28.1	<5	29.4	57.7	77.5	109	81.7	101
S4 0.0m	<5	<5	19.8	73.6	88.6	124	97.8	107
S4a 0.0m	<5	<5	<5	57.3	76.6	102	75.5	86.1
S5 0.0m	<5	<5	19.2	66.6	91.0	108	89.5	104
S6 0.0m	<5	<5	26.2	105	140	159	135	164
S7 0.0m	<5	<5	21.4	84.4	95.4	116	98.2	108
S8 0.0m	<5	<5	14.6	45.2	51.4	79.6	60.5	66.4
S9 0.0m	<5	<5	15.0	88.7	138	148	132	141
S10 0.0m	<5	<5	22.2	90.3	89.5	113	89.4	105
S11 0.0m	<5	16.2	42.9	151	139	146	117	153
S12 0.0m	<5	<5	<5	48.3	58.3	67.1	55.4	66.1
S13 0.0m	<5	<5	<5	44.6	56.3	69.3	56.3	70.4
S14 0.0m	<5	<5	15.2	74.0	82.4	83.2	79.7	111
S15 0.0m	<5	<5	35.0	40.7	52.9	61.5	53.3	66.9
S16 0.0m	<5	<5	14.8	60.1	65.3	118	69.9	85.3
S17 0.0m	<5	<5	10.6	32.6	40.1	61.1	42.4	47.0
S18 0.0m	<5	<5	13.7	54.6	72.3	123	84.0	80.3
S19 0.0m	<5	<5	9.17	21.7	27.5	35.1	27.8	24.2
S4a 2.2m	9.17	11.6	35.9	124	155	170	143	204
S4a-1.2m	9.31	9.22	22.0	70.8	87.6	137	114	141
S4 2.2m	8.24	11.4	33.8	111	152	166	130	158
S4 1.2m	18.0	11.0	26.5	78.8	121	113	112	173
S3 1.7m	6.73	8.07	20.9	62.1	89.9	115	96.6	107
S1 1.8m	8.44	12.7	26.5	89.6	129	159	131	165
S10 1.3m	2.03	2.88	7.85	22.2	29.5	33.2	24.0	26.7
S12 1.6m	5.53	7.58	20.4	66.4	93.6	146	105	123
S13 1.0m	8.60	15.2	34.3	105	157	206	168	182
S14 1.4m	8.13	22.4	46.0	179	204	205	150	218

Table A3.7 continued Sediment Contamination: PAHs (µg.kg^{-1} dry weight) compared to Republic of Ireland Action Levels

Sample ID	Chrysene	Dibenz[a,h]anthracene	Fluoranthene	Fluorene	Indeno[1,2,3-c,d]pyrene	Naphthalene	Phenanthrene	Pyrene	Sum of USEPA 16
S1 0.0m	87.3	16.6	136	24.2	113	44.1	73.6	114	1,111.00
S2 0.0m	79.6	<5	143	26.2	94.9	34.1	68.2	121	<1,049.90
S3 0.0m	77.8	18.2	375	60.2	103	39.0	298	243	1,703.6
S4 0.0m	90.6	17.3	145	25.9	108	38.1	81.6	124	1,151.3
S4a 0.0m	72.0	13.1	101	15.1	91.6	28.1	57.1	97.9	888.40
S5 0.0m	84.2	18.1	120	22.4	93.0	34.1	64.0	113	1,037.10
S6 0.0m	120	19.2	167	27.6	147	42.2	73.8	167	1,503.0
S7 0.0m	106	18.5	154	26.4	117	35.2	87.7	139	1,217.2
S8 0.0m	51.5	<5	78.0	14.9	62.6	50.8	43.6	76.0	<710.10
S9 0.0m	105	17.7	143	23.5	147	40.5	69.4	136	1,354.80
S10 0.0m	98.6	14.6	169	23.6	98.3	32.0	77.6	147	1,180.1
S11 0.0m	159	24.1	339	21.8	136	41.2	117	267	1,875.2
S12 0.0m	56.8	<5	86.2	15.6	64.2	28.3	45.9	74.6	<686.80
S13 0.0m	53.0	<5	89.1	17.7	65.3	26.8	49.9	77.0	<695.70
S14 0.0m	84.8	<5	112	21.8	84.2	37.6	60.4	107	<968.3
S15 0.0m	52.4	<5	72.1	15.6	53.7	23.9	50.9	65.1	<281.3
S16 0.0m	74.1	<5	102	19.1	85.0	27.1	60.3	87.4	<381
S17 0.0m	37.2	<5	59.2	13.3	45.7	22.0	40.9	53.0	<520.1
S18 0.0m	69.2	13.5	97.7	16.7	81.9	30.3	53.4	95.7	896.3
S19 0.0m	28.3	<5	42.4	<5	29.8	16.1	32.8	39.8	<354.7
S4a 2.2m	144	30.1	240	33.2	160	48.2	121	211	1,840.17
S4a-1.2m	88.3	22.3	141	25.8	127	44.5	75.9	135	1,250.73
S4 2.2m	142	28.3	224	30.1	158	48.6	117	193	1,711.44
S4 1.2m	107	23.5	162	30.2	134	46.4	85.8	152	1,394.2
S3 1.7m	87.2	19.9	128	24.0	117	38.8	78.5	114	1,113.70
S1 1.8m	119	27.0	176	30.5	158	48.2	100	160	1,539.94
S10 1.3m	26.9	5.15	44.4	5.92	26.8	7.88	26.1	40.8	332.31
S12 1.6m	89.3	22.0	127	21.1	122	38.9	75.8	115	1,178.61
S13 1.0m	129	34.1	190	30.6	190	53.2	99.1	186	1,788.10
S14 1.4m	207	33.3	375	40.4	171	34.1	239	332	2,464.33

Table A3.8 Sediment Contamination: PCBs (µg.kg^{-1} dry weight) compared to Republic of Ireland Action Levels

Sample ID	PCB28	PCB52	PCB101	PCB118	PCB138	PCB153	PCB180	Sum of ICES 7
S1 0.0m	0.20	0.25	0.15	0.29	0.10	0.23	0.10	1.32
S2 0.0m	0.30	0.33	0.13	0.24	0.17	0.19	0.11	1.47
S3 0.0m	0.18	0.22	0.14	0.30	0.09	0.18	<0.08	<1.19
S4 0.0m	0.36	0.65	0.71	1.00	0.62	0.76	0.53	4.63
S4a 0.0m	0.17	0.19	0.10	0.32	0.16	0.18	<0.08	1.20
S5 0.0m	0.16	0.14	0.09	0.18	0.15	0.14	0.09	0.95
S6 0.0m	0.19	0.22	<0.08	0.21	0.14	0.21	0.14	1.19
S7 0.0m	0.34	0.70	0.55	0.79	0.55	0.57	0.60	4.10
S8 0.0m	0.13	0.15	0.10	0.15	0.12	0.18	0.11	0.94
S9 0.0m	0.15	0.11	<0.08	0.28	0.21	0.19	<0.08	<1.10
S10 0.0m	0.10	0.09	<0.08	0.18	<0.08	0.11	<0.08	<0.72
S11 0.0m	0.11	0.10	<0.08	0.18	0.12	0.14	<0.08	<0.81
S12 0.0m	0.09	0.09	<0.08	0.08	0.08	0.12	<0.08	<0.62
S13 0.0m	0.15	0.13	<0.08	0.22	0.17	0.12	<0.08	<0.95
S14 0.0m	0.12	0.12	0.12	0.12	<0.08	0.15	0.08	<0.79
S15 0.0m	0.09	0.10	<0.08	0.09	0.10	0.11	<0.08	<0.65
S16 0.0m	0.10	0.11	0.16	0.31	0.24	0.23	0.08	<1.23
S17 0.0m	0.19	0.23	0.10	0.19	0.14	0.20	<0.08	<1.13
S18 0.0m	<0.08	<0.08	<0.08	0.09	<0.08	<0.08	<0.08	<0.49
S19 0.0m	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.56
S4a 2.2m	0.23	0.13	0.14	0.22	0.15	0.21	0.11	1.19
S4a-1.2m	0.21	0.10	0.12	0.21	0.20	0.17	<0.08	<1.09
S4 2.2m	0.18	0.12	0.15	0.15	0.26	0.29	0.15	1.30
S4 1.2m	0.19	0.10	0.10	0.23	0.21	0.30	<0.08	<1.21
S3 1.7m	0.23	0.11	0.13	0.22	0.15	0.19	0.09	1.12
S1 1.8m	0.58	0.44	0.38	0.44	0.33	0.54	0.35	3.06
S10 1.3m	0.17	0.09	0.10	0.14	0.19	0.25	<0.08	<1.02
S12 1.6m	0.22	0.15	0.12	0.19	0.25	0.30	0.08	1.31
S13 1.0m	0.21	0.14	0.19	0.22	0.19	0.31	<0.08	<1.34
S14 1.4m	0.21	0.12	0.13	0.22	0.22	0.26	<0.08	<1.24

Table A3.9 Sediment Contamination: PAHs (µg.kg^{-1} dry weight) compared to Gorham-Test Effects Ranges

Sample ID	Acenaphthene	Acenaphthylene	Anthracene	Benz[a]anthracene	Benzo[a]pyrene	Benzo[b]fluoranthene	Benzo[g,h,i]perylene	Benzo[k]fluoranthene
S1 0.0m	<5	<5	20.0	68.9	99.8	101	92.5	110
S2 0.0m	<5	<5	23.6	60.8	79.5	101	86.0	117
S3 0.0m	28.1	<5	29.4	57.7	77.5	109	81.7	101
S4 0.0m	<5	<5	19.8	73.6	88.6	124	97.8	107
S4a 0.0m	<5	<5	<5	57.3	76.6	102	75.5	86.1
S5 0.0m	<5	<5	19.2	66.6	91.0	108	89.5	104
S6 0.0m	<5	<5	26.2	105	140	159	135	164
S7 0.0m	<5	<5	21.4	84.4	95.4	116	98.2	108
S8 0.0m	<5	<5	14.6	45.2	51.4	79.6	60.5	66.4
S9 0.0m	<5	<5	15.0	88.7	138	148	132	141
S10 0.0m	<5	<5	22.2	90.3	89.5	113	89.4	105
S11 0.0m	<5	16.2	42.9	151	139	146	117	153
S12 0.0m	<5	<5	<5	48.3	58.3	67.1	55.4	66.1
S13 0.0m	<5	<5	<5	44.6	56.3	69.3	56.3	70.4
S14 0.0m	<5	<5	15.2	74.0	82.4	83.2	79.7	111
S15 0.0m	<5	<5	35.0	40.7	52.9	61.5	53.3	66.9
S16 0.0m	<5	<5	14.8	60.1	65.3	118	69.9	85.3
S17 0.0m	<5	<5	10.6	32.6	40.1	61.1	42.4	47.0
S18 0.0m	<5	<5	13.7	54.6	72.3	123	84.0	80.3
S19 0.0m	<5	<5	9.17	21.7	27.5	35.1	27.8	24.2
S4a 2.2m	9.17	11.6	35.9	124	155	170	143	204
S4a-1.2m	9.31	9.22	22.0	70.8	87.6	137	114	141
S4 2.2m	8.24	11.4	33.8	111	152	166	130	158
S4 1.2m	18.0	11.0	26.5	78.8	121	113	112	173
S3 1.7m	6.73	8.07	20.9	62.1	89.9	115	96.6	107
S1 1.8m	8.44	12.7	26.5	89.6	129	159	131	165
S10 1.3m	2.03	2.88	7.85	22.2	29.5	33.2	24.0	26.7
S12 1.6m	5.53	7.58	20.4	66.4	93.6	146	105	123
S13 1.0m	8.60	15.2	34.3	105	157	206	168	182
S14 1.4m	8.13	22.4	46.0	179	204	205	150	218

Table A3.9 continued Sediment Contamination: PAHs (µg.kg^{-1} dry weight) compared to Gorham-Test Effects Ranges

Sample ID	Chrysene	Dibenz[a,h]anthracene	Fluoranthene	Fluorene	Indeno[1,2,3-c,d]pyrene	Naphthalene	Phenanthrene	Pyrene	Sum of USEPA 16
S1 0.0m	87.3	16.6	136	24.2	113	44.1	73.6	114	1,111.00
S2 0.0m	79.6	<5	143	26.2	94.9	34.1	68.2	121	<1,049.90
S3 0.0m	77.8	18.2	375	60.2	103	39.0	298	243	1,703.6
S4 0.0m	90.6	17.3	145	25.9	108	38.1	81.6	124	1,151.3
S4a 0.0m	72.0	13.1	101	15.1	91.6	28.1	57.1	97.9	888.40
S5 0.0m	84.2	18.1	120	22.4	93.0	34.1	64.0	113	1,037.10
S6 0.0m	120	19.2	167	27.6	147	42.2	73.8	167	1,503.0
S7 0.0m	106	18.5	154	26.4	117	35.2	87.7	139	1,217.2
S8 0.0m	51.5	<5	78.0	14.9	62.6	50.8	43.6	76.0	<710.10
S9 0.0m	105	17.7	143	23.5	147	40.5	69.4	136	1,354.80
S10 0.0m	98.6	14.6	169	23.6	98.3	32.0	77.6	147	1,180.1
S11 0.0m	159	24.1	339	21.8	136	41.2	117	267	1,875.2
S12 0.0m	56.8	<5	86.2	15.6	64.2	28.3	45.9	74.6	<686.80
S13 0.0m	53.0	<5	89.1	17.7	65.3	26.8	49.9	77.0	<695.70
S14 0.0m	84.8	<5	112	21.8	84.2	37.6	60.4	107	<968.3
S15 0.0m	52.4	<5	72.1	15.6	53.7	23.9	50.9	65.1	<281.3
S16 0.0m	74.1	<5	102	19.1	85.0	27.1	60.3	87.4	<381
S17 0.0m	37.2	<5	59.2	13.3	45.7	22.0	40.9	53.0	<520.1
S18 0.0m	69.2	13.5	97.7	16.7	81.9	30.3	53.4	95.7	896.3
S19 0.0m	28.3	<5	42.4	<5	29.8	16.1	32.8	39.8	<354.7
S4a 2.2m	144	30.1	240	33.2	160	48.2	121	211	1,840.17
S4a-1.2m	88.3	22.3	141	25.8	127	44.5	75.9	135	1,250.73
S4 2.2m	142	28.3	224	30.1	158	48.6	117	193	1,711.44
S4 1.2m	107	23.5	162	30.2	134	46.4	85.8	152	1,394.2
S3 1.7m	87.2	19.9	128	24.0	117	38.8	78.5	114	1,113.70
S1 1.8m	119	27.0	176	30.5	158	48.2	100	160	1,539.94
S10 1.3m	26.9	5.15	44.4	5.92	26.8	7.88	26.1	40.8	332.31
S12 1.6m	89.3	22.0	127	21.1	122	38.9	75.8	115	1,178.61
S13 1.0m	129	34.1	190	30.6	190	53.2	99.1	186	1,788.10
S14 1.4m	207	33.3	375	40.4	171	34.1	239	332	2,464.33