



River Hamble Maintenance Dredge Plan

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River Hamble Harbour Authority

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Summary

This Dredge Management Plan has been developed by ABP Marine Environmental Research Ltd (ABPmer) on behalf of the River Hamble Harbour Authority (RHHA) in association with participating marina and boatyard owners on the River Hamble. The aim of this document is to collate relevant information to assist operators and regulators seeking, or giving approval, for maintenance dredging activities that could potentially affect European designated sites.

Designated habitats within the River Hamble are components of the Solent and Southampton Water Special Protection Area (SPA) and Ramsar Site and the whole estuary is a component of the Solent Maritime Special Area of Conservation (SAC). The marine sites of these areas are a component of the Solent European Marine Sites (SEMS), protected under The Conservation of Habitats and Species Regulations 2010, commonly referred to as the 'Habitats Regulations'.

Dredging operations in the River Hamble have continued in marinas and berths for many years in support of important recreational boating activity. Between 1986 and 2010 the average volume of maintenance dredging has been estimated at about 16,000m³. With respect to the disposal of the maintenance-dredged material from the River Hamble, the majority of this material is deposited at the Nab Tower (WI060) licensed sea disposal site, with smaller amounts being deposited at the Hurst Spit/Fort (WI080) disposal site during bad weather.

This document assesses the changes that the current dredging practices are likely to cause within the estuary and then these changes are assessed against environmental receptors of importance within the Hamble. The overall assessment is that, based on the information that currently exists, the current maintenance dredging regime (that which existed between 1986 and 2010) has negligible impact on the main environmental features of the estuary, and does not affect their favourable status with respect to the Habitats Regulations. This assessment is based on current information, which will be reviewed annually and the document amended accordingly, if necessary. It could and should therefore be used to assist the process of seeking subsequent consents subject to any new legislation, planning policy guidance or EC Directives.

With regards to the Water Framework Directive (WFD), the current dredging and disposal on the River Hamble as detailed within this Dredge Management Plan document, complies with WFD and Environmental Quality Standards Directive (EQSD) objectives. Although various water bodies are presently failing to meet 'good' status/potential across some parameters, this failing cannot be attributed (directly or indirectly) to ongoing established maintenance dredging activities. Furthermore, the continuation of maintenance dredging and the subsequent disposal of material at licensed sea disposal sites as described by this assessment, is unlikely to prevent a water body which is not at good status from reaching its WFD objective in relation to those parameters which are currently failing.

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1. Introduction

1.1 Purpose of Study

The Hamble Dredge Management Plan has been prepared by the River Hamble Harbour Authority (RHHA) to strategically consider maintenance dredging activities within the River Hamble. It is the Government's view, supported by rulings in the European Court of Justice, that maintenance dredging should be considered as a 'plan or project' for the purposes of the EC Habitats Directive (92/43/EEC), and assessed in accordance with Article 6(3) of that Directive (Defra, 2007). A requirement therefore exists to ensure that maintenance dredging operations with the potential to affect Natura 2000 (N2K) sites are considered in a wider sediment management context.

To fulfil this obligation the RHHA (part of Hampshire County Council (HCC)), who are the Harbour Authority for the River Hamble, and the participating marinas and boatyards in the River Hamble have commissioned ABP Marine Environmental Research Ltd (ABPmer) to compile this Dredge Management Plan. The aim of this document is to make the process of assessing the effect of maintenance dredging more explicit for all parties by collating relevant information into a single 'Baseline Document', providing those wishing to carry out maintenance dredging on the River Hamble with relevant information to inform an assessment of their activities.

In addition to the requirements of the Habitat Regulations, this document also addresses requirements under the EU Water Framework Directive (WFD) (2000/60/EC) and the EU Environmental Quality Standards Directive (EQSD) (2008/105/EC) in respect of maintenance dredging and disposal. The lead authority for overseeing the implementation of the WFD within England is the Environment Agency.

This Dredge Management Plan therefore aims to provide an agreed basis for the licensing authority to consider maintenance dredge applications. The presumption, in assessing any potential consequences of dredging activity, is that maintenance dredging will continue in line with established practice. To establish existing maintenance dredge activities, this document has drawn on existing and readily available information, and presents the current and historical patterns of dredging in relation to the conservation status of the designated sites.

1.2 Need for Dredging

The River Hamble represents a major recreational boating centre in the Solent providing economic benefits to a range of associated businesses and local communities. It has been estimated that there are well over 3,000 moorings within the Hamble with significant recreational boating activity in the summer and racing seasons (RHHA, 2003).

To maintain adequate water depth in the various boat yards and marinas maintenance dredging must be undertaken for the most part on an intermittent basis.

In accordance with Section 20 of Statutory Instrument 1970 No. 249, The Harbours, Docks, Piers and Ferries, The River Hamble Harbour Revision Order 1969, Hampshire County Council has statutory powers to dredge and maintain the River Hamble. This legislation also allows for disposal of material (or beneficial use) within the river provided that consent is given by the appropriate regulator (in this case the Marine Management Organisation (MMO)) through a Marine Licence (from 6 April 2011) or through the Food and Environment Protection Act 1985 (FEPA) and Coast Protection Act 1949 (CPA) previous to the Marine Licence.

1.3 Report Structure

The main role of this report is to provide an agreed basis for the licensing authority to consider maintenance dredge applications and make an assessment of the likely impact of maintenance dredging on environmental receptors within the Hamble Estuary.

The structure of this report is as follows:

- | | |
|------------------|--|
| Section 1 | Introduction: Provides context for the study summarising and the need for dredging. |
| Section 2 | Legislation: Details the legislation context behind dredging licenses and the Marine Navigation Dredging Framework under the Water Framework Directive. |
| Section 3 | Conservation Status: Provides a description of the conservation status of the River Hamble and relevant Nature Conservation Objectives. |
| Section 4 | Dredging Review Summary: Summarises the historical patterns of dredging within the Hamble. |
| Section 5 | Background Environmental Conditions: Presents baseline understanding of physical processes, water quality and sediment contamination within the estuary. |
| Section 6 | Change Analysis: Presents information on likely change to the marine environment as a consequence of maintenance dredging. |
| Section 7 | Impact Assessment: Provides baseline environmental information and evaluates the potential effects of maintenance dredging on Natura 2000 features of interest. |
| Section 8 | Discussion: Discuss the effects of the current dredging regime on the working of the estuary and the main areas of impact identified. |

2. Legislation

Marine navigation dredging (both capital and maintenance dredging) and disposal are highly regulated activities due to their potential to negatively affect the environment if they are not carefully considered and controlled. Dredging activities are primarily licensed under application to the MMO, a new executive non-departmental public body (NDPB) established and given powers under the Marine and Coastal Access Act 2009. Also, where powers to dredge in Harbour Areas are conferred by Acts of Parliament, local works or dredge licences issued by the Harbour Authority may permit dredging (and other activities) within the scope of the special Act under which they are issued. The following section details the legislative context in which this Dredge Management Plan has been drafted.

2.1 National Legislation

Dredge and disposal operations are regulated by the MMO, using powers conferred primarily through the 'Marine and Coastal Access Act' 2009. This Act has established a single Marine Licence, which came into effect on 6 April 2011. Previous to the implementation date of the Marine Licence, dredge and disposal operations were regulated by two separate Parliamentary Acts; the first is the Coast Protection Act (CPA) 1949 as amended by Section 36 of the Merchant Shipping Act 1988. The second Act regulated disposal of dredged material at sea, and is termed the 'Food and Environment Protection Act (FEPA) 1985 (as amended)'. The FEPA licence provided the basic environmental control for sea disposal of dredged material and regulated beneficial use.

2.2 Maintenance Dredging Under the Habitats Regulations

Under Regulation 61 of the Habitat Regulations all competent authorities are required to carry out an Appropriate Assessment if the proposed works are within or adjacent to a designated European Marine Site (EMS) and if they are likely to have a 'significant effect' on the site, either alone or in combination with other 'plans and projects'. The UK Government considers that maintenance dredging proposals, which could potentially affect an EMS, need assessing in accordance with Article 6(3) of the Habitats Directive (Defra, 2007). In effect this means that ongoing maintenance dredging should be considered as a relevant 'plan or project' and requires its effects on the EMS to be considered according to a specified procedural framework that may result in a requirement for an Appropriate Assessment prior to any consent being granted.

This Dredge Management Plan is intended to use readily available information, drawing upon existing information, to describe the current and historical patterns of dredging in relation to the conservation status of the EMS. It is the desire of the RHHA that the licensing authority (MMO) will use this document as a reference point to provide a basis against which maintenance dredging applications can be assessed. It is anticipated that this process will streamline the consenting procedure.

2.3 Maintenance Dredging Under the Water Framework Directive

The EU Water Framework Directive (WFD) (2000/60/EC), which came into force on 22 December 2000, is implemented in the National water regulations of the Member States. The Directive establishes a new approach to the protection, improvement and sustainable use of Europe's rivers, lakes, estuaries, coastal waters and groundwater. The Directive applies to all surface waters out to 1 nautical mile (nm) seaward of the baseline for territorial waters and to ground waters. For management purposes, surface and ground waters are divided into a number of discrete units termed 'water bodies'.

The WFD is implemented in England and Wales through the 'Water Environment (Water Framework Directive) (England and Wales) Regulations 2003' (commonly termed the Water Framework Regulations). The WFD introduces new broader ecological objectives, designed to protect and where necessary, restore the structure and function of aquatic ecosystems themselves and thereby safeguarding the sustainable use of water resources (UK TAG, 2009).

Under the Regulations, the Environment Agency is the competent authority for implementation of the Directive in England and Wales. Programmes of measures have been developed through a process of river basin management planning and are set out in a number of regionally based River Basin Management Plans (RBMPs) formally published in December 2009. To help those undertaking navigational dredging and disposal activities to comply with the requirements of the WFD in transitional (estuary) and coastal water bodies, the Environment Agency has published the 'Marine dredging guidance for compliance with the Water Framework Directive' (Environment Agency, 2010). This guidance framework is expanded upon in Appendix A of this document, with the additional collation of relevant material and the required assessment.

3. Conservation Status

The Hamble Estuary is very sheltered with a complex tidal regime, narrow entrances and fast tidal currents, which are considered typical characteristic of those found in the Solent. The river can be broadly divided into the upper estuary (north of the M27 bridge), which contain many relatively unspoilt habitats of significant conservation value, and lower estuary (south of the M27 bridge), which have rather more fragmented habitats (but still of significant conservation value) set amongst the largest recreational boating centre in Europe.

All the marine and coastal fringing habitats and the species they support within the Hamble Estuary are protected to varying degrees under International and National legislation. They include the Solent European Marine Site (SEMS), which comprises the Solent Maritime Special Area of Conservation (SAC) and the Solent and Southampton Water Special Protection Area (SPA) and Ramsar Site. The spatial extent of these designations is provided in Figure 1.

The most significant of these designated habitats and species are outlined in Natural England's advice on Regulation 35 of the Conservation of Habitats and Species Regulations 2010 (referred to as the Habitats Regulations within this document). This advice was formerly provided under Regulation 33(2) of the Conservation (Natural Habitats, &c.) Regulations, 1994.

The recent update of the 1994 Habitats Regulations with the latest 2010 publication has changed the regulation advice section number, within the context of this document; reference to Regulation 33 should be read as Regulation 35.

There are a number of site-specific designations for nature conservation within the Hamble Estuary at the following locations:

- Upper Hamble and Woods Site of Special Scientific Interest (SSSI) (a component of the SPA/SAC);
- Lincegrove and Hackett's Marsh SSSI and Local Nature Reserve (component of SPA/SAC);
- Hook and Warsash Local Nature Reserve (component of SPA);
- Mercury Marshes Local Nature Reserve (component of SPA);
- Hamsworth Row National Trust Nature Reserve (component of SPA);
- Holly Hill Woodland Park;
- Hamble SINC's (Site of Importance for Nature Conservation) including areas not designated in SPA;
- Manor Farm and Upper Hamble Country Park (parts designated as SINC); and
- Lee-on-The-Solent to Itchen Estuary SSSI.

The following sections consider the designations outlined under the Solent European Marine Site (i.e. SEMS, SAC and SPA) in more detail, as this will form the basis on which the environmental effects of dredging activities within the Hamble Estuary will be assessed.

3.1 Solent European Marine Sites

The Hamble Estuary forms part of the SEMS protected under Regulation 33 (35) of the Habitats Regulations. The Solent is the only European Marine Site within the UK to contain more than one physiographic estuary type¹, in particular four coastal plain estuaries that include the Hamble.

As a component of SEMS the Hamble Estuary comes under the SEMS management scheme, which considers dredging an activity which may pose a risk to the site and its features, but until the protocol governing maintenance dredging is finalised, no management considerations have been put in place in the scheme.

Natural England has a statutory responsibility to advise relevant authorities as to the conservation objectives for European Marine Sites and on operations, which may cause deterioration or disturbance of the habitats and species. This advice is provided under Regulation 33 (35) of the Habitats Regulations.

Natural England's Regulation 33 (35) Package for the SEMS has been used as one source of information in order to provide information on habitats and species within the Hamble Estuary that may potentially be affected by all types of dredging operations.

¹ English Nature, Solent Marine Site. Regulation 33(2) of Conservation (Natural Habitats &c.) Regulations 1994.

3.2 Special Area of Conservation

The EU Habitats Directive (92/43/EEC) requires the establishment of a network of important high quality conservation sites that will make a significant contribution to conserving the 169 habitat types and 623 species identified in Annexes I and II of the Habitats Directive. There is one SAC within the study area, the Solent Maritime SAC. The Hamble Estuary is included within the Solent Maritime SAC as part of the functionally linked suite of estuaries and was seen to be an essential functional component of the Solent estuary system.

The SAC designation identifies primary 'interest features' and 'sub-features' which together characterise the conservation value of the designated site and against which conservation objectives are framed. These are described for the designated area as a whole and not all the interest features or sub-features will occur at any particular site within the estuary complex. The features qualifying under Annex I of the Habitats Directive and the primary reason for the selection of the Solent Maritime as a SAC are listed in Table 1.

The Hamble Estuary supports a wide range of both intertidal and subtidal habitats displaying the transition from marine to terrestrial environments, although these do not specifically contribute to the interest features. It is both the habitats (generally described by their vegetation or sediment types and location within the tidal frame) and the communities that they support that are considered within the setting of favourable condition status. Further information on favourable condition is contained within Natural England's advice under Regulation 33 (35) (English Nature, 2001).

Table 1. Interest features and sub features identified in the SAC designation

Interest Feature	Sub Feature
Estuaries	Saltmarsh communities Intertidal mudflat and sandflat communities Intertidal mixed sediment communities Subtidal sediment communities
Annual vegetation of drift lines	
Atlantic salt meadow (<i>Glauco-Puccinellietalia</i>)	Low marsh communities Mid-marsh communities Upper marsh communities Transitional high marsh communities
<i>Salicornia</i> and other annuals colonising mud and sand	Annual <i>Salicornia</i> saltmarsh communities <i>Suaeda maritima</i> saltmarsh communities
Cordgrass swards (<i>Spartinion</i>)	Small cordgrass (<i>Spartina maritima</i>) communities Smooth cordgrass (<i>Spartina alterniflora</i>) communities Townsend's cordgrass (<i>Spartina x townsendii</i>) communities
Mudflats and sandflats not covered by seawater at low tide	Intertidal mud communities Intertidal muddy sand communities Intertidal sand communities
Sandbanks which are slightly covered by seawater all the time	Subtidal gravelly sand and sand Subtidal muddy sand Subtidal eelgrass <i>Zostera marina</i> beds

3.3 Special Protection Area and Ramsar Site

The Hamble Estuary is a component of the Solent and Southampton Water SPA and Ramsar Site. The SPA is designated under the Wild Birds Directive² for supporting significant numbers of Internationally important wild birds, whilst the Ramsar Site is designated under the Ramsar Conservation³. Not all the interest features of the Solent and Southampton Water SPA and Ramsar designations occur within the Hamble Estuary or are at a level of abundance for qualification. However they still contribute as part of a component estuary, which supports the designation of the wider Solent and Southampton Water interests.

The qualifying species for designation as a SPA or Ramsar sites are referred to as 'interest features'. Those that have been reported to be found on the Hamble Estuary are denoted in bold.

- Mediterranean gull;
- Sandwich tern;
- Little turn;
- **Ringed plover;**
- **Dark bellied brent geese;**
- **Black-tailed godwits;**
- **Roseate tern;** and
- **Common tern.**

The key habitats necessary to support the birds that qualify within the Solent and Southampton Water SPA are classified as 'sub-features'. For the definition of these features see the Natural England Regulation 33 (35) advice (English Nature, 2001). Those that are found in the Hamble Estuary are denoted in bold.

- **Sand and shingle;**
- Shallow coastal waters;
- **Saltmarsh;**
- Boulder and cobble shores;
- **Intertidal mud and sandflats;**
- Mixed sediment shores;
- Shingle;
- **Estuaries;**
- Saline Lagoons;
- Intertidal reefs; and
- Cordgrass swards.

3.4 Site of Special Scientific Interest (SSSI) and Local Nature Reserves (LNR)

The Hamble Estuary has a number of designated SSSI and LNR. For the purpose of this study, only the most relevant ecological information relating to these sites in the context of

² Council Directive 79/409/EEC on the conservation of wild birds.

³ Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention), 1971.

potential impacts from dredging activities has been described. This provides the most appropriate baseline information on the diversity and most likely sensitive ecological elements to dredging impacts associated with the Hamble. In addition, this provides a more detailed and site-specific context for those areas designated within SEMS, SAC and SPA. There are a number of other areas designated for nature conservation value (e.g. Hamsworth Row National Trust Nature Reserve and Hamble Site of Interest for Nature Conservation (SINC)), which have not been specifically described as the main SSSI designations capture the nature of the most sensitive ecological elements within the Hamble Estuary. These main areas are:

- Lincegrove and Hackett's Marsh (SSSI and LNR);
- Upper Hamble and Woods (SSSI);
- Lee-on-The-Solent to Itchen Estuary (SSSI);
- Hook and Warsash (LNR); and
- Mercury Marshes (LNR).

Lincegrove and Hackett's Marsh is characterized as a mature saltmarsh that is dissected by complex patterns of drainage creeks. The saltmarsh vegetation is dominated by sea purslane *Halimione portulacoides* and common cord-grass *Spartina anglica*. Saltmarsh grass *Puccinellia maritima*, sea lavender *Limonium vulgare*, thrift *Armeria maritima*, sea aster *Aster tripolium* and sea club-rush *Scirpus maritimus* form a mixed community on the higher marsh levels and at the landward margin. The marshes grade either to a sea couch *Elymus pycnanthus* or reed *Phragmites australis* zone. Structurally the marshes are one of the best examples of mature saltmarsh on the south coast. They are one of only eight extensive saltmarshes on the central south coast between Poole in Dorset and Pagham in West Sussex.

The Upper Hamble Estuary and Woods has been designated for its saltmarsh zones, reed swamps and ancient woods. The graduation from ancient woodland to saltmarsh is a Nationally rare feature. Saltmarsh communities are dominated by sea couch *E. pycnanthus*. The site has a mixed saltmarsh community containing a wide range of saltmarsh grasses such as *P. maritima* and sea club-rush *S. maritimus*. The saltmarsh also supports a rare marshland beetle *Mecinus collaris* and moth *Bactra robustana*. The site also has swamp and fen vegetation that includes reed sweet grass *Glyceria maxima* and reedmace *Typha latifolia*. The reedbeds support breeding populations of sedge warblers and occasional visits by great crested grebes. At low water there is a narrow band of mudflats, which are rich in fine particulate matter and organic detritus and support a range of marine worms, crustaceans and molluscs. The mudflats provide a source of food for many waders and ducks.

Lee-on-The-Solent to Itchen Estuary SSSI extends into the lower Hamble and comprise of extensive intertidal muds, vegetated shingle, saltmarsh and reedbeds. The site supports Nationally scarce coastal plants and is part of the Southampton Water site for internationally important over-wintering bird populations. The mudflats in the Hamble contain a high clay fraction and receive abundant organic matter that support high densities of benthic invertebrates, including one of the largest remaining British populations of the hard shell clam *Mercenaria mercenaria*. There is limited marsh development in the Hamble, and the marsh is now in recession and the accreted mud platforms are disintegrating. At the mouth of the Hamble are areas of grazing marsh reclaimed from saltmarsh in the seventeenth century.

Swamp and fen vegetation occurs along several points within the Hamble (Bunny Meadows and Mercury Marshes).

Mercury Marshes comprise of hemlock water-dropwort *Oenanthe crocata*, lesser and greater pond-sedges *Carex acutiformis*, *C. riparia*, and rush *Juncus articulatus*. Where the reeds border saltmarsh there is a rich range of typical saltmarsh vegetation such as sea purslane *H. portulacoides*, sea aster *A. tripolium*, sea lavender *Limonium vulgare* and the common saltmarsh grass *P. maritima*. At **Bunny Meadows (Hook and Warsash LNR)**, the Nationally scarce Borrer's and Stiff saltmarsh grasses *P. fasciculata* and *P. rupestris* have been found and there are large areas of cord grass *Spartina* that dominate outside the seawall, where the saltmarsh has been subjected to erosion for the past 50 years. The intertidal areas at Bunny Meadows are important to many bird species.

3.5 Regulation 35 Advice

The role of the conservation objectives for a European Marine Site is to define the nature conservation aspirations for the features of interest, thereby representing the aims and requirements of the Habitats and Birds Directives in relation to the site.

Natural England's Regulation 33 (35) Package for the SEMS has been used as one source of information in order to provide information on habitats and species within the Hamble Estuary that may potentially be affected by maintenance dredging operations.

3.6 Relevant Features

For the purpose of the present study, the potential impact of dredging activity on environmentally sensitive receptors will be assessed under the following features. These features are components of those sites designated for their nature conservation values under SEMS, SAC, SPA, SSSI and LNR legislation.

- Estuaries;
- Annual vegetation of drift-lines;
- Saltmarsh communities (including Atlantic salt meadow, *Salicornia* and cordgrass);
- Mudflat and sandflat communities;
- Subtidal communities (including sandbanks, gravel and sand communities);
- Birds; and
- Fish.

Whilst the Regulation 33 (35) Advice highlights the above features to be relevant to the Hamble, detailed mapping of some of these features is limited. English Nature has compiled information on the spatial extent of habitats and substrates within the Solent⁴. The maps show the sediment composition of the Hamble as divided between the upper reaches comprising of mud and the lower reaches being predominantly muddy sand and sandy mud. Hence the extent of gravel and sand substrates is not known although it is likely to be confined to the

⁴ Solent and South Wight mapping of intertidal and subtidal marine SACs. English Nature. Report No. UC382, 1998.

reach near the mouth of the estuary. Other sources of information on broadscale maps of these estuarine habitats are also available⁵.

3.6.1 Estuaries

Estuaries are complex and dynamic ecosystems supporting a mosaic of habitats and species to form an interface between freshwater and marine environments. Characteristically they are comprised of extensive areas of mudflats and sandflats, which are inhabited by a wide range of invertebrates that provide a rich source of food for waterfowl and seabirds. At higher elevations saltmarsh communities are usually dominant. These habitats are an important nursery for juvenile fish and feeding grounds for roosting waterfowl and adult fish when inundated by the tide.

Estuaries have a natural tendency to accumulate sediment thus potentially altering their width and depth over time towards a state of dynamic equilibrium. In other words, an estuaries cross section will evolve until it balances the tidal prism, velocities, erosional/depositional thresholds and changes in sea levels (O'Brien, 1969).

The Hamble estuary is an example of a coastal plain estuary, which is sheltered from prevailing southwesterly winds typically resulting in finer sediment mudflats dominating the intertidal area and have reduced or variable salinity. Saltmarsh communities are another very important habitat feature, as are a number of other features such as intertidal sandflats, mixed sediment and subtidal communities that form components of the SEMS.

Nature conservation objective for SAC	Subject to natural change, maintain Estuaries in favourable condition. Communities associated with the Hamble Estuary include: ■ Saltmarsh communities ■ Intertidal mudflat and sandflat communities ■ Subtidal sediment communities
Nature conservation objective for SPA and Ramsar	Subject to natural change, maintain in favourable condition of the habitats for the internationally important populations of the regularly occurring Annex I species . Habitats associated with the Hamble Estuary include: ■ Saltmarsh ■ Intertidal mudflats and sandflats Annex I species associated with the Hamble Estuary include: ■ Sandwich tern ■ Common tern ■ Roseate tern

3.6.2 Annual Vegetation of Drift-Lines

Often referred to as drift-line habitats, they are areas of shingle or sand/shingle beaches with vegetation coverage that may not persist from one year to the next. Therefore, areas with persistent coverage are rare. The vegetation grows during the summer months, lying at or above mean high water spring tides. These dynamic habitats are dependent on naturally occurring processes of erosion and accretion of the substrate. The ecology associated with these habitats is variable and is usually dominated by annual and short-lived perennial species.

⁵ HCC Biodiversity Action Plan, and Hamble Estuary Management Plan.

Two important key drift-line communities exist, namely *Atriplex* dominated communities and *Honkenya peploides-Cakile maritima* communities. These habitats are often a precursor to more stable vegetation above Highest Astronomical Tide (HAT).

Shingle spit drift-line vegetation is associated with transitional areas leading to saltmarsh in the lee of the spit such as that at the mouth of the Hamble Estuary.

Nature conservation objective for SAC	Subject to natural change, maintain Annual vegetation of drift-lines in favourable conditions
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3.6.3 Saltmarsh Communities (Including Atlantic Salt Meadow, *Salicornia* and Cordgrass)

The main features of interest in the designation of saltmarsh communities includes the pioneer saltmarsh species *Salicornia* and other annuals, Atlantic salt meadows and Cordgrass swards, which are classified separately under the Habitats Directive (English Nature, 2001). The total area of mapped saltmarsh within the Hamble Estuary is 60ha (hectares).

Saltmarsh provides suitable habitats for breeding and roosting waders important for supporting features under the designation of SPA and Ramsar (Bayliss, 2002).

The Hamble Estuary provides some of the best examples of mature saltmarsh on the south coast. These are found at Lincegrove and Hackett's Marsh (adjacent to Universal Marina). These sites provide a near full range of marsh communities from low marsh to the low shore, to mid and upper marsh and transitional to freshwater reedswamp and alluvial woodland at the limits of tidal inundation⁶.

- **Atlantic salt meadow** (*Glauco-Puccinellietalia*) forms the upper and middle reaches of the saltmarsh. The habitat is considered to be a relict feature of a previous larger expanse of marsh, displaying the classic stages of development in relation to the position in the tidal frame. The vegetation of this habitat grades to high mixed marsh, primarily sea lavender *L. vulgare*, sea blite *Suaeda maritima* and sea plantain *P. maritima*. The sea couch-grass *Elytrigia atherica* grades from this level to dominate the highest zone with sea club-rush *Bolboschoenus maritimus* and sea aster *A. tripolium*. The highest and upper marsh communities display greater diversity with a more complex structure as the tidal inundation is reduced (English Nature, 2001). Atlantic salt meadow supports a wide range of organisms including invertebrates and birds. The sea couch-grass zone is particularly important for orthopteran invertebrates (dragonflies) such as the long-winged conehead *Conocephalus discolor* which is Nationally scarce (CCZM, 1996).
- ***Salicornia* and other annuals colonising mud and sand** are present at the lower reaches of saltmarsh and is an interest feature that comprises of species associated with pioneer saltmarsh. Sizable areas of *Salicornia* and *Suaeda* communities are found within the Hamble Estuary.

⁶ English Nature, Solent Marine Site. regulation 33(2) of Conservation (Natural Habitats &c.) Regulations 1994.

- **Cord-grass swards** (*Spartinion*) are an important precursor to saltmarsh colonising a range of substrates from soft mud to shingle, usually in areas sheltered from strong wave action. The native species *Spartina maritima* and introduced species *S. alterniflora* are rare in the UK. The sterile hybrid *Spartina x townsendii* is found only in the Solent and saltmarshes containing this hybrid are considered the most important in relation to site selection for conservation purposes.

Nature conservation objective for SAC	Subject to natural change, maintain Atlantic salt meadows, <i>Salicornia</i> and other annuals colonising mud and sand, and cord-grass swards in favourable condition. Saltmarsh communities associated with the Hamble Estuary include: ▪ Low marsh communities ▪ Mid-marsh communities ▪ Upper marsh communities ▪ Transitional high marsh communities ▪ Annual <i>Salicornia</i> saltmarsh communities ▪ <i>Suaeda</i> maritime saltmarsh communities
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3.6.4 Mudflat and Sandflat Communities

In the Hamble there are 125ha of mudflat habitats, which are sub-divided into intertidal mud communities, intertidal mixed sediment communities, intertidal muddy sand communities and intertidal sand communities. The intertidal mudflats of the Hamble Estuary are comprised of fine silt sediment, organic matter and varying degrees of sand and shell fragments that are covered in algal mats (English Nature, 2000). There are a number of sub-features associated with mudflats. These include intertidal mud, muddy sand and mixed sediment communities.

- **Intertidal mud communities:** located seaward of saltmarsh they support a wide range of marine worms such as *Arenicola marina* and *Manayunkia aestuarina* and crustaceans such as *Talitrus saltator* (sand hopper). The gastropod *Hydrobia ulva*, amphipods *Corophium volutator* and the polychaete worm *Hediste diversicolor* dominate the fauna of the mudflats. These species provide an abundance of prey species for waders, wildfowl and marine predators. They also provide food and shelter for many fish species.
- **Intertidal muddy sand communities:** Located at the mouth of estuaries or behind barrier islands with stable sediment conditions. A number of worms and bivalve molluscs colonise these sediments, usually with substantial beds of mussels *Mytilus edulis* on the lower shore. In addition, the lower shore may have eelgrass beds of *Zostera*, which have been reported in the Hamble Estuary. Eelgrass beds are Nationally rare habitats (Stewart *et al.*, 1994) and provide important feeding grounds for birds, spawning and nursery sites for fish.
- **Intertidal mixed sediment communities:** These communities tend to be dominated by the bivalve *Mya arenaria*, polychaete worms, and a range of epifaunal and algae species (Connor *et al.*, 1997; English Nature, 2001). Typically, the infauna characteristics of these communities include *Fabricia sabella*, *Scoloplos armiger*, *Pygospio elegans*, *Nereis diversicolor*, *Eteone longa* and *Anaitdes maculata*.

Nature conservation objective for SAC	Subject to natural change, maintain mudflats and sandflats not covered by seawater at low tide in favourable condition. The main communities associated with the Hamble Estuary include: ■ Intertidal mud communities ■ Intertidal muddy sand communities ■ Intertidal sand communities
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3.6.5 Subtidal Communities (Including Sandbanks, Gravel and Sand Communities)

These communities include soft sediment habitats associated with sandbanks, which are slightly covered by seawater all the time. A range of physical factors such as relative exposure, depth, turbidity and salinity largely determines the diversity and nature of these communities. The typical species inhabiting these communities include burrowing worms, crustaceans, molluscs and echinoderms, and more mobile fauna such as shrimps, crab and fish. Subtidal habitats are sub-divided into three sub-features; subtidal gravelly sand and sand, subtidal muddy sand and subtidal eelgrass *Zostera marina* beds. Only subtidal gravel and sand, and muddy sand communities have been previously reported in the Hamble Estuary as part of the SEMS.

- **Subtidal gravelly sand and sand** are characterised by mobile species and form bars/spits shaped by the predominant west to east tidal flow. This feature is widespread throughout the Solent and is extensive throughout the lower Hamble Estuary.
- **Subtidal muddy sand** is widespread in the Solent and a particular feature of the lower reaches of the Hamble. A number of sources document the seabed sediment type within the Hamble Estuary, but describe varying degrees of spatial resolution. Velegrakis (2000), shows the Hamble to be predominated by muddy sand between the estuary mouth at Hamble Point and up stream as far as Swanwick Marina. Beyond this point the sediment is described as gravelly mud, which is characteristic of the sediment type within Southampton Water adjacent to the mouth of the Hamble.
- **Subtidal eelgrass *Zostera marina* beds** were common throughout the Solent, forming meadows across sandy intertidal and subtidal habitats (Tubbs, 1999). *Zostera* tends to occur on firm sand, sometimes mixed with gravel and are also submerged. It is a major food source for the dark-bellied goose *Branta bernicla bernicla*.

Nature conservation objective for SAC	Subject to natural change, maintain sandbanks slightly covered by seawater all the time in favourable condition, in particular: ■ Subtidal gravelly sand and sand ■ Subtidal muddy sand ■ Subtidal eelgrass <i>Zostera marina</i> beds
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3.6.6 Birds

The link between birds and the potential impact from dredging activity is habitat. Habitats provide both food and shelter to bird species within the Hamble. Those that have been reported to be found on the Hamble include, ringed plover, dark bellied brent geese, black-tailed godwits, roseate tern, and common tern. The following sections describe those habitats found within the Hamble and their association with specific International and Nationally important birds protected under the SPA and Ramsar designations.

Saltmarsh provides a food supply to migratory birds and roosting areas for over-wintering species. They are important to curlew, brent geese and teal. The upper marshes also provide ideal roosting habitats for many waders. Saltmarsh provides important nesting areas for Mediterranean gulls, which prey on small fish and invertebrates such as molluscs, but these birds are not typically associated with the Hamble Estuary.

Intertidal mudflats and sand flats are abundant with ragworms and cockles, which provide a rich source of food for black-tailed godwits and other migratory wildfowl. Dark-bellied brent geese also prey on molluscus such as *Hydrobia*, and vary their diet to include green algal mats *Enteromorpha* and *Ulva lactuca* which occur on the surface of mudflats.

Subtidal habitats provide food such as small fish, shrimps, prawns and crabs for the common and roseate terns. These birds are foraging species that feed over shallow waters.

A more detailed summary of the bird species associated with the SPA and Ramsar sites within the Hamble Estuary is presented in Section 3.3 above.

Nature conservation objective for SPA/Ramsar	Subject to natural change, maintain the habitats for the internationally important population of the regularly occurring Annex II species in favourable condition, in particular sand and shingle, saltmarsh, intertidal mudflats and sandflats and shallow coastal areas. Subject to natural change, maintain the habitats for the internationally important populations of the regularly occurring migratory species in favourable condition, in particular the saltmarsh, intertidal mudflats and sandflats, boulder and cobble shores and mixed sediment shores. Subject to natural change, maintain the habitats for the internationally important assemblage of waterfowl in favourable condition, in particular the saltmarsh, intertidal mudflats and sandflats, boulder and cobble shores and mixed sediment shores.
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3.6.7 Fish

Southampton Water is host to a large number of fish species including sand smelt, sprat, pouting, and bass. Many of the intertidal areas are important for bass, flatfish species and mullet, for example. The Hamble is also a protected bass nursery area.

Saltmarsh habitats are important nurseries for juvenile fish and feeding grounds for adult fish when inundated by the tide. Intertidal mud communities support a wide range of marine worms such as *A.marina* and *M. aestuarina* and crustacean *Talitrus saltator*, gastropod *H. ulva*, amphipod *Corophium volutator* and polychaete worm *Hediste diversicolor*. These species provide food and shelter for fish. Intertidal muddy sand communities are located at the mouth of estuaries with occasional coverage of eelgrass beds of *Zostera* at the lower shore. They provide important feeding grounds, spawning, and nursery sites for fish. Similarly, gravel and sand communities are typically comprised of burrowing worms, crustaceans, molluscs, shrimp and crab, which provide a rich food source for fish.

However, for the present study fish are not being assessed.

Nature conservation objective	No specific designation relevant to the Hamble, other than the Hamble Estuary is a protected nursery area for Bass.
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4. Dredging Review Summary

Dredge information for the period 1986 to 2010 (25 year period) has been collected in order to assist the production of this Dredge Management Plan, and to assist each contributing marina in applying for dredge and disposal licences. Data has been collated from the Department for Environment, Food and Rural Affairs (Defra) Disposal at Sea Database (DAS) together with supplementary information from Horter (2003) for the period 1986 to 2002, with more recent information (2003 to 2010) provided by the various marina operators on the Hamble. Care has been taken to ensure duplicate records in the database have been accounted for and amendment of possible capital dredge contributions made. A historical timeseries of dredging is provided in Table 2 and Figure 2. All data is presented in metres cubed (m^3) at an assumed density of $1,300kg/m^3$. It is believed that all dredging undertaken within the River Hamble for this period has been achieved through backhoe to self propelled split hopper barge. It must also be highlighted that since the original production of the figures contained in this document, Universal and Crableck Marinas have merged, and the combined marina areas are now known solely as Universal Marina.

The total volume of sediment dredged from the estuary over the 25 year period was about $484,100m^3$, representing on average approximately $19,400m^3$ per annum. However, after the likely occurrences of capital dredging are taken into account, the annual maintenance dredge average is in the order of $16,000m^3$. Over this period, most of the locations within the estuary have been dredged on average once every 2-9 years, although Hamble Point Marina, which is located nearest to the mouth of the estuary, has been dredged more regularly on an interval of about two years. General dredging of the River Hamble ('River Hamble, general') has not occurred since 1994, with anecdotal information from the Harbour Master suggesting that dredging is unlikely to be undertaken in the near future. In addition, dredging and disposal is likely to be required from the Riverside and Cabin Boatyards, however these organisations have not contributed to this management plan process. Furthermore, Rank Marine Int has been taken over by what is now Marina Developments Limited (MDL) Marinas.

Based upon the maintenance dredging volumes and known areas of each dredge location, an approximate annual siltation rate has been estimated for the period 1986 to 2010. This suggested that siltation rates were fairly uniform in the estuary with rates of approximately $0.1m/annum$ to $0.2m/annum$ up to and including Mercury Yacht Harbour, with reducing rates upstream (Table 3).

With respect to the disposal of the maintenance-dredged material from the River Hamble, the majority of this material is deposited at the Nab Tower (WI060) licensed sea disposal site, with smaller amounts being deposited at the Hurst Spit/Fort (WI080) disposal site during bad weather.

Table 2. Historical dredge volumes within the River Hamble ($\times 10^3 \text{m}^3$)

Location	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Hamble Point Marina	1.4	15.8	4.0		18.3	16.5		6.3		6.3	4.2	2.4	7.6	6.9
Stone Pier Yard				0.3							2.0			
River Hamble, HM Pier					14.8						3.8			
Port Hamble Marina			11.0			22.1					15.8	5.9	5.4	
Hamble Yacht Services														
Mercury Yacht Harbour			11.0	17.9							7.4		5.8	
Universal Marina	0.6	3.4		6.4										
Swanwick Marina			5.7	10.2						26.4*			5.0	10.0
River Hamble, general	1.7								3.8					
Rank Marine Int.	1.6			12.2		5.0								
Totals	5.3	19.2	31.7	47.0	33.1	43.6	0.0	6.3	3.8	32.7	33.2	8.3	23.8	16.9

Location	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total	Average
Hamble Point Marina	4.8	3.6		10.4	6.3		5.4	4.5		4.4	3.5	132.6	5.3
Stone Pier Yard							6.6#					5.6	0.2
River Hamble, HM Pier												21.9	0.9
Port Hamble Marina			5.3		1.8			5.1	5.5	5.0	1.7	84.6	3.4
Hamble Yacht Services	8.0					6.2						14.2	0.6
Mercury Yacht Harbour	10.0		15.7	5.1		3.8	5.4		5.1	3.9		91.1	3.6
Universal				5.8		6.4	13.0			1.9		37.5	1.5
Swanwick Marina	5.0				10.0							72.3	2.9
River Hamble, general												5.5	0.2
Rank Marine Int.												18.8	0.8
Totals	27.8	3.6	21.0	21.3	18.1	16.4	30.4	9.6	10.6	15.2	5.2	484.1	19.4

Note: Underlined volume represents a volume that most likely includes a proportion of capital dredging.

* This value was originally included in the DEFRA database as River Hamble, general. However further consultation has revealed that it was dredged from Swanwick Marina. In addition, 8,400m³ of capital dredging also took place.

This combined value has been equally divided between Stone Pier Yard and River Hamble HM Pier within the Total column.

Note: Underlined volume represents a volume that most likely includes a proportion of capital dredging.

* This value was originally included in the DEFRA database as River Hamble, general. However further consultation has revealed that it was dredged from Swanwick Marina. In addition, 8,400m³ of capital dredging also took place.

This combined value has been equally divided between Stone Pier Yard and River Hamble HM Pier within the Total column.

Table 3. Siltation rates in marinas (average between 1986-2010)

Location	Area (ha)	Mean Annual Deposition ($\times 10^3 \text{ m}^3$)	Mean Annual Siltation Rate (m/yr)
Hamble Point Marina	3.2	5.3	0.17
Stone Pier Yard	0.7	0.2	0.03
River Hamble, HM Pier	0.8	0.9	0.11
Port Hamble Marina	3.4	3.4	0.10
Hamble Yacht Services	0.7	0.6	0.08
Mercury Yacht Harbour	3.6	3.6	0.10
Universal Marina	1.8	1.5	0.08
Swanwick Marina	6.3	2.9	0.05

5. Background Environmental Conditions

In order to assess the potential effects of maintenance dredging activities on the nature conservation features within the estuary it is important to understand the baseline environmental conditions, particularly for physical processes and water quality aspects which provide the context for environmental changes (Section 6). Therefore, baseline conditions for these two environments have been presented here. The effects of the environmental changes on the environmental receptors are assessed in Section 7.

5.1 Physical Processes and Morphology

5.1.1 The Hamble River System

The Hamble River is a component river of the Southampton Water Estuary (Southampton Water, Rivers Test, Itchen and Hamble) and Solent System (East and West Solent). The Upper Hamble River splits into two arms flowing to Bishops Waltham and Curbridge and is tidally influenced for approximately 10km between Botley and Hook Spit, which marks its mouth and the junction with Southampton Water.

The Hamble meanders through open countryside above the M27 motorway bridge. Below the bridge, the river has only limited hard protection to its banks, but is extensively developed with marinas and moorings.

The underlying geology influences the nature of surface water discharge into the Hamble and of the total catchment of approximately 170km², about two thirds derives from Tertiary clay below the tidal limit with the remaining catchment above the tidal limit comprising of chalk (Tosswell, 1984).

The mouth of the River Hamble opens into Southampton Water and hence will be influenced by the physical processes operating within this larger body of water.

5.1.2 Driving Mechanisms

Maintenance dredging within the Hamble will be driven by a number of physical mechanisms and processes both internal and external to the Hamble system including, freshwater input, sediment supply, tidal regime, wave climate and characteristics (physical and biological) of the bed sediments and their degree of consolidation. The Hamble sits within a much larger system comprising Southampton Water and the Solent and the coupling together of the processes acting within these components, over different space and time scales will determine the physical regime that will influence maintenance dredging within the Hamble, specifically the marinas and berths.

5.1.3 Physical Processes

5.1.3.1 Freshwater input

Freshwater discharge from the head of the Hamble River and surface water run-off have the ability to both supply sediment to the lower reaches of the Hamble, potentially being trapped within deepened berths and also alter the physical processes.

To examine the potential influence of the freshwater input to the system, river discharge data were analysed for the period August 1981-December 2003 from the gauging station at Frog Mill (supplied by the Environment Agency). The mean freshwater discharge for the whole period was about $0.5\text{m}^3/\text{s}$ with 90% of the recordings below $1.0\text{m}^3/\text{s}$. The highest mean daily discharge was about $7\text{m}^3/\text{s}$.

Additional freshwater will be supplied to the river from surface run-off from the surrounding land and drains from road and rail crossings and adjacent to the estuary.

The mean river discharge over a tidal cycle of about $0.5\text{m}^3/\text{s}$ represents about 0.65% and 0.35% of neap and spring tidal prisms of the estuary, respectively.

5.1.3.2 Tidal regime

The location of the Hamble River ensures that both the Southampton Water and Solent systems will heavily influence the internal physical processes.

The tidal wave delivered to the mouth of the Hamble is controlled by the tidal characteristics of the English Channel with a unique tidal curve that exhibits both a double high water and a stand on the flood tide (young flood stand) and consequently a pronounced flood/ebb asymmetry with the flood tide typically 50% longer duration than the ebb. The nature of the tidal wave is also more pronounced on spring tides.

Analysis of tidal flow field measurements collected during 1979 within the Hamble system suggests (after taking consideration of changes in tidal range) that the form of the tidal wave (peak speeds and tidal height) is roughly preserved in an up estuary direction with any pronounced variation not occurring until upstream of the Mercury Yacht Harbour (Table 4).

Table 4. Variation in peak tidal flows within the Hamble

Location	Spring Peak Speed (m/s)		Neap Peak Speed (m/s)		Tidal Range (m)	
	Ebb	Flood	Ebb	Flood	Spring	Neap
Warsash Jetty	1.1	0.9	0.6	0.4	4.7	2.2
Bunny Meadows	1.0	0.7	0.4	0.3	4.6	1.9
Port Hamble	1.0	0.6	0.5	0.4	4.3	2.3
Mercury Yacht H.	0.7	0.4	0.4	0.2	3.8	2.1

Comparing the Hamble tidal prism with that of the Southampton Water system can put the scale of the tidal discharges into context. Given a tidal prism for the River Hamble of between $3.4 \times 10^6 \text{ m}^3$ and $6.4 \times 10^6 \text{ m}^3$ for neap and spring tides respectively (ABP Research, 1999), this represents about 6% of the tidal prism for the Southampton Water system.

5.1.3.3 Wave conditions

Wave conditions within an estuary system can be extremely important for remobilising intertidal sediments and shaping the form of intertidal slopes. The Hamble is relatively narrow and hence is fetch limited. The largest fetch over which waves could be generated will be approximately 5km in a direct line up the river from Calshot. It is therefore only southerly wind conditions that could generate pronounced waves in the Hamble and even under these conditions significant wave heights are only likely to be in the order of 0.2m (Tosswell, 1984). Work undertaken by HR Wallingford (1995) confirms the relatively sheltered nature of the Hamble and limited wave activity.

5.1.3.4 Sediment transport pathways

The unique nature of the tidal wave affects the sediment transport in a complex way. The longer duration of the flood tide than the ebb tide and in particular the longer slack water period before the ebb in comparison to that before the flood will mean that there is a potential mechanism for upstream transport of fine materials in suspension and deposition over the slack water periods. The asymmetry of the tide with its shorter ebb duration compared to the flood tide also results in highest flow speeds on the ebb tide, which are capable of causing bedload movement in a seaward direction.

Bray *et al.* (1991) suggest a westward movement of sand and shingle towards Hook Spit at the mouth of the estuary with accumulation of this material along the frontage of the Hook Nature Reserve and Hook Spit (HR Wallingford, 1987). The high ebb tide currents would effectively prevent up stream movement of this material into the Hamble.

There is a scarcity of good quality suspended sediment measurements within the Hamble although it is acknowledged that concentrations are generally relatively low, as in the main body of Southampton Water.

Tosswell (1984) measured and analysed flood and ebb tide concentrations over an extended duration between October 1980 and April 1982 and concluded that background concentrations were in the order of 15-30mg/l. Importantly, his work suggested that the main source of suspended sediments was from a seaward direction with the dominant mass transported on the flood rather than ebb tide.

5.1.4 Estuary Stability

The stability of the intertidal and subtidal bedform within the Hamble will be a function of natural long term trends in estuarine response (i.e. sea level rise) superimposed with more recent and ongoing adjustments to anthropogenic changes (reclamation, capital and maintenance dredging and marina development). It should be noted that the only known dredging within the Hamble is associated with capital works for marina development and ongoing maintenance dredging within the marinas. There is no known dredging of the navigation channel within the Hamble.

Volumetric analysis of bathymetric charts covering the period 1965-1994 (ABP R&C, 1994a) suggested that overall there is a tendency for erosion in the channel towards the mouth with a positive balance upstream. However, over the shorter term erosional and accretional patterns are variable with the channel largely stable. The short term variability is particularly the case for the reach between Bursledon Point and Crableck where erosion has been identified between 1988 and 1994.

Independent analyses of the high water level within the Hamble was undertaken as part of an English Nature study (2000) and suggests stability of the intertidal over the last 30 years.

In an effort to ascertain the impact of marina developments on flow patterns within the Hamble, numerical simulations were carried out for the pre-developed and post-developed Hamble bathymetries (ABP R&C, 1994b). This study suggested that changes to flow conditions were largely localised to the immediate vicinity of each marina and overall, the increase in tidal volume caused by marina construction manifested as a small increase in flow speeds on the ebb and flood tide near low water.

The significance of subtle changes to flow speeds and tidal regime on the estuary bedform is difficult to ascertain and may have positive and/or negative effects on sediment supply and bedform stability.

However, where deepening of the bedform results in ongoing accumulation of material this will reduce upstream sediment supply unless the changes to morphology also results in an increased and balancing supply at the mouth. Subsequent maintenance dredging may both remove the sediment from the system and also allow the effects of sediment accumulation and potential reduction in upstream sediment supply to continue.

The reduction in upstream sediment supply and removal of sediment (dredge disposal outside of the system) does not directly imply cause and effect with ongoing bedform changes since stability of a bedform will be a function of processes operating over temporally and spatially varying scales. However such a link can occur and is usually inferred.

Based upon the estimated annual maintenance dredging volume of 16,000m³ it was possible to estimate that on average maintenance dredging represents about 7% of the available sediment transported into the estuary.

5.1.5 Conceptual Model

Based on available evidence the sediment transport processes operating in the Hamble can be summarised as follows:

- The freshwater system appears to have limited potential to supply sediment to the Hamble given knowledge of the catchment characteristics and relatively low discharge in comparison to the tidal prism;
- Orientation of the Hamble and its sheltered nature will limit the capacity of littoral drift and together with high ebb tide currents, coarse sediment fractions will be largely prevented from upstream transport with little input to the sediment budget;
- Characteristics of the tidal wave will be responsible for transporting fine sediments in suspension into the estuary with upstream transport and deposition over extended high water periods. Transport of fines in suspension is therefore likely to be the dominant sediment transport mechanism; and
- Maintenance dredging in marinas could potentially limit upstream availability of fine sediments but the significance of this factor is unknown.

5.1.6 External Influences

The Hamble Estuary is not an isolated system and given the likely dominance of tidal import of suspended sediment within the sediment budget, variability and change in the dynamics of the processes and supply from Southampton Water will influence sediment transport in the Hamble.

The annual maintenance dredging data compiled in Table 5 from the DEFRA returns, covers the period 1986-1997 (ABP Research, 2001) and demonstrates the scale of historical dredging within the Hamble in comparison to other areas in the Southampton Water system.

Table 5. Dredging volumes for Southampton Water and component rivers

Area	Mean (x10 ³ m ³ /yr)	Variability (x10 ³ m ³ /yr)	Percentage of Total Dredged from Southampton Water System (%)
Southampton Water	244	±114	61
River Test	136	±94	34
River Itchen	3	±4	1
River Hamble	15	±31	4
Total	398	±151	

Dredging in the Hamble represents about 4% of the total volume within the Southampton Water system. The majority of the total annual dredge volume occurs upstream of the Hamble, therefore the dredging which takes place within the rest of the system is unlikely to significantly affect the supply through the mouth of the Hamble unless such changes also affect supply through the mouth of Southampton Water.

Table 6 Sediment budget for Southampton Water system

Source/Sink	Volume (x10 ³ m ³ /year)	Variability (x10 ³ m ³ /year)
Rivers	-17	(±10)
Saltmarsh erosion	-6	(±3)
Saltmarsh accretion	+4	(±2)
Cliff erosion	-5	(±3)
Intertidal change (net) ⁷	-46	(±39)
Subtidal change (net)	-28	(±63)
Average annual dredging	+398	(±151)
Balance	+300	(±168)

(Adapted from Table 3 of ABP Research, 2001)

Annual maintenance dredging volumes for the Southampton Water System represent an important component of the sediment budget as shown from Table 6.

Importantly, any factors external to the Hamble that may alter the sediment budget in the Southampton Water system will influence the physical processes within the Hamble. These factors are ongoing, since the sediment budget and dredge volumes within the River Test and Southampton Water is in no small way influenced by previous historical channel deepening.

5.2 Sediment Quality

This section describes the chemical characteristics of sediments within the study area. As part of the FEPA maintenance dredge licensing process, Cefas routinely undertake analysis of sediments within the River Hamble for the individual marinas and boatyards.

On receiving a FEPA application, Cefas is instructed by the MMO as licensing authority, to carry out a sediment analysis in order to assess the nature and degree of any chemical contamination present. The results of geochemical analysis are used in conjunction with other assessment methods (for example bioassays) as well as historical data and expert knowledge of a site, to make a decision regarding the fate of the dredged material following disposal or disturbance. It should be noted that the Action Levels are used as part of a 'weight of evidence' approach to assessing dredged material and its suitability for disposal to sea. Results of sediment samples are shown in Appendix B in tabular form. For ease of comparison, the tables have been coloured with the current guidance Action Levels.

⁷ For Southampton Water and River Test between 1965 and 1996 (no data for River Hamble and River Itchen).

In general, contaminant levels in dredged material below Action Level 1 are of no concern with respect to their potential to cause pollution, and are unlikely to influence the decision to issue a licence. Whereas dredged material with contaminant levels above Action Level 2 are generally considered unsuitable for sea disposal. However, these action levels are not absolute 'pass/fail' levels, but are used as guidance in conjunction with other assessment criteria mentioned previously.

Cefas do not routinely test for the whole range of contaminants, as this is determined on a case by case basis depending on a number of factors. However, the chemical characteristics of the sediments are described in terms of a range of chemical parameters, listed below:

- Heavy metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc) and other metals (aluminium, boron, iron, manganese, selenium, silver and vanadium);
- Organotins (Tributyltin (TBT) and dibutyltin (DBT));
- Total petroleum hydrocarbons (TPH);
- Polyaromatic hydrocarbons (PAHs) (USEPA 16 (United States Environmental Protection Agency));
- Polychlorinated biphenyls (PCBs) including 25 congeners;
- Ammonia; and
- Sulphide.

In 2003, Cefas carried out Project AE0258 entitled 'The Use of Action Levels in the Assessment of Dredged Material Placement at Sea and in Estuarine Areas Under FEPA 2', and reported revisions to the sediment contamination guidance Action Levels (as seen in Table B1, Appendix B). These revisions have yet to be formally adopted, but they have been included in OSPAR Guidelines and will be included alongside the current action levels in the forthcoming London Convention action level guidance document. These Action Levels are not designated as standards in the legislation, and therefore do not constitute 'pass/fail' thresholds, but are used as guidance in conjunction with other assessment criteria, as mentioned previously. This allows variation in local hydrodynamics, sedimentary patterns and material types to be taken in account along with the background geology, as well as recent trends, natural variability and existing ecology of the specific system. Therefore, dredged sediment with a certain geochemical signature may be regarded as contaminated marine sediments in one water body but not in another (ABPmer, 2010).

5.2.1 Sediment Quality within the Study Area

Available sediment quality data sampled within the River Hamble are presented in Tables B2 to B4 of Appendix B for the period between 1999-2009 (values highlighted in either blue or red exceed Cefas Action Levels 1 and 2, respectively), with the location of the samples shown in Figure 3, and a summary of sediment quality provided below. Unfortunately, the depths in which samples were taken for analysis (i.e. on the surface or at depth) have only been recorded systematically in the past 3 years (pers comms, Luca Doria - Cefas, 2011), and as such, Cefas could only provide information to distinguish between data for 2009. Therefore, any elevated concentrations of contaminants within the samples prior to 2008 may be as a result of historic contamination at depth, rather than contamination within the surface maintenance-dredged material.

- **Metals:** Metal concentrations within the River Hamble are below Cefas Action Levels in general, although some metals exceed Action Level 1 in a number of samples (more specifically Copper, Mercury and Zinc). In many of these cases, the exceedance itself is relatively small in comparison to the concentration range between Action Levels 1 and 2; i.e. for Mercury the Action Level levels are set at 0.25 and 1.5 milligrams per kilogram (mg/kg), respectively, with all of the Action Level 1 exceeded samples below 0.5ppm (apart from one). As such, these contaminants are less likely to cause pollution than if they were closer to Action Level 2 when considered with other assessment criteria, as mentioned previously. Of all the samples analysed, only one sample (taken in 2004) had a metal concentration exceeding Action Level 2, which was for Mercury. The depth of which this sample was taken is unknown.
- **Organotins:** Levels of Tributyltin (TBT) exceed Cefas Action Level 1 for a number of the sampled locations, with Action Level 2 being exceeded for three samples. However, it is not possible to determine whether these samples were taken on the surface or at depth, and therefore may be due to historical contamination. Levels of Dibutyltin (DBT) are below Cefas Action Levels for all samples apart from two.
- **Polychlorinated Biphenyls (PCBs):** PCB concentrations within the River Hamble are below Cefas Action Levels for all samples.
- **Polyaromatic Hydrocarbons (PAHs):** All samples exceed Cefas Action Level 1 for at least three of 22 PAH substances, and for a maximum of seven PAH substances. Additionally, all samples exceed Cefas Action Level 1 for Total Hydrocarbons (100mg/kg), with the lowest concentration recorded at 129mg/kg and the highest concentration reaching 409mg/kg in 2009 (surface sample).

5.2.2 Summary of Sediment Quality

As FEPA licences have been issued to the various marinas and boatyards for the disposal of dredged material from the River Hamble at sea, it can be concluded that the concentrations in these areas are not thought to present an unacceptable risk to the marine environment in terms of further pollution.

6. Change Analysis

6.1 Dredge Methodology, Rate and Frequency

Nearly all dredging within the Hamble Estuary has been undertaken by a relatively small backhoe type dredger depositing material to a self-propelled barge, depositing the majority of the material at the Nab Tower licensed deposit site, with smaller amounts deposited at the Hurst Spit/Fort licensed deposit site during bad weather; both of which are outside the Hamble Estuary. This means that nearly all the material has been removed from the immediate hydrodynamic system. For the most part, the same contractor has been used, which means dredging at individual marinas does not take place concurrently, therefore direct interaction during the dredging operations is unlikely to occur. However, since all marinas negotiate their own contracts, concurrent dredging is not impossible.

Due to the nature of marina operations, nearly all dredging is undertaken during the winter months, mainly from October through to the end of March. Since 1986 the maximum amount removed from any one location was 22,100m³, which included some capital dredging. Most purely maintenance dredge campaigns are generally between 5,000-10,000m³ at any one time. Table 2 shows the pattern of dredging since 1986 at the various dredging locations. This shows that only Hamble Point Marina is dredged nearly every year but for generally smaller volumes than for other marinas which are dredged less often, between every 2-9 years, but with no regular pattern. It should also be noted that the whole area of a marina is rarely dredged at any one time. Whilst the depth of dredging will vary between marinas, all of the marinas in the Hamble will typically maintenance dredge to a depth of between 1.5m and 2.0m below Chart Datum (CD). Closer to the marina walls the depth is likely to be 1.5m below CD in order to provide additional support for the walls. The actual frequency therefore depends on siltation rates, which are variable, marina management practices and other factors such as business and financial constraints.

The actual length of time each dredging campaign takes is not specified but will depend on a number of factors. These include:

- Dredge bucket size and speed of operation;
- Size of disposal barge, which is generally in the 100-350m³ range to allow access and manoeuvrability within the estuary and to be able to sit alongside the backhoe; and
- Length of time for continuous dredging per day. Dredging takes place as allowed by tidal conditions. However, work is restricted due to vessel manoeuvring at the dredge site and the time taken for the barges to dispose of material at the disposal site (8 hour return trip). As such, dredging may be restricted to an average of about 4 to 6 hours per day but at all states of tide for the smaller barges, whilst larger barges may also be restricted at some locations on low waters of spring tides.

Taking these factors into account, the very maximum rate of production would be estimated as around 75m³ *in situ* per hour. However, accounting for restrictions, backhoe and barge manoeuvrability and weather conditions, actual average production is likely to be 30-50m³ per hour during the working day. At these rates, a maintenance dredge campaign would take from 2-4 weeks depending on the amount to be removed. Since the same or similar equipment are used at all dredge locations, these rates are likely to be similar throughout the estuary.

6.2 Environmental Effect

The main environmental receptors/features that could be potentially affected by maintenance dredging campaigns are summarised in Table 7. Most of the potential effects are associated with the excavation operation, particularly the disturbance of the material to the water column. This has the potential to increase turbidity and suspended solid concentrations, thus increasing the risk of release of toxic contaminants and deoxygenation of the water. The dispersal of sediment could have the potential for smothering benthos and produce further loss of sediment from the system. Also there is a potential benefit of temporarily increasing the sediment supply, particularly during the flood tide, thus creating increased potential for mudflat/saltmarsh accretion, most likely within the inner estuary.

Table 7. Environmental receptors/features potentially affected by maintenance dredging

Environmental Change	Environmental Receptors (SAC and SPA Features)						
	Estuaries (Morphological)	Annual Veg. of Driftlines	Saltmarsh Communities	Mudflat Communities	Subtidal Communities	Gravel and Sand Communities	Birds
Physical Presence ⁸				X	X	X	X
Noise Generation							X
Generation of Waves ⁹	X		X	X			
Alteration to Tidal Propagation and Estuary Processes	X		X	X	X		X
Increase in Turbidity				X	X		X
Increase in suspended solids	X	X	X	X	X	X	X
Release of toxic Contaminants			X	X	X	X	X
Deoxygenation			X	X	X		
Note: This Table does not indicate the significance of any potential effects, only the areas where assessment and evaluation is required.							

6.3 Evaluation of Sediment Disturbance

To allow an assessment of the importance of these effects, an evaluation of the amount of sediment disturbed to the water column and the extents of the effects have been made for each marina, based on the knowledge of local flow conditions, an assumption of material type and general information on average release rates of the type of dredging operation. These must be considered as approximate, as no site specific measurements or monitoring has been carried out within the Hamble Estuary.

6.3.1 Material Type

Little particle size distribution data is available for the sediments dredged, however they are generally described as fine sediments (muds) particularly from up estuary. It is estimated that the median particle size for the material is of the order of 10-20 microns based on analysis of the deposit areas around the Fawley Oil Terminal. Such material would have a settling velocity in the range of 0.008-0.02cm/s once disturbed into the water column.

At many locations, dredging only occurs after periods of several years, therefore it is likely that the bed density of the material removed would be of the order of 1,300kg/m³ and may be even denser where dredging has not occurred for at least five years.

⁸ Physical Presence refers to the direct effects from the presence of a dredging vessel such as visual disturbance and seabed scour.

⁹ Refers to waves generated by passage of a dredging vessel/barge.

6.3.2 Sediment Disturbance Rate

For the purpose of this evaluation, it has been assumed that the average disturbance rate and rate of production are uniform for all dredging locations and that a backhoe dredger is used. The rate of production has been taken as 50m^3 *in situ* per hour, which probably 'errs' towards a worse case for average disturbance rates. Kirby and Land (1991) reviewed a series of disturbance monitoring measurements around the world for dredging into soft marine or harbour muds. The information was used to determine approximate sediment disturbance rates for different dredge methodologies and size of plant. Thus, for the methodology used in the Hamble Estuary, the sediment release to the water column is estimated as 25kg of dry solid for every m^3 *in situ* dredged. This figure should however be considered as approximate due to the 'spread' within the measured data. It is considered that the material type in the Hamble would be similar to the sediments within the review as would the flow within the marina recesses. Flows however across the entrances may be slightly higher than those during the monitoring studies.

This disturbance rate represents a loss of about 5% of the material dredged to the water column, which again, based on values from the literature, is a representative amount. Taking these rates into account, the historic dredge volumes and the timescales over which they would have been dredged, indicates a realistic loss to the water column equivalent to $20\text{-}30\text{m}^3$ (*in situ*) per day whilst dredging with a backhoe dredger. The average rate of supply equates to approximately 0.347kg/s of dry matter, predominantly from disturbance at the bed and wash-off/overspill from the bucket in transit to the surface. However, not all of the material lost to the water column during dredging will be dispersed and available for suspended sediment transport (within a plume); a proportion of consolidated material will fall directly to the seabed where it will then be available for re-dredging.

6.3.3 Extent of Dispersal

The extent of dispersal is dependent on the flow conditions at the dredge location, the settling velocity of the sediment, the height of disturbance in the water column and the net impact of the tidal propagation. In general, throughout the estuary, peak and average flow speeds are higher on the ebb compared to the flood with neap speeds being about 50-60% of the spring equivalents.

The highest flows occur in the Port Hamble reach with peak flood and ebb flows of around 0.5m/s and 0.75m/s respectively (averages of 0.32 and 0.48m/s). Down estuary the flows are generally slower with flood and ebb peaks up to 0.3 and 0.5m/s respectively. Flows appear to be lowest near to the Mercury Yacht Harbour but increase again through the Universal Marina reach.

Based on the overall average flood and ebb spring tide flow rates and neglecting settling shows that the extent of travel of sediment is about 8km during the flood and just under 5km on the ebb. Thus, most of the material disturbed from the Swanwick Marina will be 'trapped' within the estuary system and is most likely to settle out in the upper reaches of the river. For sites moving down estuary, a greater proportion will be lost into Southampton Water and the Solent, during dredging on the ebb tide, although much is likely to return. Flood tide dredging will

cause all the material disturbed to be retained within the estuary, however, it may not be practical for marina operators to only dredge on the flood tide.

This may seem a little odd bearing in mind the higher ebb flows, however, the ebb only effectively lasts for three hours of the 12.42 hour tide. Thus sediment in suspension moves into the estuary and has the potential to settle out during the slacks at the half tide stand and over high water.

Whether the sediment actually moves over these distances depends on the fall velocity and the water depths. For the type of material disturbed, the fall velocity is very low, therefore will stay in suspension a long time, covering the complete extent of the flow excursion, albeit considerable dilution of the concentrations would take place over time and eventual settlement, probably over the high water slack would occur.

The extents calculated do not apply to all sediment disturbed, only that from the fastest flows across the entrances. The proportion of the disturbed dredged material that will move throughout the estuary will depend on the shape of the marina and its depth. For Hamble Point Marina, Port Hamble, the Harbour Master's Pier and the Universal Marina area, previous modelling shows that flows are generally drawn through the marina areas, albeit slowing towards the rear of the 'pockets'. In these cases, more of the disturbed material will move into the estuary than for Swanwick Marina and Mercury Yacht Harbour. These latter marinas are inset into the mud flats further and flows tend to eddy within the back half of the marina or are slack for much of the tide. Thus, whilst dredging these areas, the disturbed material just increases the turbidity and suspended solids concentrations in these areas and eventually will re-settle to be re-dredged. Since the maximum amount of dredging is usually required from these inner areas, the loss to the estuary is likely to be proportionately smaller than for the other marina locations. It would be difficult to calculate the relative amounts without knowing the distribution of the sediment to be dredged over each area.

6.3.4 Suspended Sediment Concentrations and Plume Decay

Suspended sediment concentrations caused by the disturbed material are mainly a function of the rate of disturbance, the area of water column over which they are disturbed, the ambient flow conditions, depth of water, relative rate of dispersion and settling characteristic of the material.

For the purpose of this evaluation, a dispersion factor of 0.1 has been assumed that will result in a long narrow plume, which is more conducive to higher flow environments. The USACE (1978) suggest the dispersion factor could be as high as 0.25 for similar estuaries. The value of 0.1 would give a slower rate of decay of the plume, therefore the evaluation tends towards an environmental worse case. At the location of disturbance, considered to be within the main flows through the dredge areas, average initial concentrations at source through the water column have been estimated to be around 530mg/l on neap tide flood, down to about 170mg/l spring tide ebb. These concentrations are based upon the theoretical amount of sediment released through bed disturbance and wash-off/overspill from the dredger bucket within the immediate water column (Kirby and Land, 1991). However, concentrations near the dredger are likely to be higher near to the rear of the marinas as explained above. With a dispersion

factor of 0.1 with the estuary flows, average concentrations above background are expected to decay to well below 100mg/l on all tides within 100m from the dredge location. Figures 4 to 9 show the predicted extent of plumes exceeding an arbitrary value of 10mg/l above background for flood and ebb dispersal on spring and neap tides from each of the main dredge locations. A value of 10mg/l has been used in the figures to give an approximate extent to which the plumes may be measureable above the background concentrations within the Hamble, whilst not necessarily being visible in the water column. Beyond the extent of these plumes (i.e. below 10mg/l), and potentially to an even lesser extent, any increase in suspended sediment concentrations as a result of maintenance dredging will not be discernable from natural variability in concentrations along the Hamble.

These plots indicate the main extent of the plumes, however, as stated earlier, further dilution of the plumes will take place and the whole estuary background concentrations will be marginally increased for a period following each dredge. This material will eventually settle out over the higher mudflat and saltmarsh predominantly within the upper estuary. Rates of sedimentation will however be very slow, widespread and immeasurable in the short term. Due to the slow settling rates, maximum accumulations on the estuary bed close to the dredge will be small, no more than a few millimetre, and most accumulation would occur in areas requiring to be re-dredged. The potential for smothering of benthos or saltmarsh is therefore very small from all locations. Due to the overall widespread distribution of sediment, dredging at one marina will temporarily increase the supply of material to all other marinas, however the actual volumes will be insignificant and well within the natural variability which occurs within the estuary.

6.3.5 The Simultaneous use of two Dredgers within the Hamble

Figure 10 shows the plume coverage if dredging occurred at all locations at the same time. This identifies the relatively small areas of interaction between each individual dredge, and as such, the use of two or more dredgers simultaneously within the Hamble is unlikely to have a significant impact on the estuary, with the potential for some aggregation of increased suspended sediment concentrations at the zones of plume interaction (i.e. twice the predicted 10mg/l increase from any dredge area). Additionally, Figure 10 also shows that two areas of intertidal foreshore below the road bridges are not significantly affected by sediment disturbed by dredging, namely the inside of Bursledon bend and much of the intertidal in front of Bunny Meadows.

6.3.6 Maintenance Dredging with Respect to Sediment Supply

The annual average maintenance dredge commitment for the estuary is approximately 16,000m³ *in situ* (from 1986-2010), which represents about 7% of the supply of sediment to the estuary from tidal sources per annum. All this material is removed from the local system. The estuary, however, cannot be described as natural, because over the last 50 years, considerable modification has taken place to create the marinas. Inspection of Figures 4 to 10 clearly shows that large areas of intertidal/saltmarsh were removed to create the marinas thus increasing the tidal prism of the estuary, the high and low water volumes and water cross sectional areas. Thus, if we assume the propagation of the water levels has not significantly changed, the volume of water and sediment passing to and from the estuary would have

considerably increased relative to the pre-marina development situation. Average depths and cross-sectional areas at a number of locations will have considerably increased, thus lowering local flow speeds, making the estuary more sedimentary in nature, particularly near to the marinas. Table 2 represents the approximate areas of the estuary that require periodic maintenance dredging, however some of this area would have already been sub-tidal prior to the individual capital dredging works. Information from the latest Admiralty chart has been used to calculate the area of intertidal removed by each capital dredge to create the marinas. The average depth of the intertidal in these areas before dredging has been estimated. This allows a calculation of the increase in tidal prism attributable to each marina. The individual data are shown in Table 8.

Table 8. Area, average depth and volume of intertidal removed to create individual marinas within the Hamble Estuary

Marina	Area of Intertidal Removed (Ha)	Average Level Of Intertidal (Pre-Dredge) (m(CD))	Increase in Tidal Prism (m ³)
Hamble Point Marina	2.88	2.0	57,600
Harbour Masters and Stone Piers	0.15	1.0	1,500
Port Hamble and Hamble Yacht Services	3.09	2.5	77,250
Mercury Yacht Harbour	2.81	2.5	70,250
Universal/Crableck Marina	0.75	1.0	7,500
Swanwick Marina	5.00	2.5	125,000
Totals	14.68	-	339,100

The approximate estuary tidal prism was established in ABP Research (1999) as springs $6.4 \times 10^6 \text{ m}^3$, neaps $3.4 \times 10^6 \text{ m}^3$, therefore the average increase in tidal prism caused by the marina dredging represents a 7.4% increase in the average estuary tidal prism, i.e. very similar to the proportion that maintenance dredging represents of the annual supply of sediment to the estuary. As a check on this conclusion, the amount of additional imported sediment caused by the increase in tidal prism should equate approximately to the average maintenance dredging commitment. Tosswell (1984) noted that background concentrations were generally between 15 and 30mg/l, which are slightly lower than the average values for Southampton Water. Using 30mg/l as the average background for the estuary and assuming an *in situ* density of 1,300kg/m³ gives an additional input of just over 16,000m³ of *in situ* material per annum.

This calculation would suggest that the maintenance dredging is only removing the increase in sediment brought in due to the marina developments. The sediment available to supply the mudflats and saltmarsh would therefore appear to be little changed from the situation prior to marina developments and would in fact be supplying 14.68ha less intertidal area. Overall the sediment supply to the natural estuary has therefore not been affected by the maintenance dredging.

A qualitative comparison of aerial photographs of the estuary below the A27 road bridge between 1991, 2001 and 2007 shows no significant change in the area of mudflat or saltmarsh. This would suggest that the estuary is not being depleted of sediment and is presently sufficient to enable it to develop with current rates of sea level rise. This agrees with the analysis of high

water levels undertaken for English Nature (2000) over the last 35 years, which suggested stability in the intertidal. This does not however indicate that sufficient sediment will be available to maintain the saltmarsh/mudflats should rates of sea level rise increase in the future.

7. Impact Assessment

7.1 Introduction

To assess the potential impact of dredging activities on relevant nature conservation areas within the Hamble, it is necessary to determine the sensitivity and vulnerability of these areas to potential impacts. Sensitivity is the response of a habitat, community or individual species to an environmental change, whereas vulnerability is the comparison between exposure of the potential impact and the sensitivity of the ecological features (called response characteristics).

However, it should be noted that estimating the significance of an impact remains very subjective. Determining 'significant' may depend on other factors such as the permanency of the impact, its relative importance to the ecosystem and/or its statutory designation, its spatial extent and potential secondary impacts. Moreover, greater consideration may come from the perceived tolerability of the stakeholder(s) to risk.

As part of the impact assessment a number categories for describing the level of significance of the impact have been used. These have been developed on the basis of the potential impact to nature conservation objectives outlined in Natural England's advice under Regulation 33 (35) of the Habitats Regulations.

- **Significant:** Considerable evidence of direct or indirect impact occurring to the feature of interest that prevents its nature conservation targets from being achieved.
- **Not significant:** Little evidence of direct or indirect impact occurring to the feature of interest that has a temporary affect on nature conservation targets.
- **Negligible:** No evidence of direct or indirect impact occurring to the feature of interest that prevents nature conservation targets from being achieved.

A number of impacts from dredging operations have been identified as important to environmentally sensitive receptors in the Hamble:

- Physical Presence;
- Noise Generation;
- Generation of Waves;
- Alteration to Tidal Propagation and Estuary Processes;
- Increase in Turbidity;
- Increase in suspended solids;
- Release of toxic Contaminants; and
- Deoxygenation.

These factors will be assessed in terms of their potential impact on environmentally sensitive receptors. This assessment is based on sensitivity, exposure and the combination of the two to determine vulnerability. Impact will be evaluated against the nature conservation objectives of each of the features of interest and expressed in terms of the significant categories described above.

The spatial extent of SAC's, SPA's, Ramsar sites, SSSI's and LNR's are presented in Figures 11-15. These figures show the extent and proximity of these Nature Conservation designations to the potential dispersion of dredge plumes in the Hamble Estuary. These designation maps and their features of interest e.g. estuaries, annual driftlines, saltmarsh etc were used in the evaluate proximity impacts.

7.2 Estuaries

7.2.1 Baseline Conditions

Baseline information on the Hamble Estuary has been discussed in detail against designated sites of nature conservation interest in Section 3. The Hamble Estuary is an example of a coastal plain estuary, which is sheltered from prevailing southwesterly winds typically resulting in finer sediment mudflats dominating the intertidal area and have reduced or variable salinity. Saltmarsh communities are another very important habitat feature, as are a number of other features such as intertidal sandflats, mixed sediment and subtidal communities that form components of the SEMS.

7.2.2 Sensitivity

The Hamble Estuary is sensitive to a wide number of impacts associated with the maintenance dredging operations. This is partly due to the variety of important nature conservation habitats (and indirectly the species they support) that make-up the estuary such as saltmarsh communities, intertidal mudflat and sandflat communities, intertidal mixed sediment communities and subtidal sediment communities. The sensitivity of an estuary is in part driven by the sensitivity of its habitats, which are described in detail under the relevant sections below.

However, the morphology of an estuary is perhaps the single most important consideration to natural conservation when assessing the impact of dredging activity because of their sensitivity to changes in sediment supply and hydrodynamics. The removal of material will directly impact the ecology, but at a more localised level.

The following potential impacts to estuaries include:

- **Physical presence:** The greatest sensitivity is the removal of subtidal communities. However, any potential changes in the seabed as a direct result of scouring effects are also important with regards to potential erosion of habitats;
- **Generation of waves:** Passing of dredging vessels/barge can cause erosion at the lower boundary of saltmarsh and cause erosion of mudflats by re-suspending material. However, this level of erosion is limited due to the speed restrictions (6 knots) present

within the Hamble. Furthermore, large cruise vessels using the river are likely to have a similar impact on the mudflats as the dredging vessels/barge;

- **Alteration to tidal propagation and estuary processes:** Morphological changes directly alter saltmarsh and mudflat habitats and their species, although these features are naturally dynamic in nature and adapted to changes. However, if localised changes in morphology or estuarine processes are intensive and persistent then they will have a detrimental affect on estuarine habitats and so more indirectly on the species they support;
- **Increase in suspended solids:** Dredging activities can alter sediment availability and could change the concentration of suspended sediment and thus siltation. In estuaries, siltation is a natural process that is increased by the flocculation of inorganic and organic substances due to mixing of fresh and saltwater. Suspended sediment concentrations around the English coast vary from 1-327mg/l and 1-227mg/l, but annual mean values are typically 1-110mg/l (Parr *et al.*, 1998). The Hamble Estuary is subjected to the lower end of these ranges;
- **Release of toxic contaminants:** Marinas are known to contain a range of synthetic substances such as tributyltin (TBT) and non-synthetic chemicals such as heavy metals (arsenic, cadmium, mercury) and hydrocarbons (oils). Many estuarine habitats are considered sensitive to synthetic chemicals and non-synthetic chemicals; and
- **Deoxygenation:** Dredging activity has the potential to increase suspended solid concentrations, which subsequently leads to bacterial activity that consumes available dissolved oxygen thus increasing the risk of deoxygenation of the water. Gray and Jensen (1993) reported <4mg/l as the concentration likely to affect marine life and, therefore, to trigger cessation of dredging operations.

7.2.3 Exposure to Environmental Changes

Based on analysis undertaken in Section 6, the Hamble Estuary will be exposed to the following environmental changes from maintenance dredging activities:

- **Physical presence:** Potential scouring of the bed immediately adjacent to the edge of the maintained area may lead to erosion to the top of side slopes, although this impact is likely to be minimal relative to background variability;
- **Generation of waves:** The Hamble Estuary is considered the largest recreational boating centre in Europe, although during the winter months activity is less intense, when most dredging is likely to occur. The degree of exposure compared against the typical background of boat activity in the Hamble will be minimal;
- **Alteration to tidal propagation and estuary processes:** The effects on tidal propagation and estuary processes will be localised and therefore changes to the wider estuary morphology are considered unlikely;
- **Increase in turbidity:** Not considered important at an estuary scale, but has the potential to indirectly effect visually orientation fauna and sessile gill/filter feeders, although this will be temporary. The greatest exposure will be created during the dredging process around the dredging plant. Maintenance dredging takes place as allowed by tidal conditions, and is not confined to daylight hours. Dredging is restricted to between 4 and 6 hours per day on average, and therefore turbidity has a period where it can disperse, rather than being continually fed throughout the dredging

process. The spatial extent of exposure will be similar to that for the exposure to increased suspended solids, see next section;

- **Increase in suspended solids:** Caused from disturbance of material to the water column, as sediment plumes from the actual dredging process. This has been evaluated for each area of maintenance dredging in Section 6 and the extent of plumes with concentration exceeding 10mg/l above background have been estimated; and
- **Release of toxic contaminants:** It is likely that some chemicals, if they exist in the sediments being dredged (see Section 5.2) will be re-suspended. Estuarine habitats along the eastern side of the Hamble are more exposed due to their proximity and extent of the dredging plumes.

However, the feature estuary will not be exposed to the following:

- **Noise generation:** At an estuary scale noise generation is considered irrelevant. Any noise will be local to the dredge location; and
- **Deoxygenation:** Despite increases in suspended solids the depletion of oxygen during the winter months is less likely than in summer, and the plume effects are localised and relatively short-lived.

7.2.4 Vulnerability

Given the level of exposure and sensitivity of the estuary to the potential environmental changes outlined above, vulnerability is likely to result in changes caused by physical presence (in terms of seabed sediment removal), wave generation and re-suspension of toxic chemicals. However, these changes are likely to be temporary in nature, as plumes will fall to within the range of variability of background levels over a relatively short period.

7.2.5 Assessment Against Nature Conservation Objectives

The nature conservation objective for SAC states that subject to natural change, estuaries in favourable condition are to be maintained. The nature conservation objective for SPA and Ramsar states that subject to natural change, in favourable condition the habitats for the internationally important populations of the regularly occurring Annex I species are to be maintained. The impact on the estuary feature resulting from environmental changes associated with maintenance dredging is considered **negligible** since any changes are both intermittent in terms of frequency of dredge campaigns and during the works themselves, localised to the dredge and do not persist. For the most part change is within the natural variability of the system. That change which does occur is unlikely to change the estuary processes or estuary-wide morphology in the long term.

7.3 Annual Vegetation of Driftlines

7.3.1 Baseline Conditions

Baseline information on annual vegetation of driftlines has been discussed in detail against designated sites of nature conservation interest in Section 3. The vegetation grows during the

summer months, lying at or above mean high water spring tides. These dynamic habitats are dependent on the naturally occurring processes of erosion and accretion of the substrate. Shingle spit drift-line vegetation is associated with transitional areas leading to saltmarsh in the lee of the spit at the mouth of the Hamble Estuary.

7.3.2 Sensitivity

Annual vegetation of driftlines is sensitive to only a single change associated with the dredging operations within the Hamble Estuary:

- **Increase in suspended solids:** Dredging activities can alter sediment availability and this could change the concentration of suspended sediment and thus siltation. Annual vegetation of driftlines is sensitive to smothering and siltation caused from disturbance of material to the water column, which has the potential to increase turbidity and suspended solid concentrations. Changes in the estuaries sediment supply have the potential to affect areas associated with annual vegetation of driftlines.

It should be noted that annual vegetation of drift-lines is also highly sensitive to removal through physical loss of habitat, but this threat is not associated with the existing maintenance dredging activities in the Hamble Estuary. This feature would need careful consideration should future capital developments be proposed.

7.3.3 Exposure to Environmental Changes

Based on analysis undertaken in Section 6, annual vegetation of driftlines will not be exposed to the following environmental changes:

- **Increase in suspended solids:** The likely extent of any sediment accumulation caused from disturbance of material to the water column is unlikely to reach the preferred habitat for annual vegetation of drift-lines in the Hamble Estuary.

7.3.4 Vulnerability

Given the location, level of exposure and sensitivity of annual vegetation of driftlines to the potential environmental changes outlined above, annual vegetation of driftlines are considered not vulnerable to the impacts of maintenance dredging.

7.3.5 Assessment Against Nature Conservation Objectives

The nature conservation objective states that subject to natural change, annual vegetation of drift-lines should be maintained in favourable condition. Thus the negligible vulnerability of annual vegetation of drift-lines will not adversely affect the nature conservation objective for this feature. Consequently, the impact on annual vegetation of driftlines resulting from environmental changes associated with maintenance dredging is considered **negligible**.

It should be noted however that Information on the precise distribution of annual vegetation of drift-lines within the SEMS is limited and their ecology is poorly understood.

7.4 Saltmarsh Communities

7.4.1 Baseline Conditions

Baseline information on saltmarsh has been discussed in detail against designated sites of nature conservation interest in Section 3. Saltmarsh communities within the Hamble Estuary include the pioneer saltmarsh species *Salicornia* and other annuals, Atlantic salt meadows and Cordgrass swards, which are classified separately under the Habitats Directive (English Nature, 2001). The total area of mapped saltmarsh within the Hamble Estuary is 60ha and there spatial distribution is presented in Figure 16. Of particular interest are the marshes found at Lincegrove and Hackett's Marsh (adjacent to Universal Marina) as these sites provide some of the best examples of mature saltmarsh on the south coast.

7.4.2 Sensitivity

Saltmarsh are sensitive to a number of impacts associated with the dredging operations within the Hamble Estuary. These include the following:

- **Generation of waves:** Passing of dredging vessels/barge can cause erosion at the lower boundary of saltmarsh. However, this level of erosion is limited due to the speed restrictions (6 knots) present within the Hamble. Furthermore, large cruise vessels using the river are likely to have a similar impact on the mudflats as the dredging vessels/barge;
- **Alteration to tidal propagation and estuary processes:** Saltmarsh habitats and their species are naturally dynamic and are adapted to morphological changes. However, if localised changes in morphology or estuarine processes are intensive and persistent then they will have a detrimental affect on saltmarsh;
- **Increase in suspended solids:** Dredging activities can alter sediment availability and this could change the concentration of suspended sediment and thus siltation. In estuaries, siltation is a natural process that is increased by the flocculation of inorganic and organic substances due to mixing of fresh and saltwater. Suspended sediment concentration around the English coast varies from 1-327mg/l and 1-227mg/l, but annual mean values are typically 1-110mg/l (Parr *et al.*, 1998). Suspended solids can have a positive effect on saltmarsh by increasing there potential to accrete. Another affect is the change in the reduction of light attenuation (turbidity), although this effect is usually short term;
- **Release of toxic contaminants:** Marinas are known to contain a range of synthetic substances such as tributyltin (TBT) and non-synthetic chemicals such as heavy metals (arsenic, cadmium, mercury) and hydrocarbons (oils). Saltmarsh are considered highly sensitive to synthetic chemicals and moderately sensitive to non-synthetic chemicals, although oil and oil products at even low levels can have a negative affect on saltmarsh (Holt *et al.*, 1995); and
- **Deoxygenation:** Dredging activity has the potential to increase suspended solid concentrations, which subsequently leads to bacterial activity that consumes available dissolved oxygen thus increasing the risk of deoxygenation of the water. Gray and

Jensen (1993) reported <4mg/l as the concentration likely to affect marine life and, therefore, to trigger cessation of dredging operations.

7.4.3 Exposure to Environmental Changes

Based on analysis undertaken in Section 6, saltmarsh will be exposed to the following environmental changes:

- **Generation of waves:** The Hamble Estuary is considered the largest recreational boating centre in Europe, although during the winter months activity is less intense. The degree of exposure from dredging activities against the typical background of boat activity in the Hamble will be minimal;
- **Increase in suspended solids:** Caused from disturbance of material to the water column, as sediment plumes (see Figure 16); and
- **Release of toxic contaminants:** It is likely that some chemicals will be re-suspended should they be present in the sediments to be dredged. The saltmarsh along the eastern side of the Hamble are more exposed due to their proximity and extent of the dredging plumes. However, the saltmarsh close to Universal Marina will also be exposed.

However, saltmarsh communities will not be exposed to the following:

- **Alteration to tidal propagation and estuary processes:** Maintenance dredging activity is not expected to alter the tidal prism or estuary processes within the Hamble. The balance of the sediment budget is considered to remain relatively the same despite dredging operations; and
- **Deoxygenation:** Despite increases in suspended solids the depletion of oxygen during the winter months is less likely than in summer, and the plume effects are localised and relatively short-lived.

7.4.4 Vulnerability

Given the level of exposure and sensitivity of saltmarsh to the potential environmental changes outlined above, vulnerability is likely to result in changes caused by suspended solids and re-suspension of toxic chemicals that may be present in the sediments to be dredged. However, these changes are likely to be temporary in nature, as plumes will relatively quickly return to background levels.

7.4.5 Assessment Against Nature Conservation Objectives

The nature conservation objective states that subject to natural change, saltmarsh should be maintained in favourable condition. Thus the vulnerability of saltmarsh will not adversely affect the nature conservation objective for this feature. Consequently, the impact on saltmarsh resulting from environmental changes associated with maintenance dredging is considered **not significant**.

Information on the precise impact of toxic chemicals on saltmarsh communities is limited, although a better understanding of saltmarsh accretion is known. Accretion rates should be assessed against changes in sea level rise and naturally occurring events.

7.5 Mudflat and Sandflat Communities

7.5.1 Baseline Conditions

Baseline information on mudflat and sandflat communities has been discussed in detail against designated sites of nature conservation interest in Section 3. The Hamble has 125ha of mudflat habitats composed of intertidal mud communities, intertidal mixed sediment communities, intertidal muddy sand communities and intertidal sand communities. Figure 15 shows the extent of the intertidal zone within the Hamble Estuary, which for the present assessment has been considered indicative of the spatial extent of intertidal mudflats.

7.5.2 Sensitivity

Mudflats are sensitive to a number of impacts associated dredging activities and include the following:

- **Physical presence:** The greatest sensitivity is the removal of subtidal communities. Visual disturbance from dredging vessels to over-wintering bird populations that use the mudflats for food can also be sensitive to maintenance dredging generally, however, this will be minimal in the Hamble as the river is typically a busy waterway for other vessels. Any potential changes in the seabed as a direct result of scouring effects, particularly to the top of the side slopes immediately adjacent to the edge of the maintained area, are also important;
- **Generation of waves:** Passing of dredging vessels/barge can cause erosion of mudflats by re-suspending soft sediment material, which is either carried to the saltmarsh boundary thus assisting in saltmarsh accretion or transported away from the mudflats in the direction of the prevailing tidal flow. However, this level of erosion is limited due to the speed restrictions (6 knots) present within the Hamble. Furthermore, large cruise vessels using the river are likely to have a similar impact on the mudflats as the dredging vessels/barge;
- **Alteration to tidal propagation and estuary processes:** As with saltmarsh, mudflats and their species are naturally dynamic and are adapted to morphological changes. Potential intensive and persistent changes in the morphology or estuarine processes will have a detrimental affect on mudflats and the species they support;
- **Increase in turbidity:** Increased suspended solids from dredging plumes will result in an increase in turbidity hence diminishing light penetration to the seabed. Mudflats are not directly affected, but species and the settling out of suspended sediments are likely to affect community dynamics. The most sensitive species are those that are visually orientated and gill/filter feeders such as bivalves;
- **Increase in suspended solids:** Dredging activities can alter sediment availability and this could change the concentration of suspended sediment and thus siltation. Mudflat communities may be sensitive to siltation as smothering may cause clogging of respiratory or feeding apparatus of species;

- **Release of toxic contaminants:** Mudflat communities may be sensitive to synthetic and non-synthetic chemicals re-suspended from marina borne sediments; and
- **Deoxygenation:** Concentrations of organic material that is considerably higher than background levels have the potential to deoxygenate the water, which will affect oxygen sensitive marine life associated with mudflats.

7.5.3 Exposure to Environmental Changes

Based on analysis undertaken in Section 6, mudflat and sandflat communities will be exposed to the following environmental changes:

- **Physical presence:** Visual disturbance of dredging vessels to over-wintering bird populations using the mudflats for food will be minimal as the estuary is typically a busy waterway for yachting vessels. Potential scouring as a result of maintenance dredging may cause erosion of the side slopes to the mudflats, although this impact is likely to be minimal as background disturbance is usually greater;
- **Generation of waves:** Is likely to be minimal considering normal levels of vessel activity within the estuary;
- **Increase in turbidity:** Visually orientation fauna and sessile gill/filter feeders will be temporarily affected, but since many of the visual species tend to be mobile they will be able to avoid plumes which are not predicted to substantially affect the whole cross section;
- **Increase in suspended solids:** Smothering due to the settling of disturbed material may cause clogging of respiratory or feeding apparatus of species. In most cases these affects will be localised to the dredge sites and temporary as the prevailing tidal flows are likely to keep most of the suspended solids in suspension; and
- **Release of toxic contaminants:** Mudflat communities will be exposed to synthetic and non-synthetic chemicals re-suspended from marina borne sediments. However, the extent of the intensive plume carrying these chemicals will be confined to localised areas (see plume envelopes in Figure 16).

However, mudflat communities will not be exposed to the following:

- **Alteration to tidal propagation and estuary processes:** Maintenance dredging activity is not expected to alter the tidal prism or estuary processes within the Hamble. The balance of the sediment budget is considered to remain relatively the same despite dredging operations; and
- **Deoxygenation:** Despite increases in suspended solids the depletion of oxygen during the winter months is less like than in summer, and the plume effects are localised and relatively short-lived.

7.5.4 Vulnerability

Given the level of exposure and sensitivity of mudflats to the potential environmental changes outlined above, vulnerability is likely to result in changes caused by physical presence, increased turbidity, suspended solids and re-suspension of toxic chemicals. However, these

changes are likely to be temporary in nature, as plumes will fall to the range of background levels over a relatively short period.

7.5.5 Assessment Against Nature Conservation Objectives

The nature conservation objective states that subject to natural change, mudflats should be maintained in favourable condition. Thus the vulnerability of the mudflats to the dredging activity will not adversely affect the nature conservation objective for this feature. Consequently, the impact on mudflats resulting from environmental changes associated with maintenance dredging is considered **not significant**.

Information on the nature and extent of chemicals, smothering and turbidity on many marine species associated with mudflats and bird populations are however limited specifically for the Hamble Estuary.

7.6 Subtidal Communities (Including Sandbanks, Gravel and Sand Communities)

7.6.1 Baseline Conditions

Baseline information on subtidal communities has been discussed in detail against designated sites of nature conservation interest in Section 3. There are three types of subtidal communities within the SEMS; gravely sand and sand, subtidal muddy sand and subtidal eelgrass *Zostera marina* beds. However, only subtidal gravel and sand, and muddy sand communities have been reported between the estuary mouth at Hamble Point and up stream as far as Swanwick Marina (Velegrakis, 2000) and form part of the SEMS.

7.6.2 Sensitivity

Subtidal communities are sensitive to a number of impacts associated with the proposed dredging activities and include the following:

- **Physical presence:** Potential changes in the seabed as a direct result of scouring effects may lead to erosion of the seabed;
- **Alteration to tidal propagation and estuary processes:** Intensive and persistent changes in the morphology or estuarine processes will have a detrimental affect on subtidal communities and the species they support;
- **Increase in turbidity:** Increased suspended solids from dredging plumes will result in an increase in turbidity. Visually orientated fauna and gill feeders such as bivalves are the most sensitive species;
- **Increase in suspended solids:** Dredging activities can alter sediment availability and this could change the concentration of suspended sediment and thus siltation rates. Subtidal communities are very sensitive to smothering as it leads to clogging of respiratory or feeding apparatus of those species unable to adjust to new levels of surface sediment;
- **Release of toxic contaminants:** Subtidal communities will be sensitive to synthetic and non-synthetic chemicals re-suspended from marina borne sediments; and

- **Deoxygenation:** Concentrations of organic material that is significantly higher than background levels have the potential to deoxygenate the water, which will affect oxygen sensitive marine life associated with subtidal communities.

7.6.3 Exposure to Environmental Changes

Based on analysis undertaken in Section 6, subtidal communities will be exposed to the following environmental changes:

- **Physical presence:** Potential scouring as a result of maintenance dredging may cause erosion of the seabed surface, although this impact is likely to be localised;
- **Increase in turbidity:** Visually orientation fauna and sessile gill/filter feeders will be temporarily affected, but since many of the visual species tend to be mobile they will be able to avoid plumes;
- **Increase in suspended solids:** Settlement of disturbed material to cause smothering may cause clogging of respiratory or feeding apparatus of species. In most cases these affects will be localised to dredge sites and temporary as the prevailing tidal flows are likely to keep most of the suspended solids in suspension for long enough to cause widespread dispersion and eventually settlement at a very slow rate; and
- **Release of toxic contaminants:** Subtidal communities will be exposed to synthetic and non-synthetic chemicals re-suspended from marina borne sediments. However, the plume extent carrying these chemicals will be confined to localised areas (see plume envelopes in Figure 16).

However, subtidal communities will not be exposed to the following:

- **Alteration to tidal propagation and estuary processes:** maintenance dredging activity is not expected to alter the tidal prism or estuary processes within the Hamble. The balance of the sediment budget is considered to remain relative the same despite dredging operations; and
- **Deoxygenation:** Despite increases in suspended solids the depletion of oxygen during the winter months is less like than in summer, and the plume effects are localised and relatively short-lived.

7.6.4 Vulnerability

Given the level of exposure and sensitivity of subtidal communities to the potential environmental changes outlined above, vulnerability is likely to result in changes caused by physical presence (habitat removal), increased turbidity, suspended solids and re-suspension of toxic chemicals. However, these changes are likely to be temporary in nature, as plumes will fall within the range of background levels over a relatively short period.

7.6.5 Assessment Against Nature Conservation Objectives

The nature conservation objective states that subject to natural change, subtidal communities should be maintained in favourable condition. Thus vulnerability will not adversely affect the nature conservation objective for this feature. Consequently, the impact on subtidal

communities resulting from environmental changes associated with maintenance dredging is considered **not significant**.

Information on the precise nature of the benthic communities removed during the dredging operations is limited.

7.7 Birds

7.7.1 Baseline Conditions

Baseline information on birds has been discussed in detail against designated sites of nature conservation interest in Section 3. Bird species and numbers are directly linked to the extent and quality of the habitats used for roosting, feeding and overwintering. For the Hamble Estuary, these habitats include saltmarsh, mudflats and subtidal communities (that support the fish and benthic fauna preyed on by birds).

7.7.2 Sensitivity

Bird populations are sensitive to a number of impacts associated with the dredging activities and include the following:

- **Physical presence:** Visual presence of the dredger has the potential to cause disturbance to feeding and roosting bird populations, however, this will be minimal in the Hamble as the river is typically a busy waterway for other vessels. Other potential changes are indirect and include loss of feeding habitat and resources through scouring of the seabed during dredging;
- **Noise generation:** Noise from a dredger has the potential to cause disturbance as outlined in above;
- **Alteration to tidal propagation and estuary processes:** Intensive and persistent changes in the morphology or estuarine processes will have a detrimental affect on bird habitats and the prey species they support.
- **Increase in turbidity:** Increased suspended solids from dredging plumes will result in an increase in turbidity. The visual ability of birds to find and catch prey could potentially be affected;
- **Increase in suspended solids:** Dredging activities can alter sediment availability and this could change the concentration of suspended sediment and thus siltation. Any changes in the extent and quality of a birds preferred habitat as a result of siltation has the potential to have a negative affect on bird populations; and
- **Release of toxic contaminants:** Birds are potentially, directly and indirectly sensitive to synthetic and non-synthetic chemicals re-suspended from marina borne sediments.

7.7.3 Exposure to Environmental Changes

Based on analysis undertaken in Section 6, bird populations will be exposed to the following environmental changes:

- **Physical presence:** The visual presence of the dredger will be minimal compared to the background boating activity of the Hamble. Where disturbance to feeding and roosting bird populations occurs it will be temporary;
- **Increase in turbidity:** Since intensive sediment plumes will be relatively short lived, impact to the birds feeding opportunities will not be an issue. The use of mudflats as feeding grounds will tend to occur during lower tides and plumes will not directly affect this activity;
- **Increase in suspended solids:** Siltation caused by the eventual settlement of the disturbed material will be an indirect effect on bird feeding opportunities. This is not expected to be an issue due to the relatively small amounts of disturbed material and its widespread dispersion thus limiting the amount of siltation in any one area; and
- **Release of toxic contaminants:** Plumes potentially carrying synthetic and non-synthetic chemicals will be confined locally to the areas of dredging plume envelopes, but is a potential indirect impact on bird population. The widespread dispersion and the legislative controls on the current dredge methodology reduce the likelihood of this being an issue.

However, subtidal communities will not be exposed to the following:

- **Alteration to tidal propagation and estuary processes:** Maintenance dredging activity is not expected to alter the tidal prism or estuary processes within the Hamble. The balance of the sediment budget is considered to remain relative the same despite dredging operations.

7.7.4 Vulnerability

Given the level of exposure and sensitivity of birds to the potential environmental changes outlined above, vulnerability is likely to result in changes caused by physical presence, increased turbidity, suspended solids and re-suspension of toxic chemicals. However, these changes are likely to be temporary in nature, as dredging activity is relatively infrequent and plumes will fall within the range of background levels over a relatively short period.

7.7.5 Assessment Against Nature Conservation Objectives

Nature conservation objectives for birds are stated in Section 3. The vulnerability to current dredging activity will not adversely affect the nature conservation objective for this feature. Consequently, the impact on birds resulting from environmental changes associated with maintenance dredging is considered **not significant**.

8. Discussion

It has been determined (Section 6) that the overall average removal of material from the estuary from maintenance dredging approximately counterbalances the additional natural annual supply of sediment to the Hamble caused by the creation of the marinas. The net effect of the maintenance dredging is therefore one of approximate stability in the system. This conclusion is supported by the observation of little widespread change of saltmarsh and

mudflat within the estuary over the last 35 years and little evidence of trends from aerial photography over the last 15 years. This information also suggests the supply of sediment to the system is, at present sufficient to allow the vertical intertidal development to keep pace with current levels of sea level rise. It does not however indicate whether this will be the case for predicted increased rates of sea level rise. Since most of the designations were set with the current dredging activities taking place and their effect is not adversely affecting those features for which it was designated there is no reason on the grounds of sediment management to curtail the current level and methodology of maintenance dredging in the Hamble Estuary.

The assessment of the extent and concentration magnitude of the plumes associated with the current maintenance dredging practice within the Hamble Estuary indicates that the main impacts remain close to the dredge location. Dilution of any disturbed plume is relatively rapid and the fine nature of the sediment means it is likely to stay in suspension for several tides. The relatively small volume compared to the background sediment in the system means that the change will be of the same order as the natural variation in the system. The impact assessment has identified and evaluated the potential effects of this disturbed sediment and has concluded that, for the most part, all potential impacts arising from the current dredging practice have a negligible impact on the nature conservation features of the estuary. The assessment, based on the information currently available, gives no reason to believe that the current dredging practice (defined as that undertaken between 1986 and 2010) is detrimental to the favourable condition of any of the designated features of the Hamble Estuary. However, it should be noted that the favourable condition assessment is based on the fact that there is no quantitative data to say otherwise.

Based on the assessment of current dredging activities within the Hamble (Section 6), there are already a number of operational activities that minimise the potential impact of dredging on natural conservation features:

- Dredging is presently conducted during the winter months, which is less likely to interfere with migration, spawning and nursery activities of marine fauna;
- Direct interactions between individual dredging operations are unlikely to occur since often the same contractor is used. This minimises any in-combination impacts from sediment plumes;
- Operations are variable from between every 1-10 years making impacts very localised and temporary in character;
- During each campaign dredging is not round the clock, restricted by material disposal (approximately an 8 hour return journey to the disposal site) and manoeuvring of the dredger/barge. This allows periods of 'recovery' during the dredging period rather than a continuous build up; and
- The disturbance whilst dredging the up estuary marinas is predominantly moved up estuary and provides an additional supply of material to this predominantly 'natural' area.

Should future monitoring suggest the estuary would benefit from maintaining additional sediment in the system there is potential to increase the disturbance during the dredging by introducing different plant/methods. Careful monitoring of these techniques would however be

required to ensure potential impacts of smothering, turbidity and deoxygenation did not increase from a negligible to a significant impact.

8.1 Future Development of the Dredge Management Plan

At the outset it was envisaged that there may be a need to develop an alternative dredging regime for the estuary, with specific beneficial use schemes to negate the impacts of the maintenance dredging. This assessment of the data available suggests such specific practices are not required to offset the dredging impacts. There is still benefit in drawing up a strategic plan for the estuary as a whole, which will ensure detriment to the estuary does not occur in the future. This will assist all stakeholders in their individual obligations under both existing and future nature conservation legislation on the estuary.

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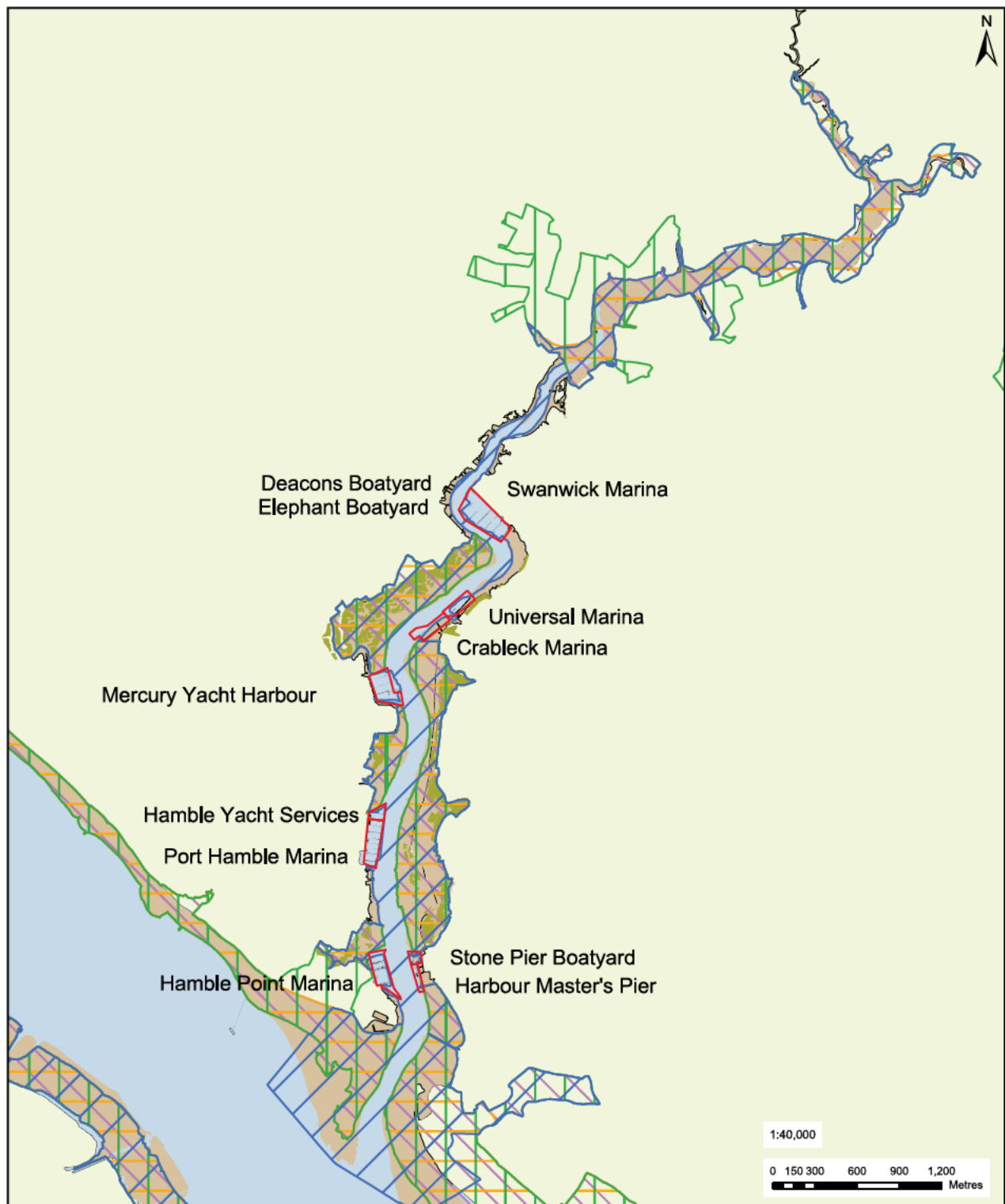
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Figures



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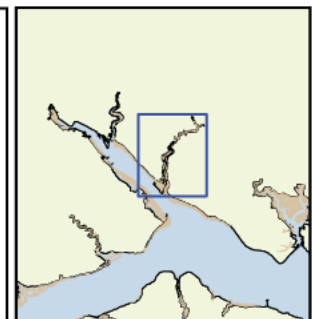
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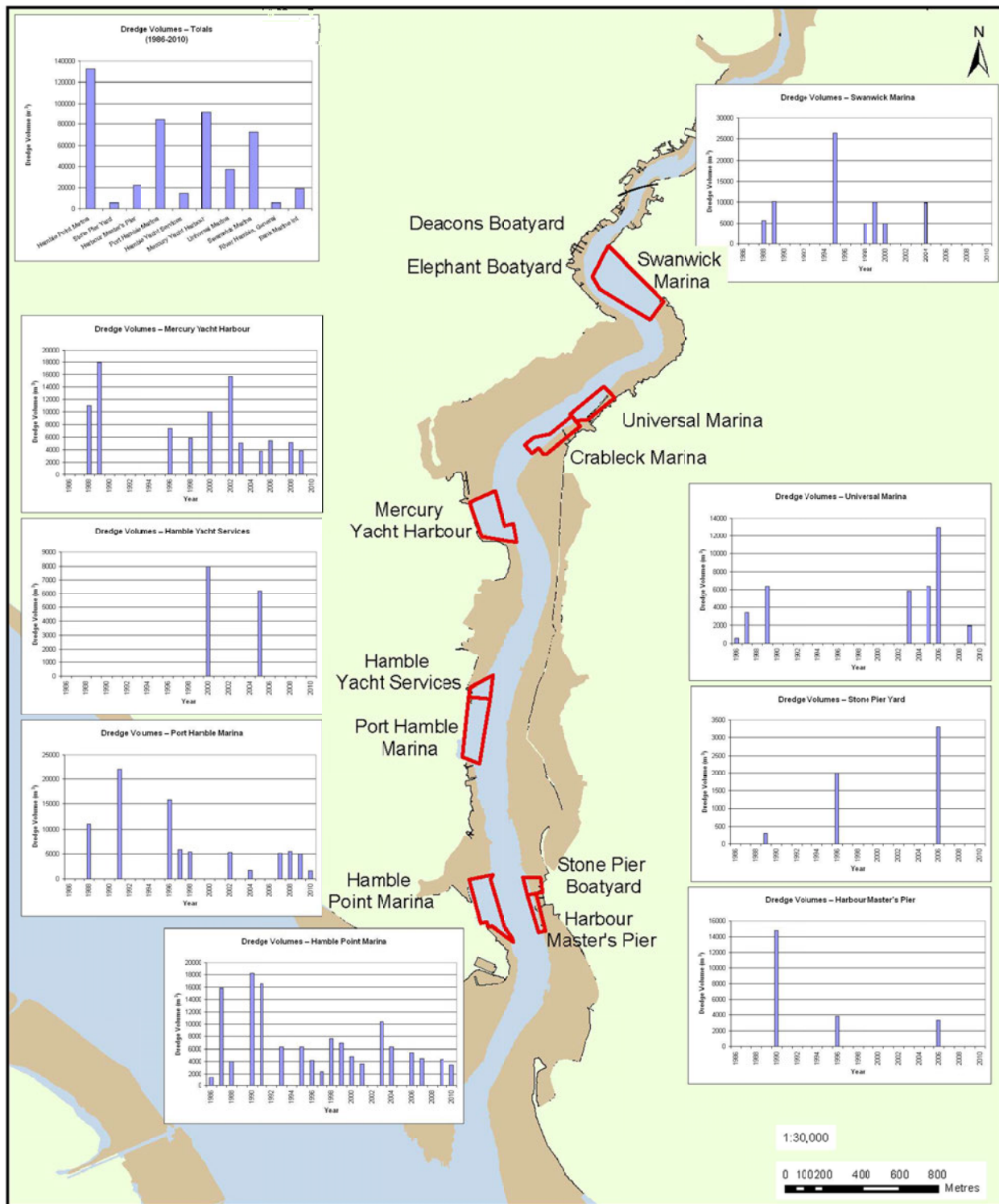
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| Site of Special Scientific Interest (SSSI) | Subtidal |
| Special Protection Area (SPA) | |
| Ramsar | |
| Saltmarsh - 1996 | |

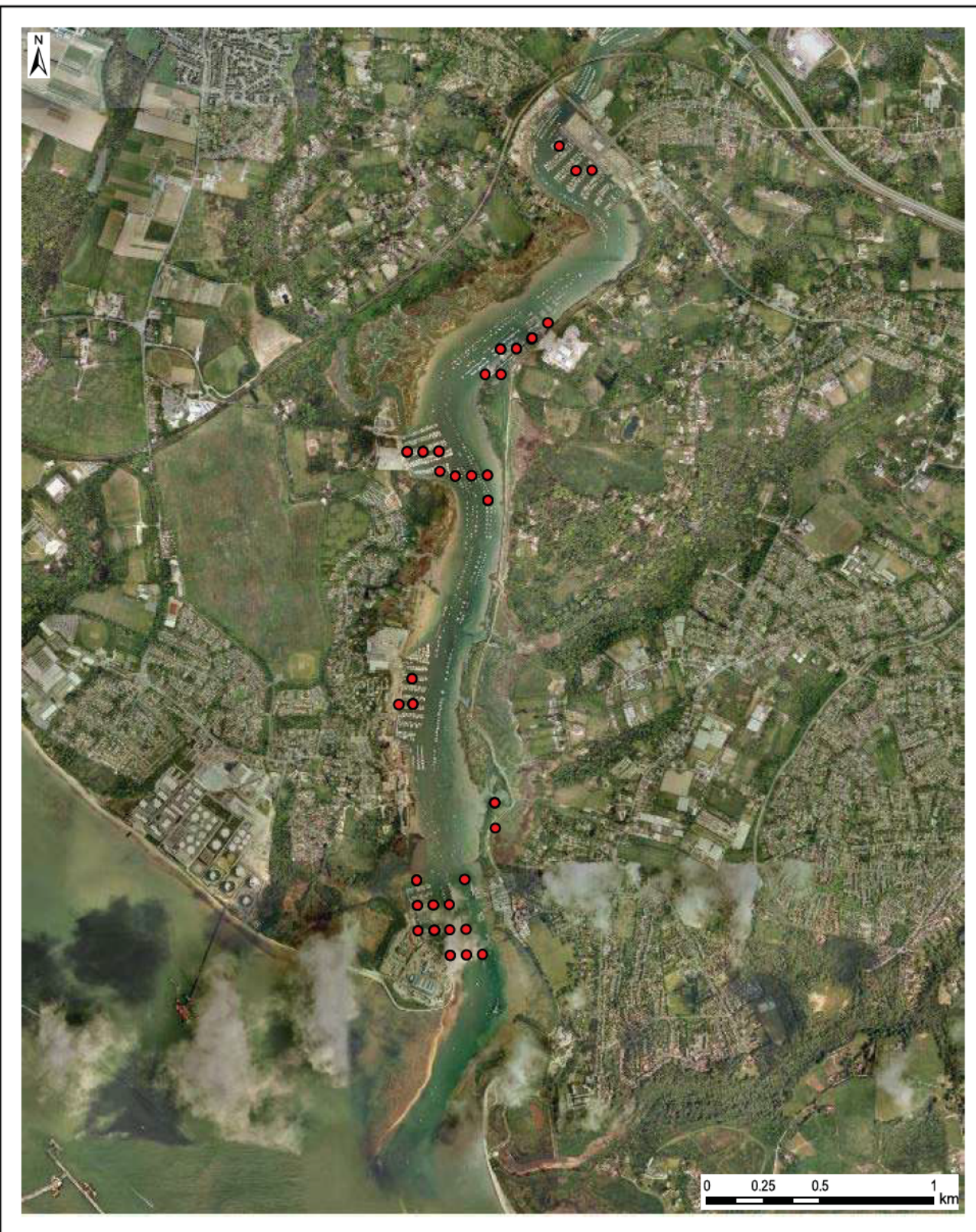




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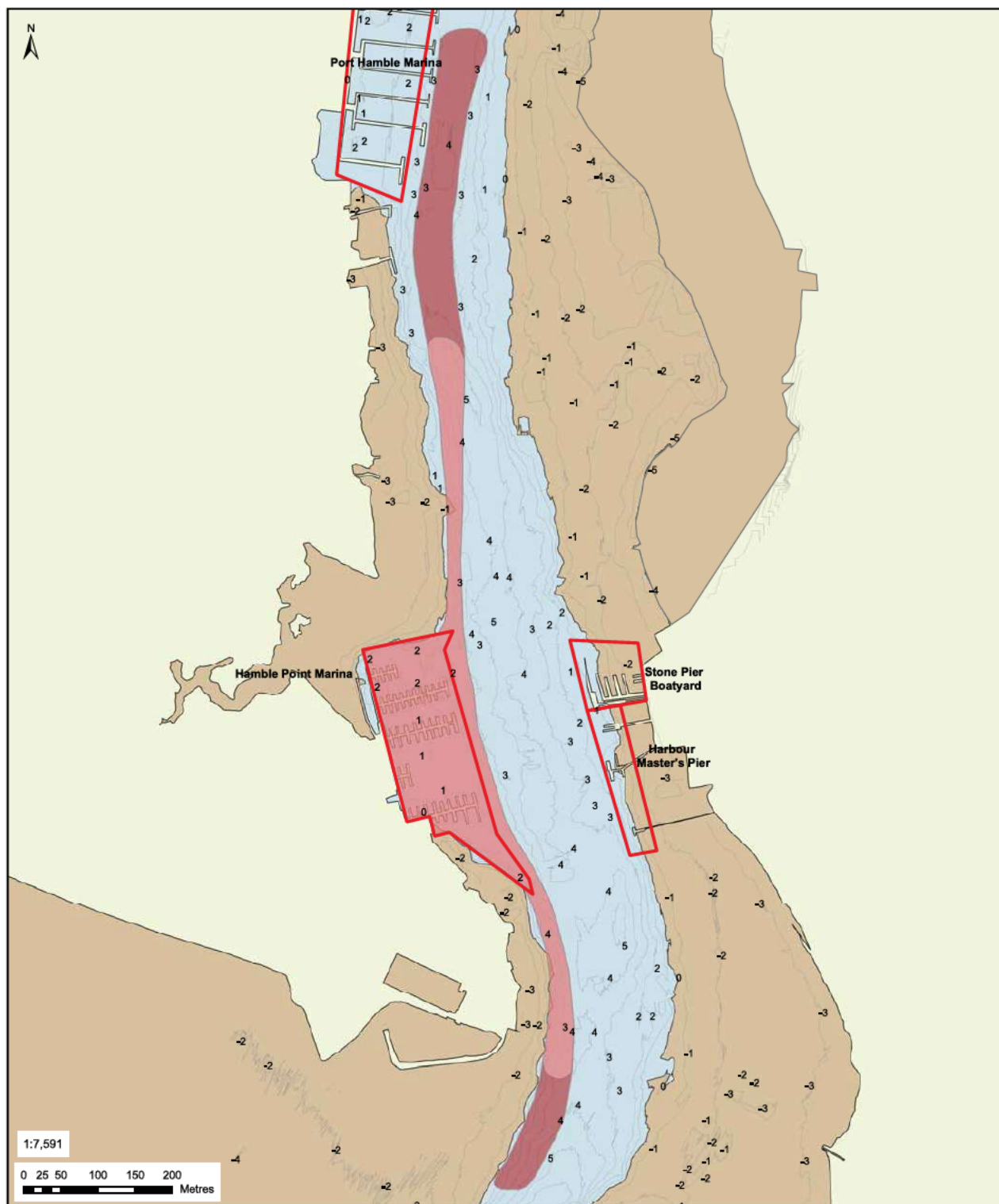
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● Sediment Quality Samples



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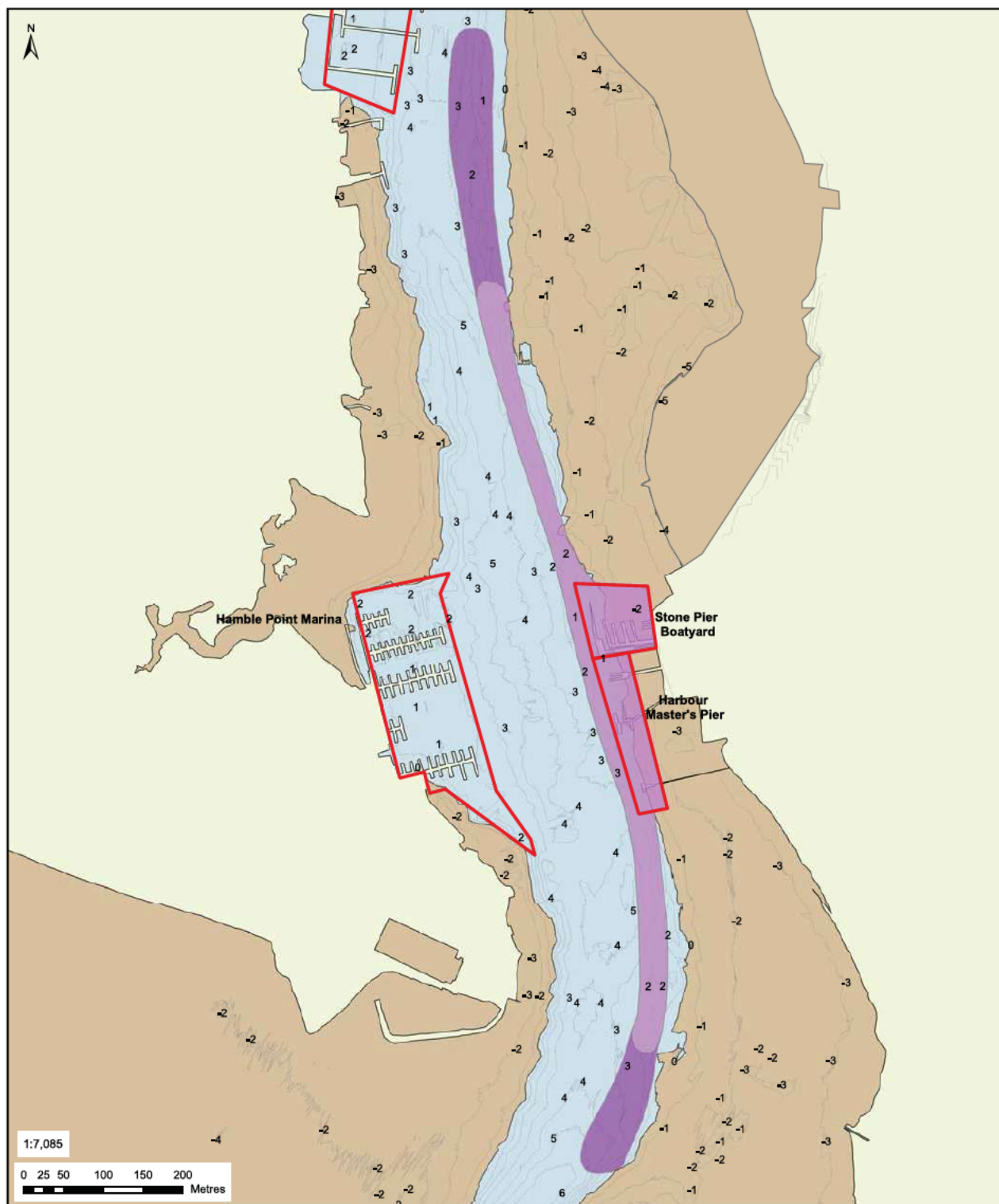
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- Hamble Point Dredge Plume - Spring Tide
- Intertidal
- Land
- Subtidal

Dredge plume extent where suspended
solids are likely to be greater than 10mg/l
above background levels





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 Dredged Areas

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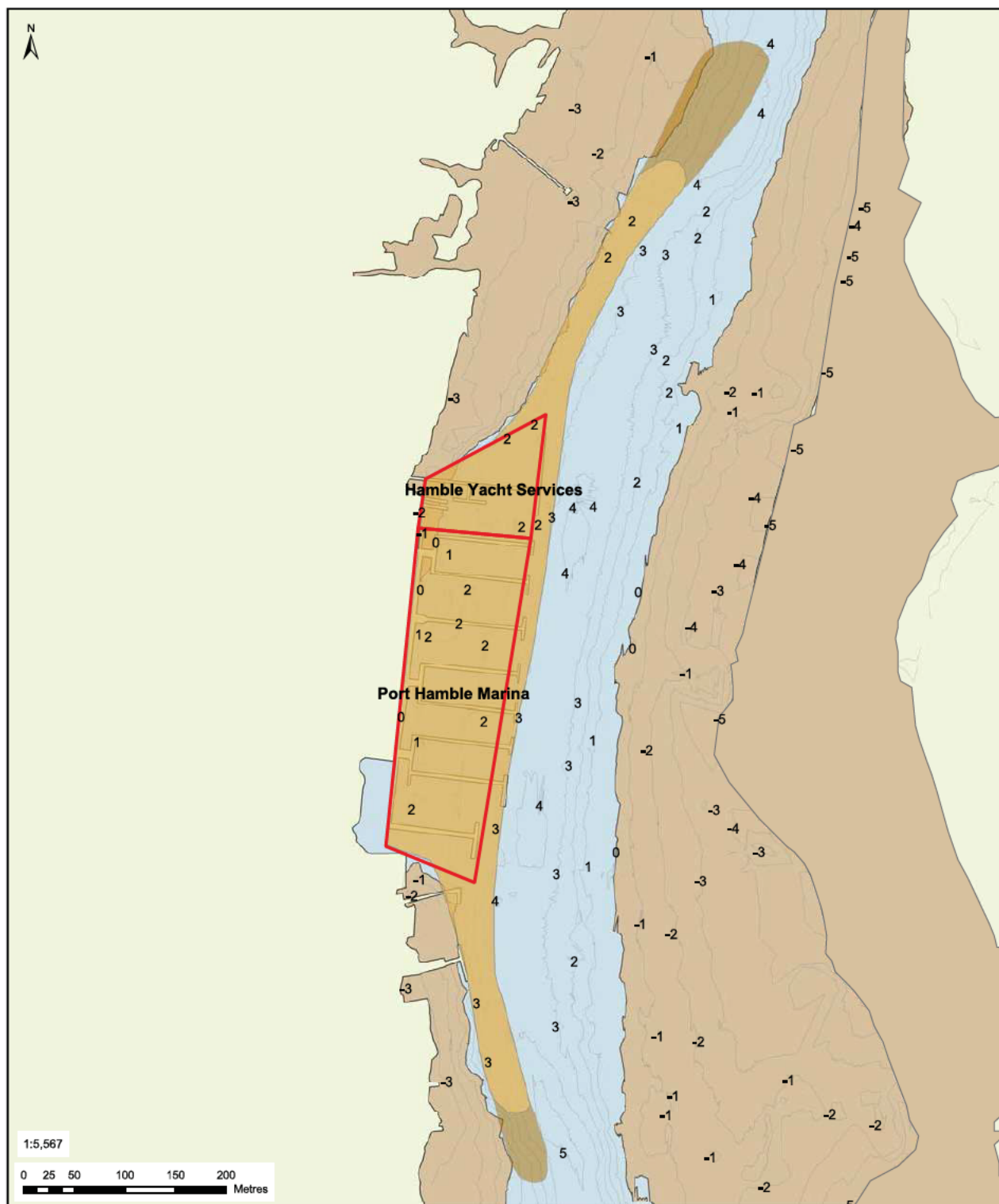
 Intertidal

 Land

 Subtidal

Dredge plume extent where suspended
solids are likely to be greater than 10mg/l
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Dredged Areas

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Port H Marina & H Yacht Services Plume - Spring Tide

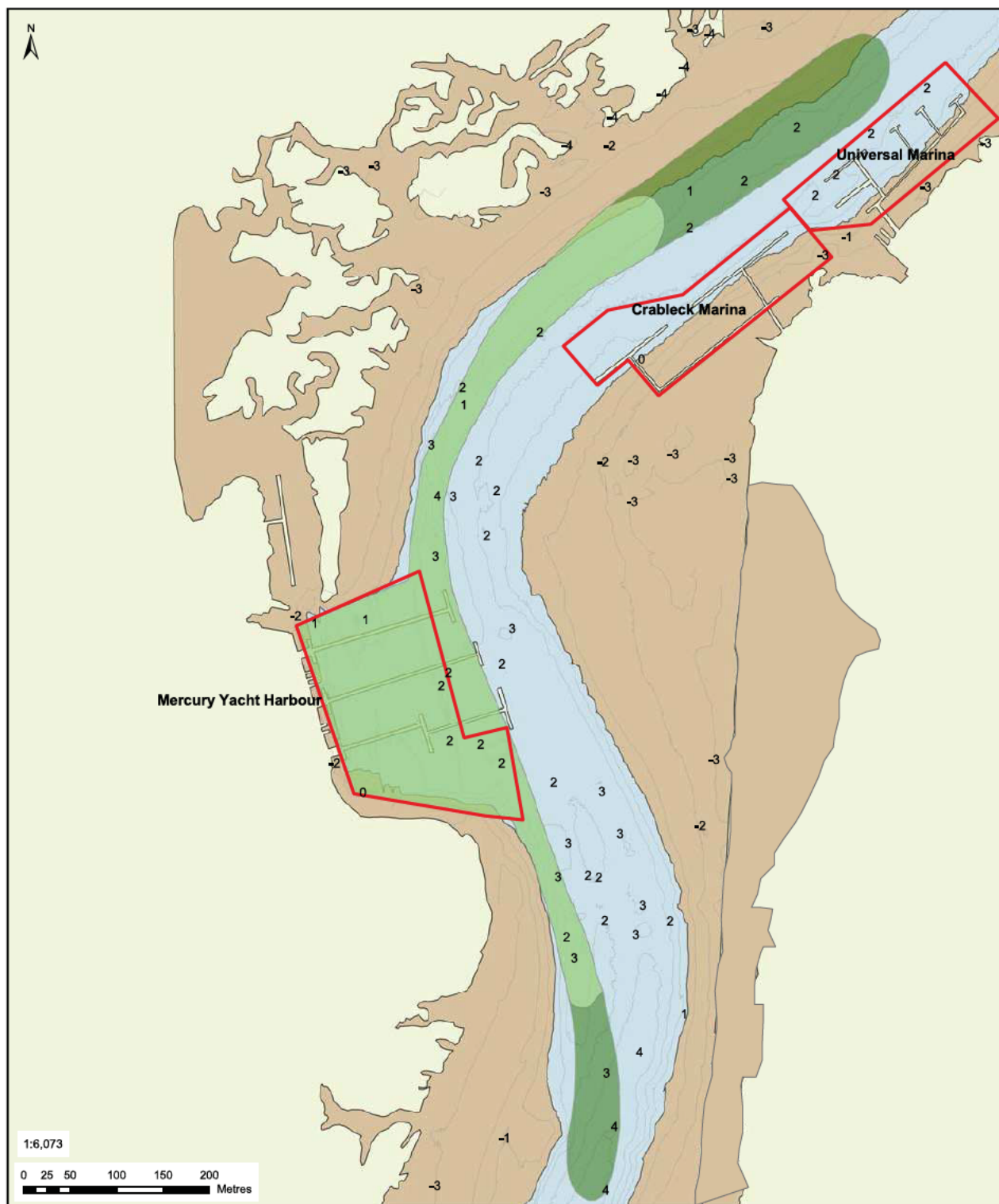
Intertidal

Land

Subtidal

Dredge plume extent where suspended
solids are likely to be greater than 10mg/l
above background levels





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 Dredged Areas

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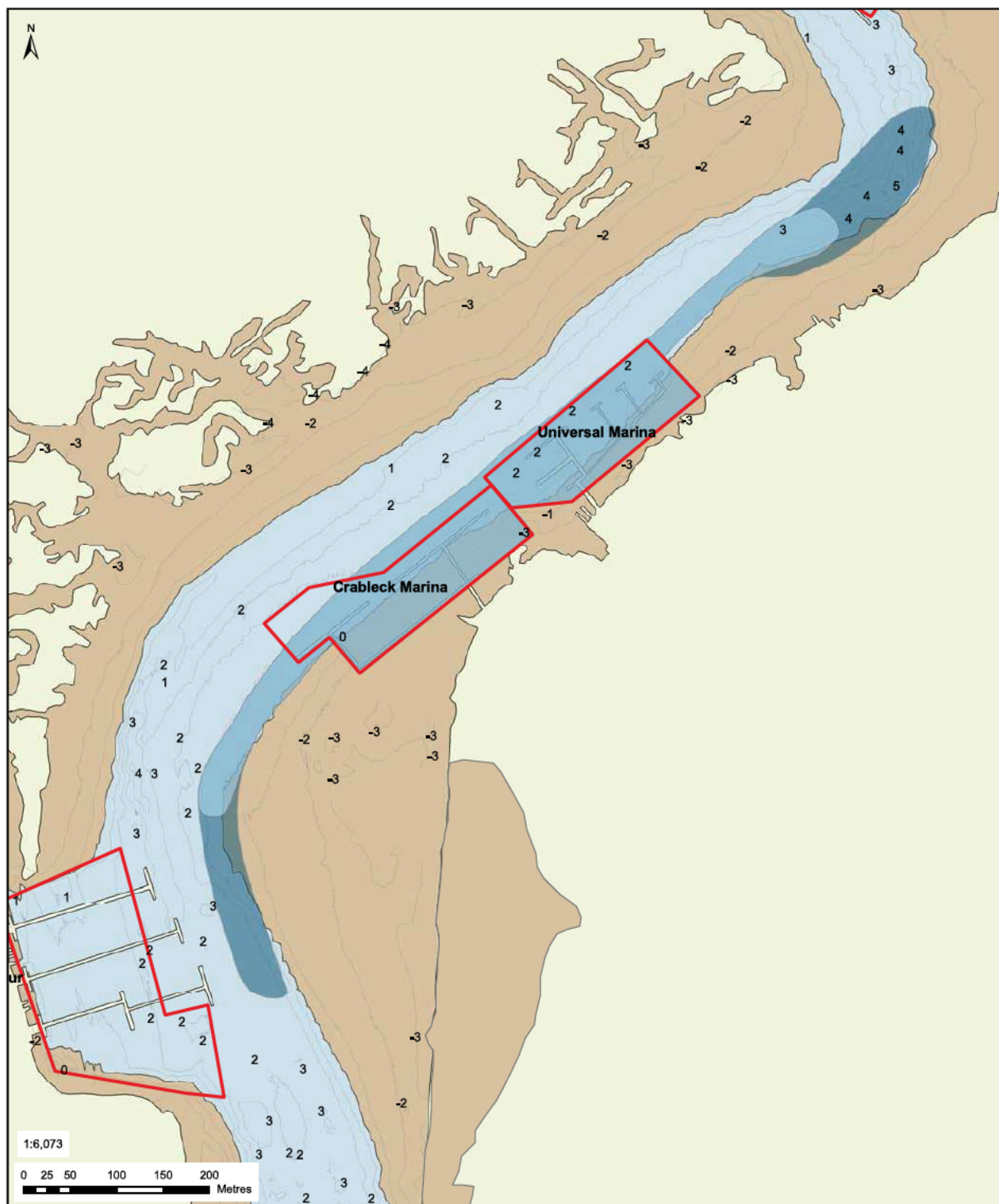
 Intertidal

 Land

 Subtidal

Dredge plume extent where suspended
solids are likely to be greater than 10mg/l
above background levels





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Dredged Areas

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Crableck & Universal Marina Dredge Plume - Spring Tide

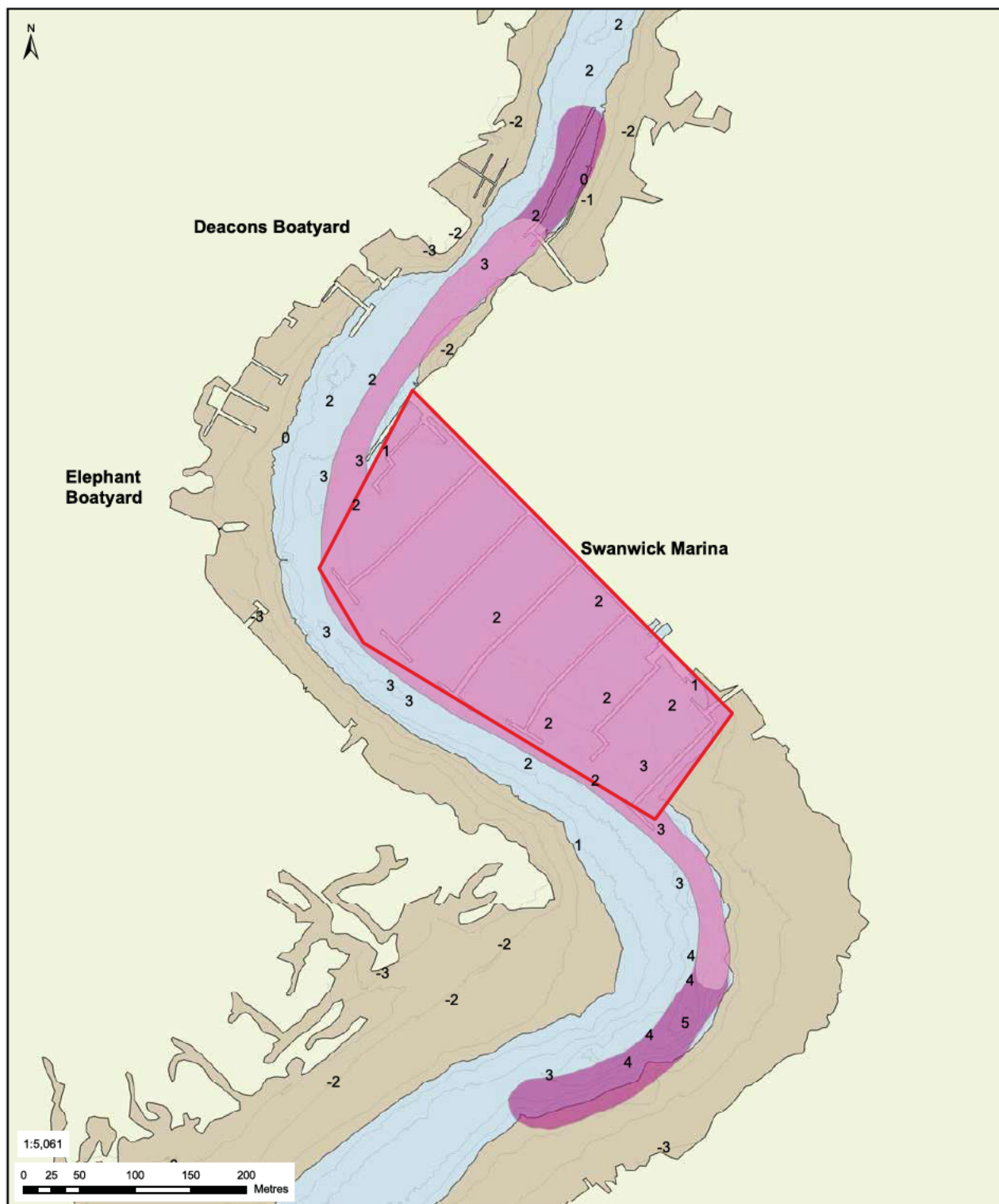
Intertidal

Land

Subtidal

Dredge plume extent where suspended
solids are likely to be greater than 10mg/l
above background levels





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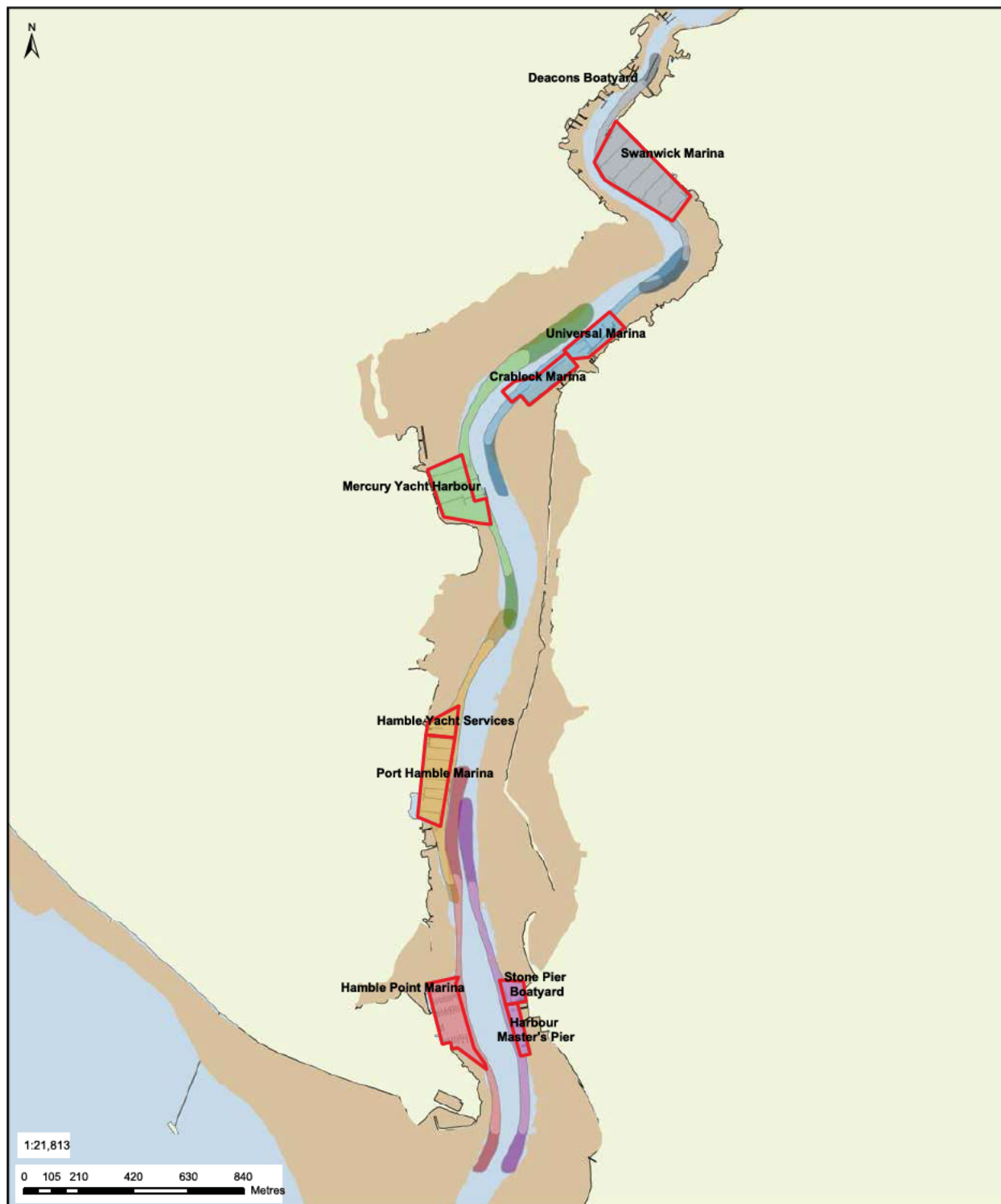
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- Dredged Areas
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- Swanwick Marina Dredge Plume - Spring Tide
- Intertidal
- Land
- Subtidal

Dredge plume extent where suspended
solids are likely to be greater than 10mg/l
above background levels





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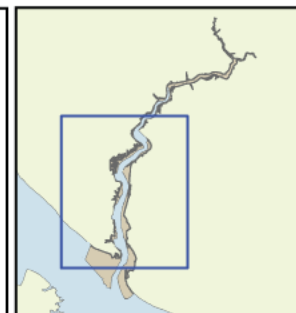
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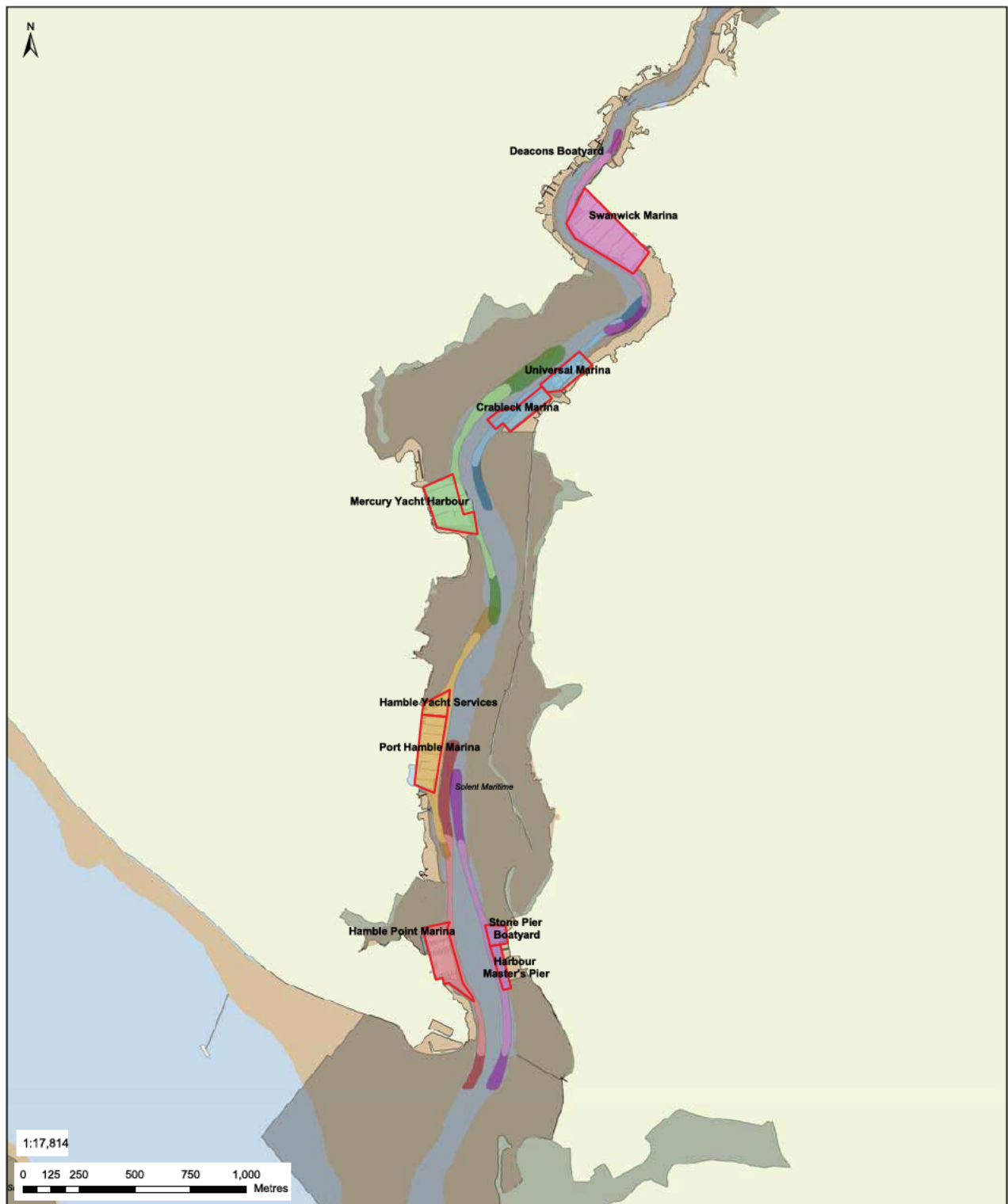
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- Crabbleck & Universal Marina Dredge Plume - Spring Tide
- Harbour Master's & Stone Pier Boatyard Plume - Neap Tide
- Mercury Yacht Harbour Dredge Plume - Neap Tide
- Mercury Yacht Harbour Dredge Plume - Spring Tide
- Port H Marina & H Yacht Services Plume - Spring Tide
- Harbour Master's & Stone Pier Boatyard Plume - Spring Tide
- Hamble Point Dredge Plume - Neap Tide
- Hamble Point Dredge Plume - Spring Tide

- Intertidal
- Land
- Subtidal

Dredge plume extent
where suspended
solids are likely to be
greater than 10mg/l
above background
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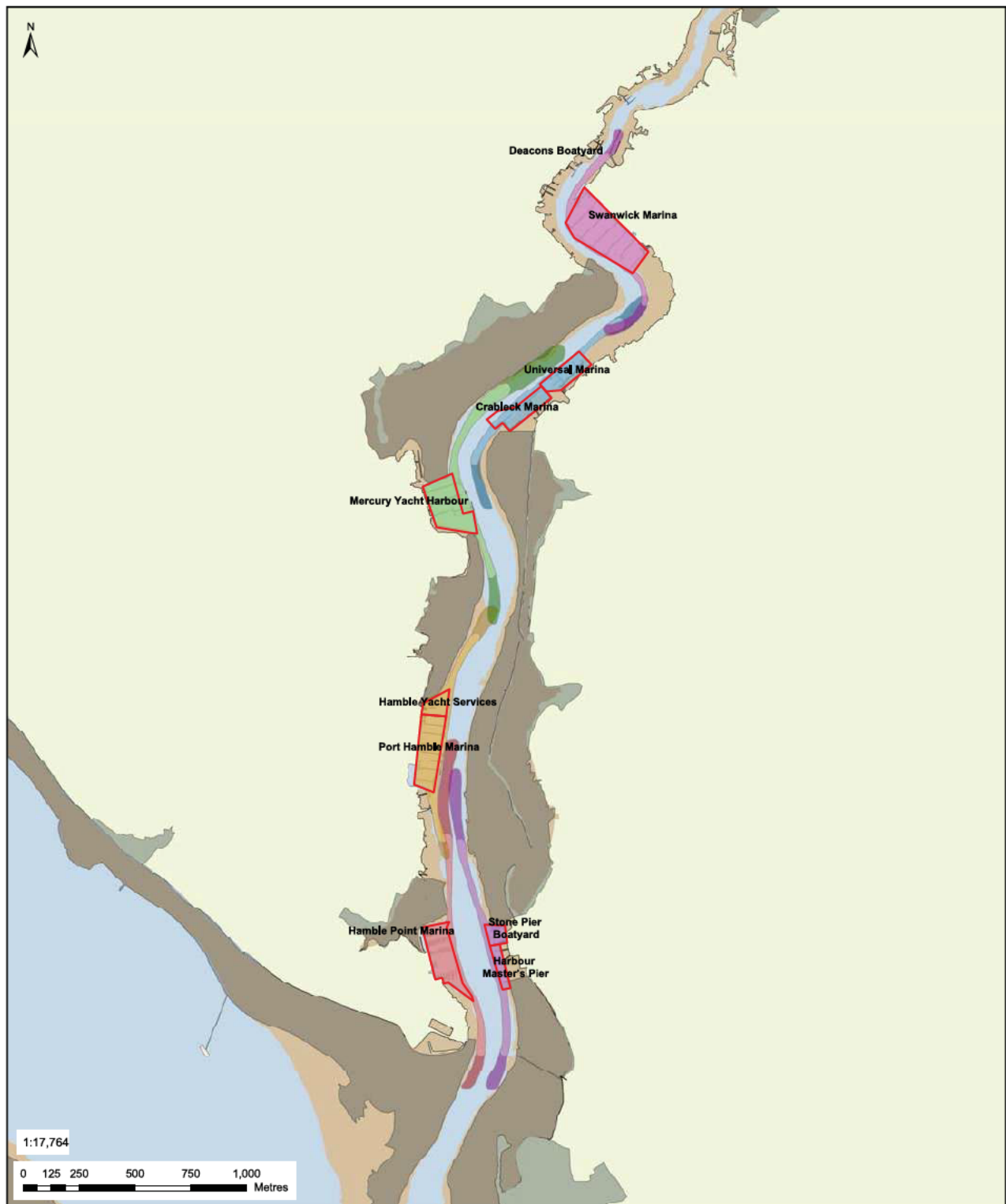
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- Harbour Master's & Stone Pier Boatyard Plume - Spring Tide
- Hamble Point Dredge Plume - Neap Tide
- Hamble Point Dredge Plume - Spring Tide

- Dredged Areas
- Intertidal
- Land
- Subtidal

Dredge plume extent
where suspended
solids are likely to be
greater than 10mg/l
above background
levels





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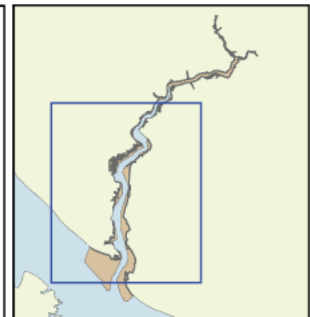
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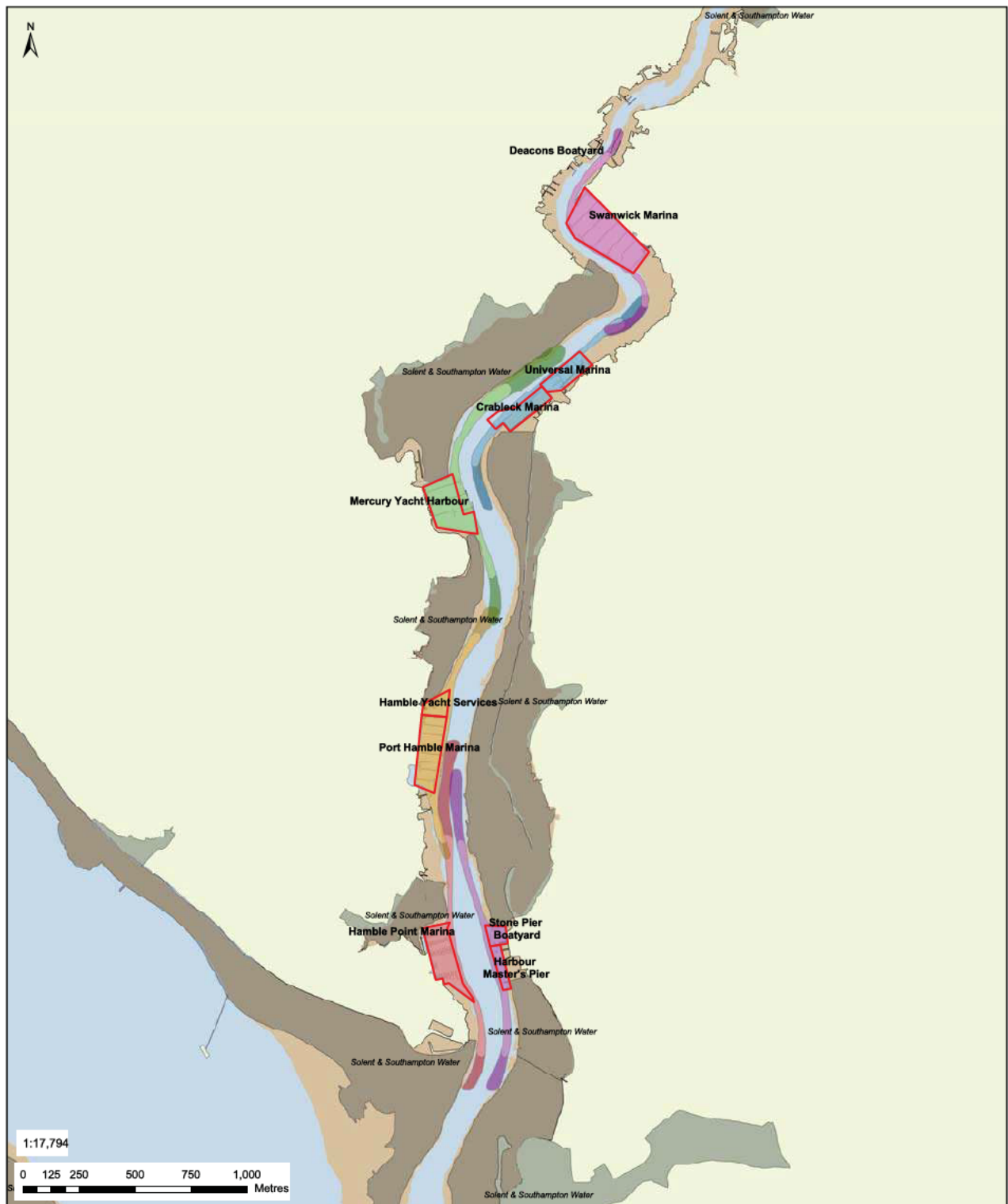
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|---|---|

Dredge plume extent
where suspended
solids are likely to be
greater than 10mg/l
above background
levels





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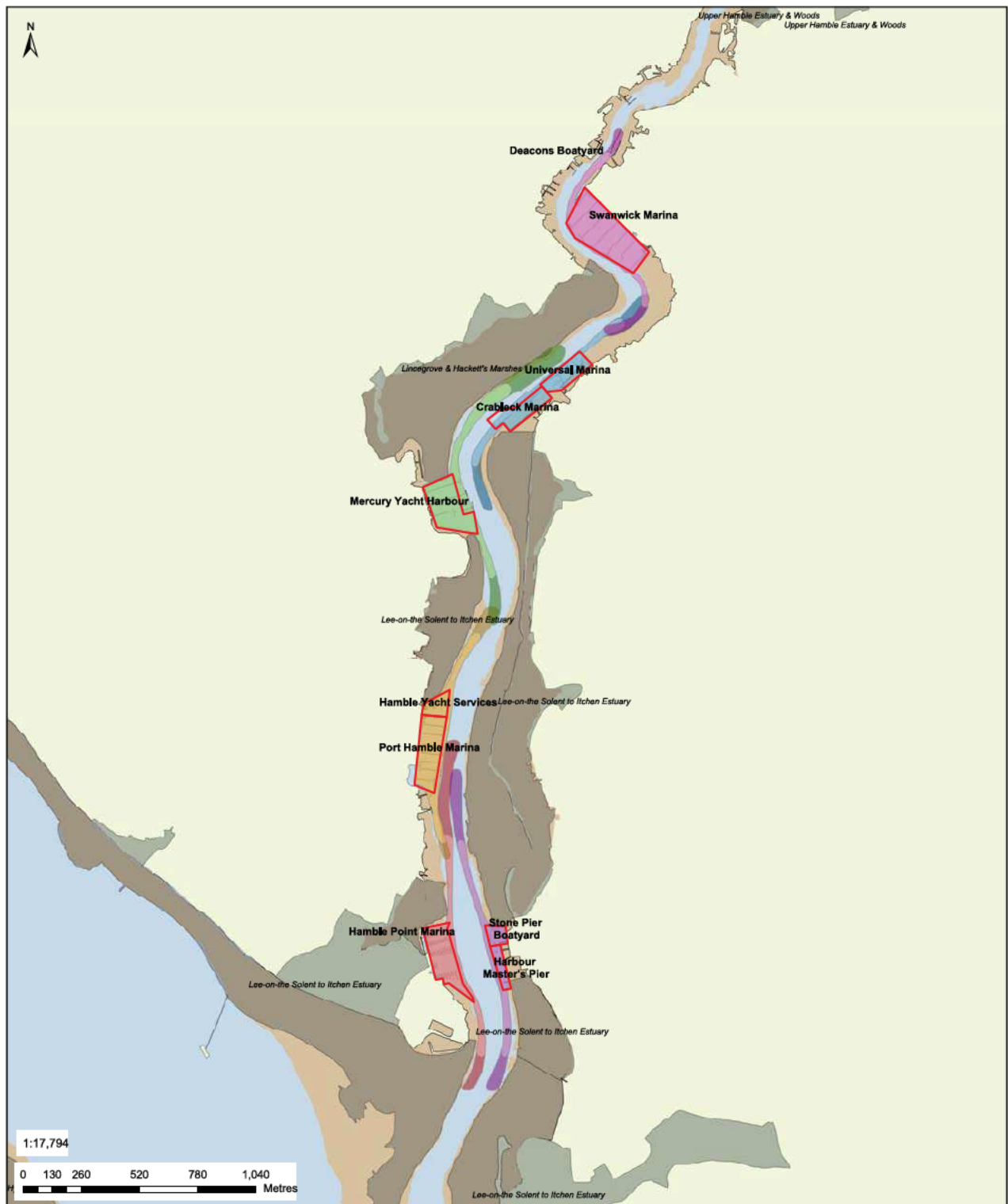
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Dredge plume extent
where suspended
solids are likely to be
greater than 10mg/l
above background
levels





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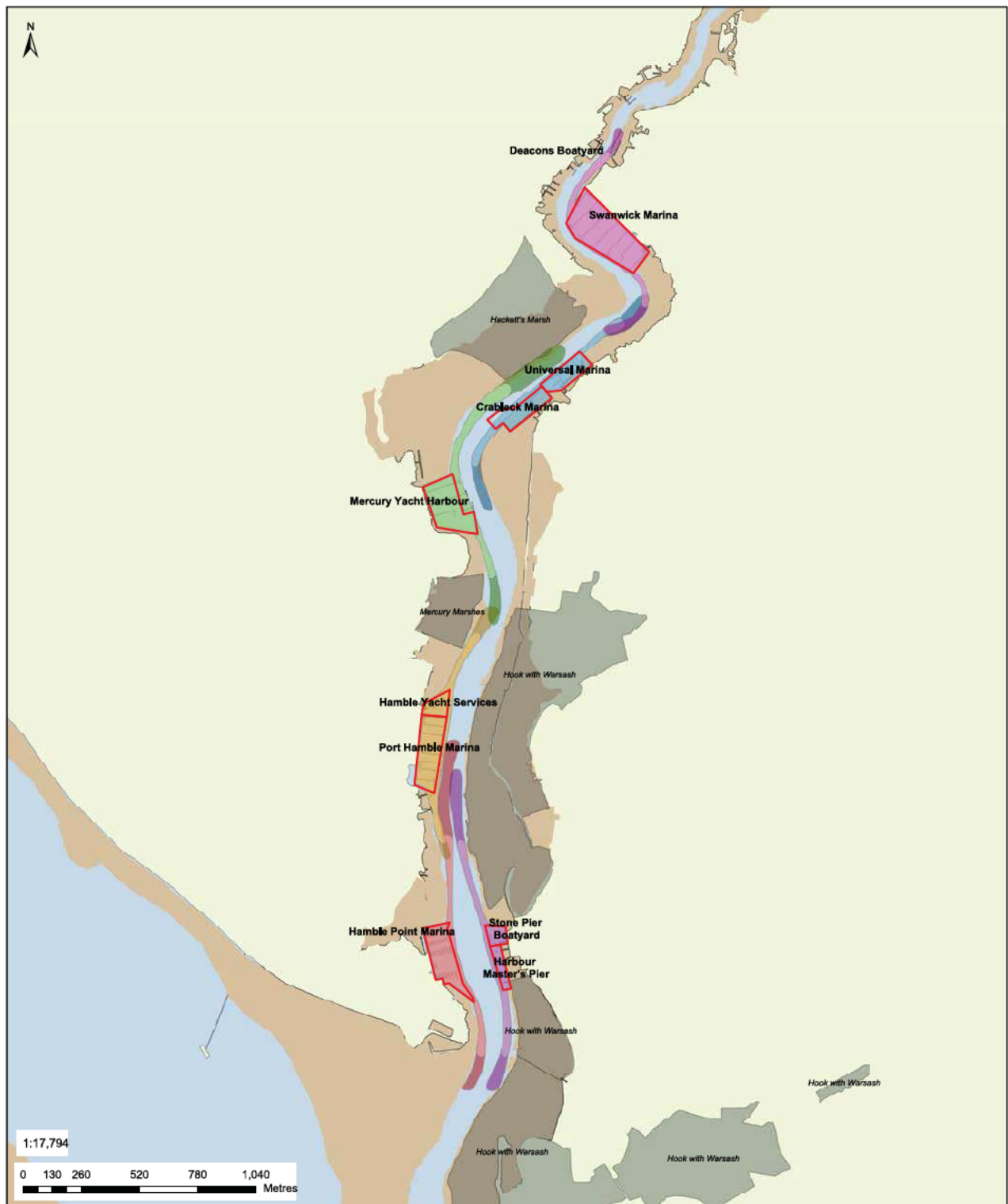
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Dredge plume extent
where suspended
solids are likely to be
greater than 10mg/l
above background
levels





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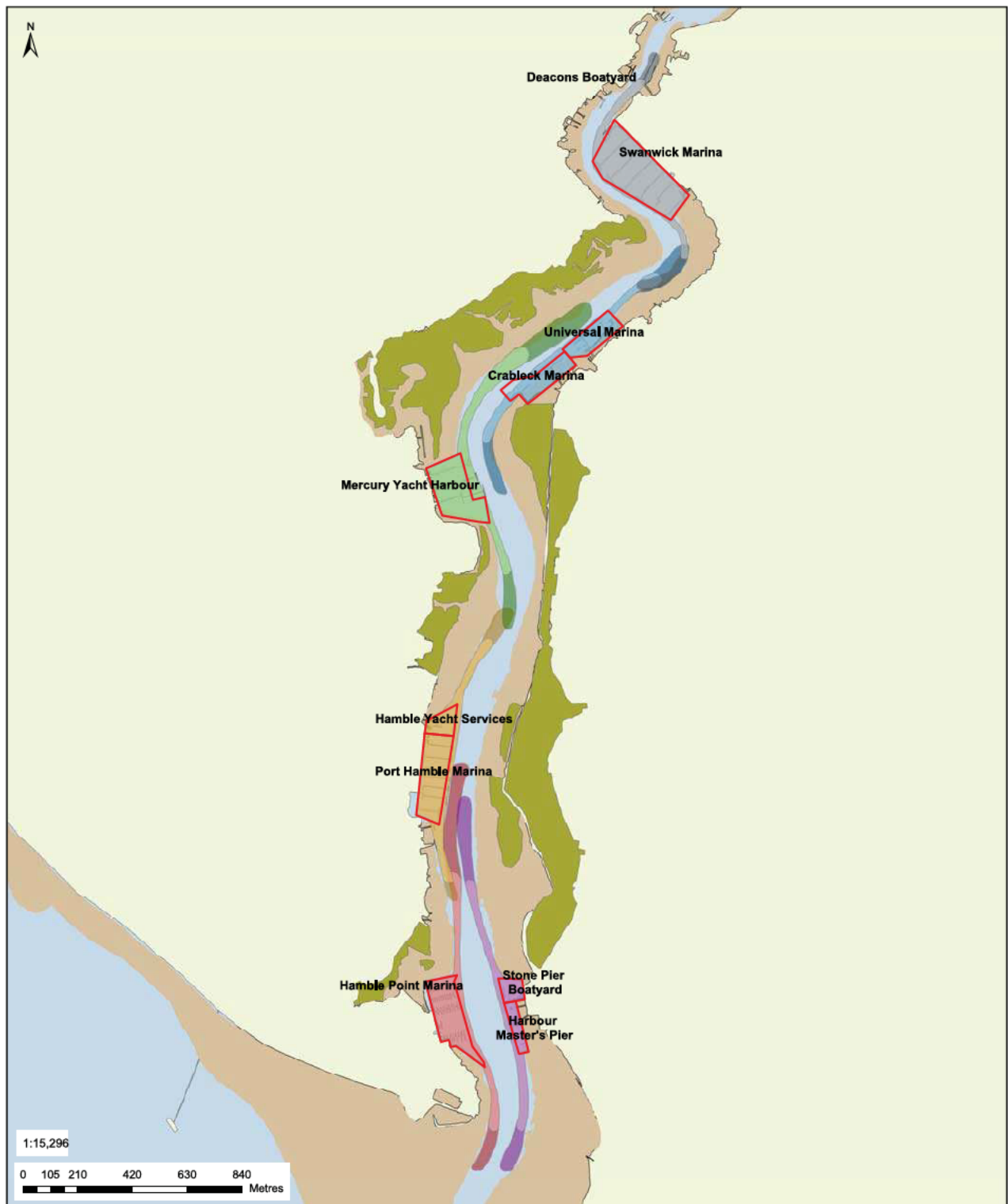
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Predicted Plume Dispersal and LNR Locations



Figure 15



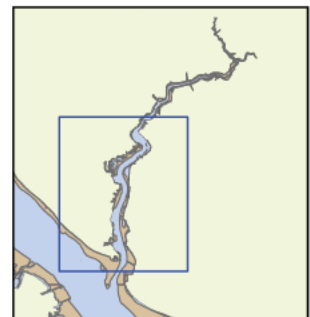
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- Swanwick Marina Dredge Plume - Spring Tide
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- Crabbleck & Universal Marina Dredge Plume - Neap Tide
- Crabbleck & Universal Marina Dredge Plume - Spring Tide
- Harbour Master's & Stone Pier Boatyard Plume - Neap Tide
- Mercury Yacht Harbour Dredge Plume - Neap Tide
- Mercury Yacht Harbour Dredge Plume - Spring Tide
- Port H Marina & H Yacht Services Plume - Spring Tide
- Harbour Master's & Stone Pier Boatyard Plume - Spring Tide
- Hamble Point Dredge Plume - Neap Tide
- Hamble Point Dredge Plume - Spring Tide
- Saltmarsh
- Mudflat
- Subtidal
- Land

Dredge plume extent
where suspended
solids are likely to be
greater than 10mg/l
above background
levels



Appendices

Appendix A

Water Framework Directive

Appendix A. Water Framework Directive

A1. Water Body Status

Under the EU Water Framework Directive (WFD) coasts, estuaries, rivers and man-made docks and canals are divided up into a series of water bodies. The WFD sets new ecological as well as chemical targets (objectives) for each water body. These objectives are derived from pristine natural conditions. However, as other factors can affect the ability of a water body to meet its ecological targets, objectives are also set under the WFD in respect of:

- Changes in parameters such as hydrology (tidal flows) or geomorphology (bed forms), for example caused by dredging, embanking for flood defence (etc): these are known as 'hydromorphological' objectives; and
- Changes in parameters such as dissolved oxygen, salinity or nutrients: these 'physico-chemical' changes can also determine whether or not a water body can achieve 'Good Ecological Status' (or Potential; see below).

Compliance with chemical status objectives is assessed in relation to quality standards for a specified list of 'priority' and 'priority hazardous' substances laid down by the EU Environmental Quality Standards Directive (EQS). The Directive sets objectives, amongst other things, for the reduction or cessation of discharges, emissions and losses of these substances.

The objective for all water bodies is to reach 'Good Ecological Status' and 'Good Chemical Status' by 2015, unless alternative arrangements (i.e. exemptions) can be justified.

A1.1 Study Area Water Bodies

The current status of water bodies in the South East and South West River Basin Districts, assessed under the WFD classification, are given in the River Basin Management Plans (Environment Agency, 2009a and b). Given the location of dredging within the River Hamble and the location of the associated disposal sites, the Dredge Management Plan study area for the purposes of evaluating WFD matters, extends to include:

- Southampton Water transitional water body (T17);
- Western Yar transitional water body (T12);
- Lymington transitional water body (T14);
- Solent coastal water body (C4);
- Isle of Wight East coastal water body (C5); and
- Dorset/Hampshire coastal water body (C20).

The extent of these water bodies are shown on Figure A1.

Although each of these water bodies will be considered under the WFD, it would be appropriate to highlight that maintenance dredging only takes place within the Southampton Water transitional water body (within the River Hamble). Disposal of dredge material is at the Nab Tower site (WI060), which is outside the Solent coastal water body but within close proximity (within 5km), and direct placement

within the Solent coastal water body at the Hurst Fort disposal site (WI080) as a secondary site used for disposal during bad weather periods when transiting to the Nab Tower site is not possible. The reason for the inclusion of the:

- Western Yar transitional water body;
- Lymington transitional water body;
- Isle of Wight East coastal water body; and
- Dorset/Hampshire coastal water body.

Is through their proximity (within 5km) of current dredging and disposal activities.

All of the aforementioned water bodies are classified as Heavily Modified Water Bodies (HMWB) which are defined as bodies of water which as a result of physical alteration by human activities, such as flood protection, port/harbour use, commercial fin and shellfisheries and resource extraction, are substantially changed in character and cannot therefore meet good ecological status. The default target for HMWBs under the WFD is to achieve good ecological potential (a status which recognises the importance of their human use whilst making sure ecology is protected as far as possible) and good surface water chemical status by 2015. Ecological potential is measured on a scale of high, good, moderate, poor and bad.

A1.2 Current Status of Water Bodies

The current ecological potential for the Isle of Wight East and Dorset/Hampshire water bodies is 'good', with the Lymington and Solent water bodies recorded as 'moderate' and the Southampton Water and Western Yar water bodies recorded as 'moderate' (uncertain). The current chemical status (recorded as good or fail) is 'good' for the Southampton Water and Isle of Wight East waterbodies, and 'fail' (uncertain) for the Solent water body; with the current status of Tributyltin Compounds (TBTs) within the water body recorded as 'moderate' (uncertain). The RBMP South East and South West River Basin Districts states that: 'the chemical status of the Lymington, Dorset/Hampshire and Western Yar water bodies does not require assessment' (Environment Agency, 2009a and b). Table A1 summarises the current overall potential and objective statuses of the aforementioned water bodies, highlighting the WFD parameters which are currently at 'moderate' status or below.

Table A1. Summary of water body status

Water Body Name	Water Body Reference	Current Overall Potential/Status	Status Objective (Overall)	WFD Parameters Currently at 'Moderate' Status or Below
Southampton Water	GB520704202800	Moderate Potential	Good by 2027	1) Invertebrates 2) Dissolved Inorganic Nitrogen 3) GEP mitigation measures for flood and coastal erosion protection
Lymington	GB520704202100	Moderate Potential	Good by 2027	1) GEP mitigation measures for flood and coastal erosion protection
Western Yar	GB520710107800	Moderate Potential	Good by 2027	1) Macroalgae 2) Dissolved Inorganic Nitrogen
Solent	GB650705150000	Moderate Potential	Good by 2027	1) Tributyltin Compounds 2) GEP mitigation measures for flood and coastal erosion protection
Isle of Wight East	GB650705530000	Good Potential	Good by 2015	None
Dorset / Hampshire	GB620705550000	Good Potential	Good by 2015	None
GEP = Good Ecological Potential				

(Source: Environment Agency, 2009a and b)

Details of the status of all the water bodies in the study area, together with their objectives and relevant protected area information, can be found in the relevant River Basin Management Plan. In addition, a number of adjacent water bodies connect to those identified in Table A1; given the distance of the various dredging and disposal locations from these adjacent water bodies, effects on the status from either the dredge or disposal is unlikely and it is therefore concluded that these water bodies are outside the scope of this management plan.

A1.3 Water Quality

A1.3.1 Bathing Waters Directive

In March 2006 the revised Bathing Water Directive (2006/7/EC) came into force, and will be implemented in stages up until 2015, when the original Directive will then be repealed. The Directive aims to protect the environment and public health, and maintain amenity use of designated bathing waters (fresh and saline) by reducing the risk of pollution. It requires popular bathing waters to be 'designated' and monitored for water quality, particularly for human waste from sewage treatment works or agricultural waste.

The mandatory standards used by the European Commission to determine compliance for Bathing Waters within the Directive are the microbiological parameters - total and faecal coliforms, and three physico-chemical parameters - surface active substances, mineral oils and phenols. Cases of non-compliance with the physico-chemical parameters are extremely rare so compliance in the UK each year is normally determined by the extent of pollution by total and faecal coliform bacteria.

To comply with these standards, bathing waters must not exceed values of 10,000 total coliforms per 100ml and 2,000 faecal coliforms per 100ml in 95% of samples. The revised Directive has updated the way in which water quality is measured, focusing on fewer microbiological indicators, and setting different standards for inland and coastal bathing sites:

- Tighter microbiological standards - to be met by 2015;
- Two microbiological parameters - Intestinal enterococci and *Escherichia coli*; and
- Water quality classification based on 3 or 4 years monitoring data, using 95 or 90 percentiles.

Four new classification categories will be introduced:

- Excellent - approximately twice as stringent as the current guideline standard;
- Good - similar to the current guideline standard;
- Sufficient - tighter than the current mandatory standard; and
- Poor - normally non-compliant water.

During the 2010 bathing season there were 493 identified and monitored bathing waters in England and Wales, a total of 599 bathing waters across the UK. Almost all of these (97.3%) met the minimum standards required by the current European Bathing Waters Directive. The closest designated bathing waters to the study area are at Colwell Bay, Totland Bay and Milford-on-sea (Figure A2). All of these bathing waters are located within 5km of current dredging and/or disposal activity areas, and are

situated in the Dorset/Hampshire coastal water body. Their water quality classifications for the period 2005 to 2010 can be found in Table A2.

Table A2. Bathing water quality classifications from 2005-2010

Bathing Water	2005	2006	2007	2008	2009	2010
Colwell Bay	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent
Totland Bay	Excellent	Excellent	Excellent	Good	Excellent	Excellent
Milford-on-sea	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent

(Environment Agency, 2010)

It can be seen that in 2010, all three beaches were classified as having 'excellent' bathing water. Water quality classification predictions for bathing waters in England and Wales under the revised and more stringent Bathing Water Directive have been assessed by the Environment Agency using 2007 to 2010 monitoring data, at which time maintenance dredge and disposal activities were being carried out. These predictions classified all three sites as having 'excellent' bathing waters.

A1.3.2 Shellfish Waters Directive

The original Shellfish Waters Directive which was adopted in October 1979, was repealed by the amended Shellfish Waters Directive (2006/113/EC), adopted on 12 December 2006. The aim of the Directive is to ensure a suitable environment for the growth of shell fisheries and to promote water of good quality to reduce the risk of food poisoning. The Directive requires mandatory compliance with imperative standards for parameters including dissolved oxygen and suspended solids. The Directive requires that dissolved oxygen, measured as the percentage of saturation, should exceed 70% (as a mean) and individual measurements may not be less than 60% unless there are no harmful consequences on the development of shellfish colonies. These standards are absolute and compliance with them is an obligation for the UK.

The Directive also requires that a discharge affecting shellfish waters must not cause the suspended solid content of the water to exceed by more than 30% the content of waters not so affected. The Directive also has mandatory standards for metals and other contaminants. It is expected that the Shellfish Waters Directive will be repealed in 2013 under the EU Water WFD. When this occurs, the WFD must provide at least the same level of protection to shellfish waters (which the WFD classifies as protected areas) as the Shellfish Waters Directive does.

Currently, there are 98 shellfish waters within England, a total of 242 in the UK. The closest shellfish waters to the study area, and within 5km of either dredging or disposal activities, are the Approaches to Southampton Water, Southampton Water, Calshot/Stanswood Bay, Totland, Yarmouth, Pennington and Lymington, all shown in Figure A2. Compliance by these shellfish waters has been assessed by the Environment Agency using monitoring data from 2008, and the results are shown in Table A3.

The objective is to achieve 'imperative standards' and endeavouring to respect the guideline standards of the Shellfish Waters Directive. All sites passed the imperative standards in 2008 showing that water quality in these areas is good. However, Southampton Water, Yarmouth and Lymington achieved a Guideline Fail. Sites failing on coliform guideline standards usually do so because mussels accumulate bacteria from water as they filter it to feed. Human and animal waste is the source input of coliform;

control measures to manage source inputs typically include reducing inputs from sewage treatment and better management of farm derived waste.

Table A3. Environment Agency monitoring of shellfish waters: 2008 data

Shellfish Water Site	2008
Approaches to Southampton Water	Guideline Pass / Imperative Pass
Southampton Water	Guideline Fail / Imperative Pass
Calshot/Stanswood Bay	Guideline Pass / Imperative Pass
Totland	Guideline Pass / Imperative Pass
Yarmouth	Guideline Fail / Imperative Pass
Pennington	Guideline Pass / Imperative Pass
Lymington	Guideline Fail / Imperative Pass

(Source: Environment Agency, 2010)

A1.3.3 Freshwater Fish Directive

The Freshwater Fish Directive (78/659/EEC) was adopted in 1978 and is concerned with the protection and improvement of fresh waters in order to support fish life. The Directive sets water quality standards and monitoring requirements for ensuring the protection of coarse and game fisheries, and requires the designation of appropriate rivers and lakes into two categories of water: those suitable for salmonids (i.e. mainly salmon and trout but also grayling) and those suitable for cyprinids (including carp, tench, bream, roach, chub and minnows). The Directive sets out 14 physical and chemical parameters for which 'imperative' and/or the more rigorous 'guideline' standards are given for the two categories of designation. Failures of the guidelines are typically caused by low dissolved oxygen concentrations, variations in pH and raised concentrations of total ammonia. These are typically associated with effluent discharges from waste water treatment works, low river flows, algal blooms and farm run-off.

The Southampton Water transitional water body is designated under the Freshwater Fish Directive due to the presence of either salmonid or cyprinid species, which is listed in the 'Protected Area Designation' section of the RBMP Water Body status information. A search of available data has not provided any information other than for water bodies upstream of the normal tidal limit. As such, no further information can be provided with respect to Freshwater Fish within the aforementioned water body.

A1.3.4 Other directives

There are further EU Directives that impose objectives relevant to the regulation of surface water quality, such as The Urban Waste Water Treatment Directive (UWWTD) (91/271/EEC) and the Nitrates Directive (91/676/EEC).

The UWWTD aims to protect the environment from the adverse effects of the collection, treatment and discharge of urban waste water. The Directive covers statutory water and sewerage companies, since they own and operate the public sewerage system and the urban waste water treatment works. Discharges from certain industrial sectors such as food and drink processing plants can have a similar polluting effect to untreated sewage, and are also covered by the Directive.

The Nitrates Directive aims to reduce water pollution by nitrate (nitrogen is one of the nutrients that can affect plant growth) from agricultural sources and to prevent such pollution occurring in the future. Surface waters have to be identified if too much nitrogen has caused a change in plant growth which affects existing plants and animals and the use of the water.

A1.3.5 Directive overlap

The WFD makes clear that, in the case of protected areas (i.e. where the presence of a protected area introduces different targets to a particular water body) the more stringent objective applies. There is no indication from the River Basin Management Plan that any of the WFD objectives would be more stringent than those of the Birds and Habitats Directives, thus it is assumed that any WFD compliance assessment for maintenance dredging and disposal would defer to the outcomes of the maintenance dredge protocol assessment with regard to compliance with Natura 2000 objectives.

A2. Water Framework Directive Assessment

The Environment Agency guidance for ensuring compliance with the WFD comprises a series of processes:

- Stage one: Screening;
- Stage two: Scoping;
- Stage three: Assessment; and
- Stage four: Identification of Measures.

This guidance will need to be applied at a scheme-specific level. This Dredge Management Plan collates and examines relevant information, and can therefore be used to inform a WFD assessment.

Dredging and disposal activities in coastal and estuarine areas have the potential to either cause deterioration in the ecological or chemical status of a water body, or to compromise improvements which might otherwise lead to a water body meeting its WFD objectives. The methodology clearly differentiates, however, between maintenance dredging and disposal which was ongoing during the WFD classification period (2006-2008) and all other dredging and disposal activities which are considered as capital works. This distinction is made because any effects of ongoing dredging or disposal on WFD status during this classification period will have been included as part of the overall assessment of status and published in the relevant River Basin Management Plan. The continuation of the same activities will not therefore cause further deterioration in WFD terms. The same conclusion cannot, however, be drawn in respect of dredging and disposal which was not ongoing during the WFD classification period. It is also possible in certain circumstances that any dredging or disposal (whether maintenance or capital) could prevent the water body from reaching its WFD objective.

By referring both to the relevant River Basin Management Plan and its supporting Annexes, and to the EA guidance for the application of the WFD mentioned above, it is possible to provide an early indication as to whether maintenance dredging and disposal activities could be:

- Contributing to an existing failure; or
- Preventing a water body which is not at good status from reaching its WFD objective in relation to those parameters which are currently failing in each of the WFD water bodies.

In order to identify which parameters are currently failing to meet 'Good' status/potential in each of the WFD water bodies, the Environment Agency have provided Tables 1 and 2 to collate the dredging and disposal information required to inform the screening process. These tables can be found at the end of this Appendix. Since information has been collated for the Dredge Management Plan, cross-reference has been made to appropriate areas of text within the document.

A2.1 Water Body Assessments

A2.1.1 Southampton Water

The South East River Basin District RBMP identifies that the Southampton Water transitional water body is currently failing its WFD objectives for three parameters, invertebrates, dissolved inorganic nitrogen and Good Ecologic Potential (GEP) mitigation measures for flood and coastal erosion protection. Within this water body, the Southampton Water shellfish water has also been taken into consideration as it is currently failing the guideline standards.

Dredging and disposal may affect benthic **invertebrate** fauna through the direct removal or disturbance to species living within the dredge site or its surroundings, or from settlement over a wider area of sediment suspended in the water column. However, long-term dredging of the estuary through backhoe methods will have already disturbed invertebrates within the area subject to maintenance dredging, and the scale of this disturbance is already taken into account in both designating the water body as an HMWB and in classifying its current status (potential). This is confirmed in Annex B of the RBMP. Given that the water body is designated as a HMWB, the continuation of maintenance dredging is unlikely to hinder the water body from achieving its objectives with regards to the invertebrate biological parameter as long as the relevant mitigation measures are in place to manage dredging impacts. Further assessment is not therefore required.

As confirmed by reference to the screening trigger table from the Environment Agency guidance, **dissolved inorganic nitrogen** can be screened out, as dredging and disposal do not generally affect nutrient conditions.

The water body is also currently failing for **GEP mitigation measures for flood and coastal erosion protection**, in which there are a range of morphological improvement measures to mitigate and reduce the biological impacts of physical modification within the water body, but these are seen as technically infeasible. Within the River Hamble, maintenance dredging of the marinas/boatyards has been a long-term process since their initial construction, and as such, continued maintenance dredging will not change the outcome of the mitigation measure objective. Further assessment is not therefore required.

The **Southampton Water Shellfish Water** passed the imperative standards in 2008 indicating that water quality within this area is good, during which time maintenance dredging was an ongoing activity. However, it also achieved a 'Guideline Fail' indicating that it failed for coliform levels. Maintenance dredging is not particularly associated with levels of coliforms, and hence is unlikely to contribute to or otherwise affect microbiological contaminant levels. As such, no further assessment is required.

A2.1.2 Western Yar

The South East River Basin District RBMP identifies that the Western Yar transitional water body is currently failing its WFD objectives for two parameters, macroalgae and dissolved inorganic nitrogen. Within this water body, the Yarmouth shellfish water has also been taken into consideration as it is currently failing the guideline standards.

Dredging may affect the biological parameter **macroalgae**, in a general sense, through the direct removal or disturbance to species living within the dredge site or its surroundings, or from settlement over a wider area of sediment suspended in the water column. With respect to the Western Yar water body, some maintenance-dredged material may be disposed at the Hurst Fort site during bad weather, approximately 2km from the water body. Disposal of this material may lead to a localised increase in suspended sediment concentrations (SSC) adjacent to the disposal site in the Solent coastal water body. However, given the scale, duration and frequency of this disposal, it is very unlikely that any increase in SSC above natural background concentrations (discernable from natural variability) will be seen within the Western Yar water body as a result of this disposal activity. As such, no further assessment is required.

As confirmed by reference to the screening trigger table from the Environment Agency guidance, **dissolved inorganic nitrogen** can be screened out, as dredging and disposal do not generally affect nutrient conditions.

The **Yarmouth Shellfish Water** passed the imperative standards in 2008 indicating that water quality within this area is good, during which time maintenance dredging was an ongoing activity. However, it also achieved a 'Guideline Fail' indicating that it failed for coliform levels. Maintenance dredging is not particularly associated with levels of coliforms, and hence is unlikely to contribute to or otherwise affect microbiological contaminant levels. As such, no further assessment is required.

A2.1.3 Lymington

The South East River Basin District RBMP identifies that the Lymington transitional water body is currently failing its WFD objectives for only a single parameter, GEP mitigation measures for flood and coastal erosion protection. Within this water body, the Lymington shellfish water has also been taken into consideration as it is currently failing the guideline standards.

The water body is currently failing for **GEP mitigation measures for flood and coastal erosion protection**, in which there are a range of morphological improvement measures to mitigate and reduce the biological impacts of physical modification within the water body, but these are seen as technically infeasible. However, no direct dredging or disposal activities are undertaken within the Lymington water body by the River Hamble Statutory Harbour Authority (SHA), or any of the marinas/boatyards mentioned within this Dredge Management Plan. As such, the maintenance dredging and associated disposal activities described within this document will not change the outcome of the mitigation measure objective for this water body.

The **Lymington Shellfish Water** passed the imperative standards in 2008 indicating that water quality within this area is good, during which time maintenance dredging was an ongoing activity. However, it also achieved a 'Guideline Fail' indicating that it failed for coliform levels. Maintenance dredging is not particularly associated with levels of coliforms, and hence is unlikely to contribute to or otherwise affect microbiological contaminant levels. As such, no further assessment is required.

A2.1.4 Solent

The South East River Basin District RBMP identifies that the Solent coastal water body is currently failing its WFD objectives for two parameters, Tributyltin Compounds and GEP mitigation measures for flood and coastal erosion protection.

Tributyltin Compounds (TBTs) are man-made organic substances containing the metal tin. Releases of TBT to the environment occur primarily by gradual leaching from marine antifouling paints, wood preservatives and potentially from their manufacture, transport and storage. There are no natural sources of release to the environment; TBT is usually associated with ship yards, dry docks, marinas and boatyards where paints containing TBTs have been used. An EU ban on the presence of TBT-based antifouling on ships hulls in EU ports came into effect on 1 January 2008; hence the main point source for this pollutant is now controlled. TBT is not very soluble in water, and tends to bind with particles/sediment where it will persist for a long period of time. TBTs are toxic to fish and other marine life, with evidence of bioaccumulation in organisms.

The links between local sediment quality samples as discussed in Section 5.2 and the water quality data used to inform decisions on WFD chemical status at water body level require further scientific research at national and international level. This is acknowledged in the Environment Agency guidance (Environment Agency, 2010). Annex C of the RBMP also recognises the need for further investigations into the reasons for TBT failures across all affected water bodies. The WFD assessment methodology makes clear that in such situations, decisions on maintenance dredging and disposal activities need to make best use of available data and understanding including a 'weight of evidence' approach until such time as further information becomes available. In this case, the Cefas Action Levels are used as a proxy insofar as these rely on the best available scientific research to establish whether the concentrations of certain substances pose a potential risk to the aquatic environment. Levels of TBT exceed Cefas Action Level 1 for a number of the sampled locations within the River Hamble, with Action Level 2 being exceeded for three samples. However, it is not possible to determine whether these samples were taken on the surface or at depth, and therefore may be due to historical contamination rather than recent inputs. Levels of Dibutyltin (DBT) are below Cefas Action Levels for all samples apart from two.

As FEPA licences have been issued to the various marinas and boatyards for the sea disposal of sediments dredged from along the River Hamble, it can be concluded that the concentrations in these areas are not thought to present an unacceptable risk to the marine environment in terms of further pollution. Furthermore, only a very small proportion of material is currently disposed within the Solent water body at the Hurst Fort disposal site, and it is therefore unlikely that levels of TBT in material dredged from the River Hamble will have an adverse effect on water quality at a water body scale. As such, no further assessment is therefore required.

The water body is also currently failing for **GEP mitigation measures for flood and coastal erosion protection**, in which there are a range of morphological improvement measures to mitigate and reduce the biological impacts of physical modification within the water body, but these are seen as technically infeasible. There is no maintenance dredging, as addressed by this assessment, occurring directly within the Solent water body, and as such, the maintenance dredging and associated disposal activities described within this document will not affect the outcome of the mitigation measure objective for this water body.

A2.1.5 Isle of Wight East

The South East River Basin District RBMP identifies that the Isle of Wight East coastal water body is not currently failing any of its WFD objectives. Given both the current status of the water body and its distance from the nearest maintenance dredging and disposal activities, no further assessment is required.

A2.1.6 Dorset/Hampshire

The South East and South West River Basin District RBMPs identify that the Dorset/Hampshire coastal water body is not currently failing any of its WFD objectives. Furthermore, within the chemical status section for the water body, it is stated that the 'chemical status does not require assessment'. Given both the current status of the water body and its distance from the nearest maintenance dredging activities, no further assessment is required.

A2.2 Summary

In summary, the current dredging and disposal activity undertaken by the River Hamble Harbour Authority and the contributory marinas and boatyards detailed within the Dredge Management Plan, complies with WFD and EQSD objectives. Although various water bodies are presently failing to meet 'good' status/potential across some parameters, this failing cannot be attributed (directly or indirectly) to ongoing established maintenance dredging activities. Furthermore, the continuation of maintenance dredging and the subsequent disposal of material at licensed sea disposal sites as described by this assessment, is unlikely to prevent a water body which is not at good status from reaching its WFD objective in relation to those parameters which are currently failing.

A3. References

Environment Agency (2009a). River Basin Management Plan (RBMP): South East River Basin District.
<http://www.environment-agency.gov.uk/research/planning/124978.aspx>

Environment Agency (2009b). River Basin Management Plan (RBMP): South West River Basin District.
<http://www.environment-agency.gov.uk/research/planning/125027.aspx>

Environment Agency (2010). Marine dredging and the Water Framework Directive - Stage two: the scoping process.
http://www.environment-agency.gov.uk/static/documents/Business/Stage_two_scoping_final.pdf

Southampton Water (GB520704202800)

Tables 1 and 2

Table 1: Dredging and disposal information required to inform screening process

	Dredging	Disposal
Location of proposed dredging or disposal activity: • Describe location(s) or provide grid reference or other coordinates. • Dredge footprint. • Dredge depth. • Dredge timing and duration (proposed). • Dredge methodology.	Section 4 and 6.1 of the Dredge Management Plan.	
Above information relating to any previous dredging and disposal activities at that location.	Section 4 of the Dredge Management Plan.	
Sediment quality data (available from MFA or CEFAS if a FEPA application has previously been made).	Section 5.2 of the Dredge Management Plan.	
Protected areas.	Section 3 of the Dredge Management Plan.	
Was this dredging and/or disposal activity carried out during the period 2006–2008? – if no, go to scoping. – if yes, continue. Do one or more of the following (area, volume, method and timing of the dredging or disposal activity) differ significantly from that carried out during 2006–2008? – if yes, go to scoping. – if no, continue.	YES	
Is there any evidence that indicates that maintenance dredging or disposal activities could lead to deterioration in the status of the water body or delay or otherwise affect the future ability of the water body to meet good status?	NO	
Is the water body (or are the water bodies) already at good status (see Table 2)? – if yes, go to step 6. – if no, continue.	NO	
Could dredging or disposal activities affect or have affected the status of the water body (or water bodies)? – if yes, go to scoping. – if no, continue	NO	
Are there any (additional) cost-effective, technically feasible and not disproportionately costly dredging- or disposal-related measures that would contribute to a meaningful improvement in the status of the failing parameters at water body level?	NO	
Activity currently complies with WFD objectives?	YES	

Table 2: Dredging and disposal information required to inform screening process

Water body name and reference	Water body size	Current status	If not at “good status”, record 2015 objective	If not at “good status”, record all WFD parameters at moderate status or below
Southampton Water GB520704202800	30.6km ²	Moderate Potential	Good by 2027	1) Invertebrates 2) Dissolved Inorganic Nitrogen 3) GEP mitigation measures for flood and coastal erosion protection

Solent (GB650705150000)

Tables 1 and 2

Table 1: Dredging and disposal information required to inform screening process

	Dredging	Disposal
Location of proposed dredging or disposal activity: • Describe location(s) or provide grid reference or other coordinates. • Dredge footprint. • Dredge depth. • Dredge timing and duration (proposed). • Dredge methodology.	Section 4 and 6.1 of the Dredge Management Plan.	Section 4 and 6.1 of the Dredge Management Plan.
Above information relating to any previous dredging and disposal activities at that location.	Section 4 of the Dredge Management Plan.	Section 4 of the Dredge Management Plan.
Sediment quality data (available from MFA or CEFAS if a FEPA application has previously been made).	Section 5.2 of the Dredge Management Plan.	Section 5.2 of the Dredge Management Plan.
Protected areas.	Section 3 of the Dredge Management Plan.	Section 3 of the Dredge Management Plan.
Was this dredging and/or disposal activity carried out during the period 2006–2008? – if no, go to scoping. – if yes, continue. Do one or more of the following (area, volume, method and timing of the dredging or disposal activity) differ significantly from that carried out during 2006–2008? – if yes, go to scoping. – if no, continue.	YES	YES
Is there any evidence that indicates that maintenance dredging or disposal activities could lead to deterioration in the status of the water body or delay or otherwise affect the future ability of the water body to meet good status?	NO	NO
Is the water body (or are the water bodies) already at good status (see Table 2)? – if yes, go to step 6. – if no, continue.	NO	NO
Could dredging or disposal activities affect or have affected the status of the water body (or water bodies)? – if yes, go to scoping. – if no, continue	NO	NO
Are there any (additional) cost-effective, technically feasible and not disproportionately costly dredging- or disposal-related measures that would contribute to a meaningful improvement in the status of the failing parameters at water body level?	NO	NO
Activity currently complies with WFD objectives?	YES	YES

Table 2: Dredging and disposal information required to inform screening process

Water body name and reference	Water body size	Current status	If not at “good status”, record 2015 objective	If not at “good status”, record all WFD parameters at moderate status or below
Solent GB650705150000	259.7km ²	Moderate Potential	Good by 2027	1) Tributyltin Compounds 2) GEP mitigation measures for flood and coastal erosion protection

Western Yar (GB520710107800)

Tables 1 and 2

Table 1: Dredging and disposal information required to inform screening process

	Dredging	Disposal
Location of proposed dredging or disposal activity: • Describe location(s) or provide grid reference or other coordinates. • Dredge footprint. • Dredge depth. • Dredge timing and duration (proposed). • Dredge methodology.		Section 4 and 6.1 of the Dredge Management Plan.
Above information relating to any previous dredging and disposal activities at that location.		Section 4 of the Dredge Management Plan.
Sediment quality data (available from MFA or CEFAS if a FEPA application has previously been made).		Section 5.2 of the Dredge Management Plan.
Protected areas.		Section 3 of the Dredge Management Plan.
Was this dredging and/or disposal activity carried out during the period 2006–2008? – if no, go to scoping. – if yes, continue. Do one or more of the following (area, volume, method and timing of the dredging or disposal activity) differ significantly from that carried out during 2006–2008? – if yes, go to scoping. – if no, continue.		YES
Is there any evidence that indicates that maintenance dredging or disposal activities could lead to deterioration in the status of the water body or delay or otherwise affect the future ability of the water body to meet good status?		NO
Is the water body (or are the water bodies) already at good status (see Table 2)? – if yes, go to step 6. – if no, continue.		NO
Could dredging or disposal activities affect or have affected the status of the water body (or water bodies)? – if yes, go to scoping. – if no, continue		NO
Are there any (additional) cost-effective, technically feasible and not disproportionately costly dredging- or disposal-related measures that would contribute to a meaningful improvement in the status of the failing parameters at water body level?		NO
Activity currently complies with WFD objectives?		YES

Table 2: Dredging and disposal information required to inform screening process

Water body name and reference	Water body size	Current status	If not at “good status”, record 2015 objective	If not at “good status”, record all WFD parameters at moderate status or below
Western Yar GB520710107800	0.5km ²	Moderate Potential	Good by 2027	1) Macroalgae 2) Dissolved Inorganic Nitrogen

Lymington (GB52070402100)

Tables 1 and 2

Table 1: Dredging and disposal information required to inform screening process

	Dredging	Disposal
Location of proposed dredging or disposal activity: • Describe location(s) or provide grid reference or other coordinates. • Dredge footprint. • Dredge depth. • Dredge timing and duration (proposed). • Dredge methodology.		Section 4 and 6.1 of the Dredge Management Plan.
Above information relating to any previous dredging and disposal activities at that location.		Section 4 of the Dredge Management Plan.
Sediment quality data (available from MFA or CEFAS if a FEPA application has previously been made).		Section 5.2 of the Dredge Management Plan.
Protected areas.		Section 3 of the Dredge Management Plan.
Was this dredging and/or disposal activity carried out during the period 2006–2008? – if no, go to scoping. – if yes, continue. Do one or more of the following (area, volume, method and timing of the dredging or disposal activity) differ significantly from that carried out during 2006–2008? – if yes, go to scoping. – if no, continue.		YES
Is there any evidence that indicates that maintenance dredging or disposal activities could lead to deterioration in the status of the water body or delay or otherwise affect the future ability of the water body to meet good status?		NO
Is the water body (or are the water bodies) already at good status (see Table 2)? – if yes, go to step 6. – if no, continue.		NO
Could dredging or disposal activities affect or have affected the status of the water body (or water bodies)? – if yes, go to scoping. – if no, continue		NO
Are there any (additional) cost-effective, technically feasible and not disproportionately costly dredging- or disposal-related measures that would contribute to a meaningful improvement in the status of the failing parameters at water body level?		NO
Activity currently complies with WFD objectives?		YES

Table 2: Dredging and disposal information required to inform screening process

Water body name and reference	Water body size	Current status	If not at “good status”, record 2015 objective	If not at “good status”, record all WFD parameters at moderate status or below
Lymington GB52070402100	2.5km ²	Moderate Potential	Good by 2027	1) GEP mitigation measures for flood and coastal erosion protection

Isle of Wight East (GB650705530000)

Tables 1 and 2

Table 1: Dredging and disposal information required to inform screening process

	Dredging	Disposal
Location of proposed dredging or disposal activity: • Describe location(s) or provide grid reference or other coordinates. • Dredge footprint. • Dredge depth. • Dredge timing and duration (proposed). • Dredge methodology.		Section 4 and 6.1 of the Dredge Management Plan.
Above information relating to any previous dredging and disposal activities at that location.		Section 4 of the Dredge Management Plan.
Sediment quality data (available from MFA or CEFAS if a FEPA application has previously been made).		Section 5.2 of the Dredge Management Plan.
Protected areas.		Section 3 of the Dredge Management Plan.
Was this dredging and/or disposal activity carried out during the period 2006–2008? – if no, go to scoping. – if yes, continue. Do one or more of the following (area, volume, method and timing of the dredging or disposal activity) differ significantly from that carried out during 2006–2008? – if yes, go to scoping. – if no, continue.		YES
Is there any evidence that indicates that maintenance dredging or disposal activities could lead to deterioration in the status of the water body or delay or otherwise affect the future ability of the water body to meet good status?		NO
Is the water body (or are the water bodies) already at good status (see Table 2)? – if yes, go to step 6. – if no, continue.		NO
Could dredging or disposal activities affect or have affected the status of the water body (or water bodies)? – if yes, go to scoping. – if no, continue		NO
Are there any (additional) cost-effective, technically feasible and not disproportionately costly dredging- or disposal-related measures that would contribute to a meaningful improvement in the status of the failing parameters at water body level?		NO
Activity currently complies with WFD objectives?		YES

Table 2: Dredging and disposal information required to inform screening process

Water body name and reference	Water body size	Current status	If not at “good status”, record 2015 objective	If not at “good status”, record all WFD parameters at moderate status or below
Isle of Wight East GB650705530000	263.7km ²	Good Potential	Good by 2015	None

Dorset/Hampshire (GB620705550000)

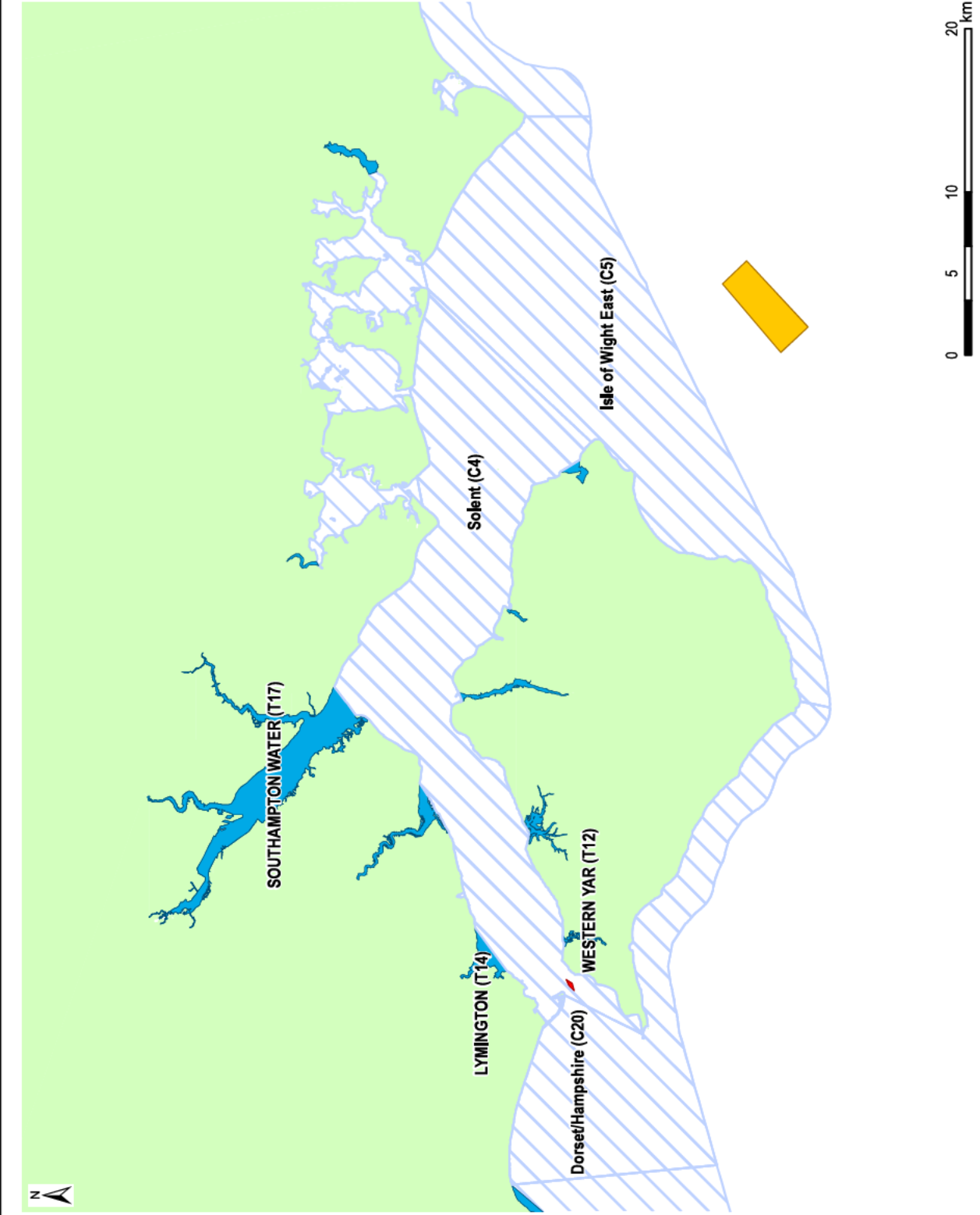
Tables 1 and 2

Table 1: Dredging and disposal information required to inform screening process

	Dredging	Disposal
Location of proposed dredging or disposal activity: • Describe location(s) or provide grid reference or other coordinates. • Dredge footprint. • Dredge depth. • Dredge timing and duration (proposed). • Dredge methodology.		Section 4 and 6.1 of the Dredge Management Plan.
Above information relating to any previous dredging and disposal activities at that location.		Section 4 of the Dredge Management Plan.
Sediment quality data (available from MFA or CEFAS if a FEPA application has previously been made).		Section 5.2 of the Dredge Management Plan.
Protected areas.		Section 3 of the Dredge Management Plan.
Was this dredging and/or disposal activity carried out during the period 2006–2008? – if no, go to scoping. – if yes, continue. Do one or more of the following (area, volume, method and timing of the dredging or disposal activity) differ significantly from that carried out during 2006–2008? – if yes, go to scoping. – if no, continue.		YES
Is there any evidence that indicates that maintenance dredging or disposal activities could lead to deterioration in the status of the water body or delay or otherwise affect the future ability of the water body to meet good status?		NO
Is the water body (or are the water bodies) already at good status (see Table 2)? – if yes, go to step 6. – if no, continue.		NO
Could dredging or disposal activities affect or have affected the status of the water body (or water bodies)? – if yes, go to scoping. – if no, continue		NO
Are there any (additional) cost-effective, technically feasible and not disproportionately costly dredging- or disposal-related measures that would contribute to a meaningful improvement in the status of the failing parameters at water body level?		NO
Activity currently complies with WFD objectives?		YES

Table 2: Dredging and disposal information required to inform screening process

Water body name and reference	Water body size	Current status	If not at “good status”, record 2015 objective	If not at “good status”, record all WFD parameters at moderate status or below
Dorset / Hampshire GB620705550000	503.1km ²	Good Potential	Good by 2015	None



- Coastal Water Bodies
- Transitional Water Bodies
- Disposal Sites
- Hurst Fort
- Nab Tower

Date	By	Size	Version
Mar 11	FMM	A4	1
Projection		OSGB 1936	
Scale		1:340,000	
QA		NMW	
3990_FigA1_Traffic_Waterbodies.mxd			
Produced by ABPmer Ltd			

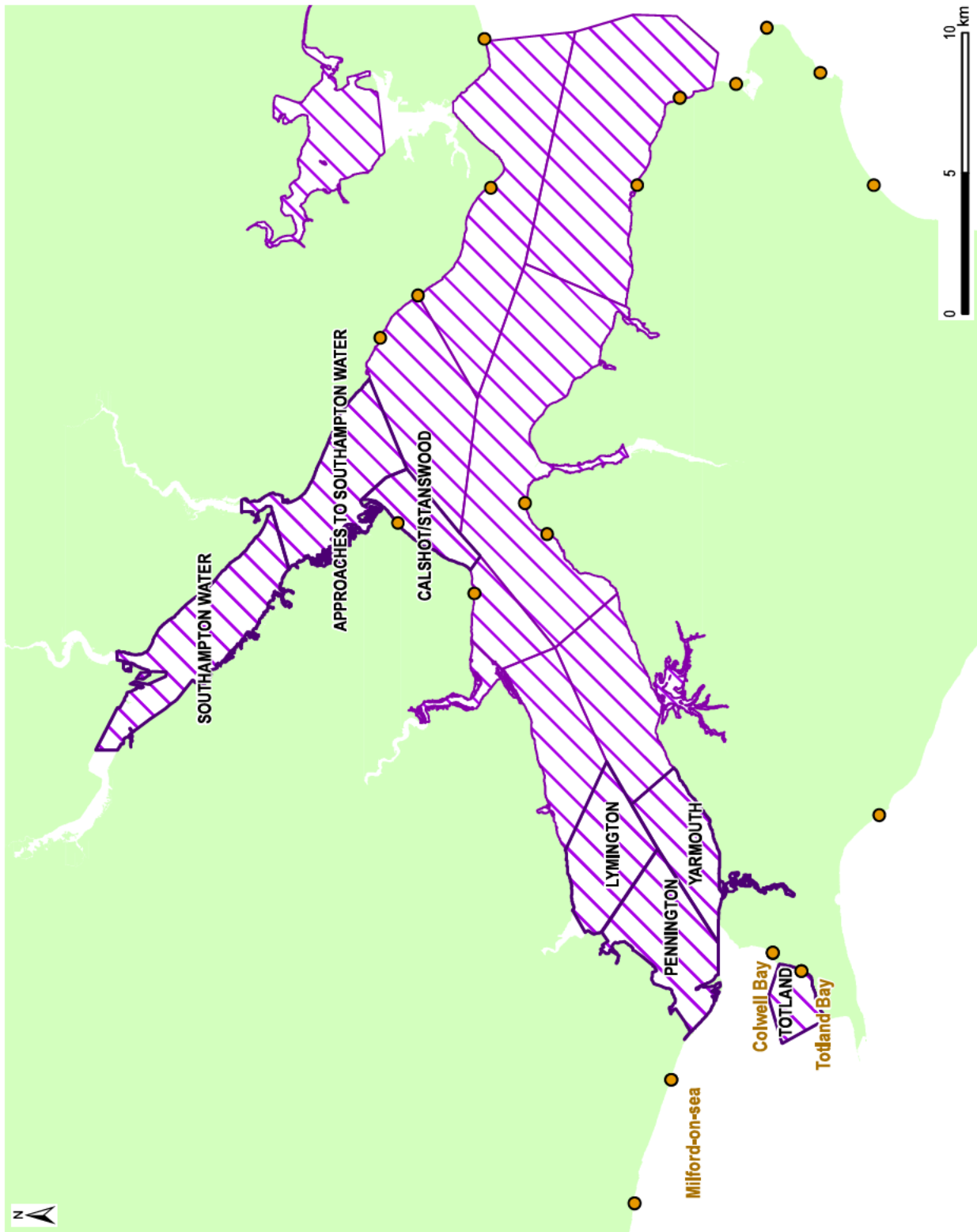
© ABPmer. All rights reserved, 2011
 Data Sources: CEFAS, 2010 & EA 2004.
 NOT TO BE USED FOR NAVIGATION



Water Bodies and Disposal Sites

Figure A1

-  Bathing Waters
-  Shellfish Waters



Date	By	Size	Version
Feb 11	FMM	A4	1
Projection			
OSGB 1936			
Scale			
1:200,000			
QA			
3985 - TW_Shellfish_bathing.mxd			
Produced by ABPmer Ltd			

© ABPmer. All rights reserved, 2011
Data Sources: Environment Agency, 2008.
NOT TO BE USED FOR NAVIGATION



Designated Bathing Waters and Shellfish Waters

Figure A2

Appendix B

Sediment Quality Data

Appendix B. Sediment Quality Data

Table B1. Proposed Revisions to Cefas Contaminant Action Levels

Contaminant	Existing		Suggested Revision	
	Action Level 1 mg.kg ⁻¹ (ppm)	Action Level 2 mg.kg ⁻¹ (ppm)	Action Level 1 mg.kg ⁻¹ (ppm) dry weight	Action Level 2 mg.kg ⁻¹ (ppm) dry weight
Arsenic (As)	20	50-100	20	70
Cadmium (Cd)	0.4	5	0.4	4
Chromium (Cr)	40	400	50	370
Copper (Cu)	40	400	30	300
Mercury (Hg)	0.3	3	0.25	1.5
Nickel (Ni)	20	200	30	150
Lead (Pb)	50	500	50	400
Zinc (Zn)	130	800	130	600
Tributyltin (TBT, DBT, MBT)	0.1	1	0.1	0.5
Polychlorinated Biphenyls (PCBs)	0.02	0.2	0.02	0.18
Polyaromatic Hydrocarbons (PAHs)				
Acenaphthene			0.1	
Acenaphthylene			0.1	
Anthracene			0.1	
Fluorene			0.1	
Naphthalene			0.1	
Phenanthrene			0.1	
Benzo[a]anthracene			0.1	
Benzo[a]fluoranthene			0.1	
Benzo[k]fluoranthene			0.1	
Benzo[g]perylene			0.1	
Benzo[a]pyrene			0.1	
Benzo[g,h,i]perylene			0.1	
Dibenzo[a,h]anthracene			0.01	
Chrysene			0.1	
Fluoranthene			0.1	
Pyrene			0.1	
Indeno[1,2,3cd]pyrene			0.1	
Total hydrocarbons	100		100	
Booster Biocide and Brominated Flame Retardants*	-	-	-	-
* Provisional Action Levels for these compounds are subject to further investigation ppm parts per million				

Table B2

Metal and Tin Results for Defra: River Hamble

Produced by: L. Doria
Date: 03/03/2011

Sample ID	Latitude	Longitude	AS	CD	CR	CU	HG	NI	PB	ZN	DBT	TBT
1999/03072	50.871	-1.31	7	0.08	24	24	0.09	11	21	55	0.031	0.086
1999/03073	50.87	-1.309	7.7	0.1	25	26	0.1	12	24	60	0.020	0.055
1999/03074	50.87	-1.308	8.1	0.09	25	31	0.1	12	25	65	0.051	0.143
1999/04494	50.851	-1.308	7.2	0.1	15	23	0.12	9.8	22	69	0.063	0.198
1999/04495	50.851	-1.31	6.5	0.05	12	23	0.07	8.3	17	61	0.040	0.102
1999/04496	50.852	-1.309	6.5	0.06	12	20	0.07	8.2	16	58	0.034	0.098
1999/04497	50.853	-1.311	8.4	0.05	10	20	0.06	7.3	14	52	0.035	0.072
1999/04498	50.854	-1.309	6.7	0	10	19	0.06	7.1	14	52	0.035	0.080
2000/01757	50.861	-1.312	6.6	0.07	24	18	0.06	8.8	15	48	0.036	0.110
2000/01758	50.861	-1.312	6.1	0.07	24	17	0.05	8.4	14	44	0.032	0.085
2000/01759	50.861	-1.312	5.5	0	20	16	0.06	7.3	13	41	0.033	0.112
2000/01760	50.861	-1.312	5.4	0	21	16	0.05	7.3	14	42	0.033	0.104
2001/02772	50.875	-1.304	6.7	0.09	21	39	0.1	5.4	21	64	0.059	0.710
2001/02773	50.875	-1.304	7.4	0.09	23	30	0.11	6.9	22	63	0.058	0.319
2001/02774	50.875	-1.304	7.1	0.09	24	31	0.1	8.9	24	63	0.040	0.260
2001/02951	50.871	-1.311									0.037	0.097
2001/02952	50.871	-1.31									0.044	0.106
2001/02953	50.87	-1.31									0.051	0.107
2001/02954	50.87	-1.309									0.050	0.132
2003/01756	50.851	-1.309	8.7	0.06	26	20	0.06	11	20	54	0.020	0.069
2003/01757	50.851	-1.31	6.9	0.06	23	18	0.09	9.7	17	46	0.028	0.088
2003/01758	50.852	-1.31	6.9	0.1	22	16	0.06	9.5	17	50	0.026	0.086
2003/01759	50.853	-1.311	7.6	0.07	25	21	0.08	11	20	54	0.033	0.094
2003/01760	50.853	-1.31	7.4	0.06	24	20	0.07	11	19	51	0.033	0.091
2003/02133	50.883	-1.302	6.1	0.07	26	42	0.1	13	21	82	0.060	0.167
2003/02134	50.882	-1.301	6.1	0.07	25	41	0.11	12	18	82	0.060	0.188
2003/02135	50.882	-1.3	6	0.07	24	38	0.1	11	19	76	0.058	0.172
2004/08488	50.874	-1.306	10	0	22	44	0.05	10	26	72	0.023	0.058

Table B2 Continued

Metal and Tin Results for Defra: River Hamble

Produced by: L. Doria
Date: 03/03/2011

Sample ID	Latitude	Longitude	AS	CD	CR	CU	HG	NI	PB	ZN	DBT	TBT
2004/08489	50.874	-1.307	15	0	39	85	3.5	19	44	127	0.052	0.137
2004/08490	50.876	-1.303	16	0.17	41	51	0.26	19	69	110	0.173	0.395
2004/10511	50.875	-1.306					0.36				0.084	0.704
2004/10512	50.875	-1.305					0.42				0.059	0.604
2004/10513	50.875	-1.305					0.27				0.050	0.128
2006/04376	50.853	-1.312	21	0	31	63	0.2	20	33	137	0.000	0.025
2006/04378	50.852	-1.311	19	0	27	67	0.23	19	35	140	0.000	0.025
2006/04380	50.862	-1.312	14	0	21	51	0.16	15	31	116	0.000	0.000
2006/04381	50.861	-1.313	18	0	28	64	0.21	18	36	138	0.000	0.094
2006/04382	50.871	-1.312	19	0	29	95	0.26	19	40	177	0.033	0.076
2006/04383	50.871	-1.311	22	0	32	87	0.3	20	42	179	0.000	0.053
2009/03824	50.87	-1.307	19	0.23	47	97	0.26	26	48	190	0.027	0.084
2009/03825	50.87	-1.307	18	0.28	48	69	0.34	25	50	155	0.084	0.291
2009/03826	50.869	-1.307	19	0.19	37	84	0.28	23	47	171	0.030	0.091
2009/03827	50.869	-1.307	22	0.21	44	98	0.28	25	53	188	0.089	0.091
2009/03843	50.854	-1.312	22	0.14	43	54	0.17	24	36	132	0.000	0.043
2009/03844	50.854	-1.312	13	0.11	32	9.7	0	18	15	55	0.000	0.000
2009/03845	50.853	-1.312	20	0.26	48	46	0.3	25	49	130	0.076	0.154
2009/03846	50.852	-1.311	21	0.14	43	55	0.16	25	37	128	0.000	0.043
2009/03847	50.852	-1.311	18	0.24	46	40	0.27	24	43	130	0.071	0.134
2009/03895	50.857	-1.307	22	0.08	45	55	0.21	25	49	139	0.038	0.087
2009/03896	50.857	-1.307	19	0.16	41	32	0.33	23	42	142	0.113	0.460
2009/03897	50.856	-1.307	30	0.31	65	64	0.91	34	70	172	0.045	0.115

Table B3

Polychlorinated Biphenyls Results for Defra: River Hamble

Produced by: L. Doria
Date: 03/03/2011

			mg/kg (ppm)											
			Dry weight											
Sample ID	Latitude	Longitude	CB#101	CB#105	CB#110	CB#118	CB#128	CB#138	CB#141	CB#149	CB#151	CB#153		
1999/04494	50.851	-1.308	0.0010	0.0005	0.0026	0.0013	0.0003	0.0013	0.0000	0.0009	0.0000	0.0011		
1999/04495	50.851	-1.31	0.0004	0.0003	0.0013	0.0006	0.0000	0.0007	0.0000	0.0004	0.0000	0.0005		
1999/04496	50.852	-1.309	0.0019	0.0006	0.0038	0.0024	0.0002	0.0011	0.0000	0.0011	0.0000	0.0014		
2004/08491	50.875	-1.306	0.0009	0.0002	0.0011	0.0009	0.0000	0.0010	0.0000	0.0008	0.0000	0.0010		
2009/03828	50.869	-1.307	0.0008	0.0002	0.0008	0.0008	0.0002	0.0009	0.0000	0.0007	0.0000	0.0009		
2009/03848	50.854	-1.312	0.0005	0.0000	0.0005	0.0006	0.0000	0.0006	0.0000	0.0005	0.0000	0.0006		

Sample ID	Latitude	Longitude	CB#156	CB#158	CB#170	CB#18	CB#180	CB#183	CB#187	CB#194	CB#28	CB#31
1999/04494	50.851	-1.308	0.0000	0.0000	0.0003	0.0000	0.0005	0.0000	0.0003	0.0000	0.0004	0.0000
1999/04495	50.851	-1.31	0.0000	0.0000	0.0000	0.0000	0.0003	0.0000	0.0000	0.0000	0.0003	0.0000
1999/04496	50.852	-1.309	0.0000	0.0000	0.0000	0.0000	0.0003	0.0000	0.0000	0.0000	0.0003	0.0002
2004/08491	50.875	-1.306	0.0000	0.0000	0.0002	0.0000	0.0006	0.0000	0.0003	0.0000	0.0000	0.0000
2009/03828	50.869	-1.307	0.0000	0.0000	0.0000	0.0000	0.0004	0.0000	0.0003	0.0000	0.0000	0.0000
2009/03848	50.854	-1.312	0.0000	0.0000	0.0000	0.0000	0.0003	0.0000	0.0000	0.0000	0.0000	0.0000

Sample ID	Latitude	Longitude	CB#44	CB#47	CB#49	CB#52	CB#56	TOT25CBS	TOTICES7
1999/04494	50.851	-1.308	0.0004	0.0000	0.0006	0.0006	0.0006	0.0127	0.0062
1999/04495	50.851	-1.31	0.0002	0.0000	0.0005	0.0003	0.0002	0.0060	0.0031
1999/04496	50.852	-1.309	0.0005	0.0000	0.0007	0.0008	0.0006	0.0159	0.0082
2004/08491	50.875	-1.306	0.0000	0.0000	0.0004	0.0004	0.0003	0.0082	0.0048
2009/03828	50.869	-1.307	0.0000	0.0000	0.0003	0.0004	0.0003	0.0068	0.0041
2009/03848	50.854	-1.312	0.0000	0.0000	0.0000	0.0003	0.0002	0.0040	0.0028

Table B4

Polycyclic Aromatic Hydrocarbon Results for Defra: River Hamble

Produced by: L. Doria
Date: 03/03/2011

Sample ID	Latitude	Longitude	mg/kg (ppm)									
			Dry weight									
			ACENAPH	ACENAPT	ANTHRAC	BAA	BAP	BBF	BENZGHI	BEP	BKF	C1N
2004/08491	50.875	-1.306	0.0018	0.0025	0.0130	0.2150	0.1010	0.2010	0.0670	0.0830	0.0680	0.0220
2006/04377	50.852	-1.312	0.0030	0.0043	0.0320	0.0780	0.1040	0.2010	0.0780	0.0840	0.0620	0.0220
2006/04379	50.862	-1.312	0.0032	0.0040	0.0210	0.0800	0.0950	0.1800	0.0710	0.0810	0.0590	0.0230
2006/04384	50.871	-1.312	0.0044	0.0051	0.0360	0.0990	0.1500	0.2620	0.1050	0.1190	0.0920	0.0260
2009/03828	50.869	-1.307	0.0000	0.0000	0.0000	0.1490	0.1895	0.2669	0.1559	0.1446	0.0848	0.0000
2009/03848	50.854	-1.312	0.0000	0.0000	0.0000	0.0725	0.0890	0.1584	0.0842	0.0807	0.0572	0.0000
2009/03898	50.857	-1.307	0.0110	0.1582	0.0592	0.1376	0.1395	0.2496	0.1284	0.1261	0.0985	0.1069

Sample ID	Latitude	Longitude	C1PHEN	C2N	C3N	CHRYSEN	DBENZAH	FLUORAN	FLUOREN	INDPYR	NAPTH	PERYLEN
2004/08491	50.875	-1.306	0.0480	0.0320	0.0820	0.0420	0.0130	0.1720	0.0058	0.0870	0.0190	0.1160
2006/04377	50.852	-1.312	0.0920	0.0510	0.1240	0.0850	0.0200	0.1510	0.0089	0.1020	0.0140	0.1370
2006/04379	50.862	-1.312	0.0730	0.0530	0.0980	0.0760	0.0200	0.1620	0.0077	0.0940	0.0120	0.1450
2006/04384	50.871	-1.312	0.1100	0.0480	0.0930	0.1150	0.0260	0.2200	0.0095	0.1310	0.0180	0.1770
2009/03828	50.869	-1.307	0.0000	0.0000	0.0000	0.1325	0.0245	0.3167	0.0000	0.1636	0.0000	0.1525
2009/03848	50.854	-1.312	0.0000	0.0000	0.0000	0.0688	0.0191	0.1572	0.0000	0.0969	0.0000	0.0991
2009/03898	50.857	-1.307	0.2278	0.3113	0.4823	0.0943	0.0297	0.2957	0.1304	0.1481	0.0706	0.2071

Sample ID	Latitude	Longitude	PHENANT	PYRENE	THC
2004/08491	50.875	-1.306	0.0240	0.1440	228
2006/04377	50.852	-1.312	0.0540	0.1370	165
2006/04379	50.862	-1.312	0.0470	0.1560	129
2006/04384	50.871	-1.312	0.0700	0.2020	211
2009/03828	50.869	-1.307	0.0897	0.3228	409
2009/03848	50.854	-1.312	0.0456	0.1736	258
2009/03898	50.857	-1.307	0.4284	0.3147	399

