

Falmouth Cruise Project

Environmental Statement

Falmouth Harbour Commissioners and
Falmouth Docks & Engineering Company

18 February 2009

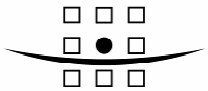
Final Report

9S4181

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Falmouth Harbour Commissioners

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1 INTRODUCTION

1.1 FALMOUTH CRUISE PROJECT

Falmouth Harbour Commissioners (FHC) and Falmouth Docks & Engineering Co. (FDEC) are proposing to undertake a joint project to improve the cruise facilities and navigation at Falmouth, Cornwall. The purpose of the "Falmouth Cruise Project" is to facilitate sustained long-term growth of the cruise business operating out of Falmouth Docks. Since the general trend in shipping is to build and operate larger cruise vessels, the long-term success of the cruise business at the Port of Falmouth is linked to FDEC's ability to accommodate visits by these vessels in terms of navigation, berthing and passenger handling.

The proposed Falmouth Cruise Project comprises:

- a deeper and straighter navigation channel from Carrick Roads / The Narrows to the Queens and Northern Wharves, including a deep water berth for cruise vessels along the combined length of the Queens and Northern Wharves, and seabed habitat mitigation in the eastern navigation channel (see Section 2.2.1);
- a longer cruise quay combining the Queens and Northern Wharves (see Section 2.2.2);
- a new cruise terminal building (see Section 2.2.3); and
- a range of infrastructure improvements around the docks estate (see Section 2.2.4).

1.2 STATEMENT OF NEED

1.2.1 Background

Falmouth Harbour Commissioners (FHC)

FHC is a Board of Trustees set up by a statutory process to administer Falmouth Harbour in the best interests of its stakeholders. As a statutory port authority, FHC has responsibility for the Inner Harbour at Falmouth (excluding Falmouth Docks), the Penryn River up as far as Boyers Cellars, the southern part of the Carrick Roads and a large part of Falmouth Bay.

FHC's aim is to administer the harbour in a manner which is both open to public scrutiny and accountable to their stakeholders. In addition, FHC aims to operate in all respects to the standards laid down in Modernising Port Trusts - A Guide to Good Governance (DfT, 2000), where the Government's broad policies for port trusts include:

- promotion of UK and regional competitiveness by encouraging reliable and efficient distribution and access to markets; and
- enhancement of environmental and operational performance by encouraging the provision of multi model access to markets.

Falmouth Docks & Engineering Co. (FDEC)

FDEC is part of A&P Falmouth and the A&P Group, and is based at Falmouth Docks. Its operations include:

- cruise business by providing alongside berths for cruise vessels and a sheltered deepwater anchorage (for cruise vessels too large to use the berths) supported by a purpose built landing facilities for passengers arriving by tender;
- ship repair and conversion at three dry docks capable of accommodating vessels up to 100,000 dead weight tonnage;
- cargo handling (e.g. bulk fertilisers, coal and stone products); and
- towage.

1.2.2 Cruise Industry

The cruise industry and its associated ports of call are driven by passenger demand to visit interesting areas and day attractions in the form of shore tours. Tours are an important factor in the choice of ports of call because they are highly profitable for cruise operators and a key selling point for the cruise (Arup, 2008). Falmouth and its surrounding area are able to offer some particularly popular shore tours and hence the potential growth in cruise business at this port.

The cruise industry and the vessels it uses are growing. As illustrated by the MS Freedom of the Seas described below (i.e. the design vessel), the size of new vessels entering service is increasing. This was the largest cruise vessel in operation at the time of its launch, but newer vessels are bigger and continuing to grow. According to Fisher (2003 in Arup, 2008), accessibility of ports could become an important issue in the future of cruise business if vessel operators place more of their large ships on European routes.

Against this background, the proposed Falmouth Cruise Project seeks to provide suitable facilities to accommodate the expected increase in size of cruise vessels and a corresponding increase in cruise business at Falmouth.

1.2.3 Current Cruise Business at Falmouth

Cruise business at Falmouth is growing and increasingly forms an important part of FDEC's commercial activity and contributes to FHC's harbour dues. The existing cruise facilities provide basic facilities for two types of cruise operations: day calls and turnarounds. The total number of cruise calls to Falmouth was 40 in 2005 and 65 in 2006. In 2005, 22 day calls brought approximately 11,000 passengers to the town and west Cornwall. Day calls were made throughout the year but tended to be concentrated from April to September. Of the passengers coming ashore in 2005, approximately 50% visited Falmouth by walking or shuttle bus, while the other 50% visited other parts of west Cornwall by coach.

The size of vessels that can be berthed at the Docks is restricted by the depths of the channel and berths and the length of quay available. At present, only vessels up to 230m in length can use the Docks due to the length restrictions along the County Wharf and Queen's Wharf. The available depth of water varies with the tidal cycle. In practise the maximum draught of vessels which can visit the Docks is 8m, this being restricted by the depth of water at the County Wharf. In addition, the times at which larger vessels

can get into and out of the Docks is restricted by the depth of water within the navigation channel.

1.2.4 Requirement for the Project

FHC and FDEC wish to improve the cruise terminal facilities in order to be able to attract a greater range of cruise vessels to Falmouth. By being able to attract a greater range of vessels, the long-term business of FDEC and the employment which is directly and indirectly related to the Docks, including those employed by FHC, will be secured.

In order to be able to attract a greater range of cruise vessels, the cruise terminal facilities require improvement. In particular, a dedicated building is required which can handle passengers and house administrative staff. In addition, the Queens and Northern Wharves require improvement in order to increase the length of quayside available for the berthing of larger cruise vessels of lengths in the order of 340m.

In order for larger cruise vessels to be able to access the Docks, the navigation channel requires deepening to -8.3m below chart datum (CD). By deepening the channel and berths, cruise vessels will be able to access the Docks at a greater range of times and so the Docks will be more attractive to vessel operators as a cruise terminal. Cruise vessels typically like to enter port early in the day and leave in the early evening. By deepening the channel, larger vessels will be able to enter the Docks at this time on a greater number of days.

The channel also requires straightening in order to improve the safety of navigation. The existing navigation channel is designed to provide vessels with safe access to FDEC's Docks Basin, but not the wharves. At present, accessing the wharves requires vessels to be lined up for the Docks Basin approach and then manoeuvred northwards around the wharves and vessels moored against them. Realigning of vessels' tracks to northwards requires course alterations and a period of settling onto the new track. This adds unwelcome complexity to the manoeuvre and reduces the margins of safety for larger vessels. The safe handling of large vessels with minimum margins for diverging from the intended track requires a track as straight as possible so that the vessel can be lined up on the intended track and maintained and effectively monitored in safe water throughout the passage.

Increasing the number and size of vessels visiting Falmouth Docks will have additional major benefits for the local economy by increasing the total amount of income that cruise passengers, crew and others associated with cruise vessels will spend in the local area while in port.

1.3 REQUIREMENT FOR ENVIRONMENT IMPACT ASSESSMENT

The following paragraphs describe the legislation that applies to the proposed Falmouth Cruise Project. These paragraphs do not constitute legal advice and are provided to describe the legislative context of the Environmental Impact Assessment (EIA) process and other environmental protection mechanisms applying to the proposals only.

1.3.1 Permissive Powers

Both FDEC and FHC have various permissive powers granted to them under Acts of Parliament. These powers entitle them to effectively self-regulate the activities included under their respective Acts.

Falmouth Docks Act

Falmouth Docks, including the dry docks, wharf and an area of tidal waters surrounding them, are under the statutory authority of FDEC, which is currently constituted under the Falmouth Docks Act 1959. This Act consolidates FDEC's statutory powers dating from the initial Falmouth Docks Act granted in 1859 and subsequent amendments to it. The powers are granted to FDEC, which is owned and managed by A&P Falmouth Ltd, part of the A&P Group.

Falmouth Harbour Act

The Falmouth Harbour Act 1870 (FHA) established the statutory powers of FHC. The harbour limits were originally from Zone Point to Rosemullion Head, but these were increased by the Falmouth Harbour Revision Order (HRO) 1991. The added limits comprise a box of approximately 3 miles by 3 miles placed adjacent to the original harbour limit line. The Falmouth Harbour Act excludes the area defined within Falmouth Docks Act.

Based on information provided by Bircham Dyson Bell (2008), the following aspects of FDEC's statutory powers are relevant to the proposed Falmouth Cruise Project:

- FDEC has a specific power contained in section 7 of the Falmouth Docks Act 1959 to undertake quay construction, but under section 10, this is subject to ministerial consent qualification;
- FDEC has a specific power contained in section 35 of the Falmouth Docks Act 1959 to construct and maintain buildings; and
- FDEC has a power to dredge contained in section 26 of the Falmouth Docks Act 1959 which is limited to lands vested in it or situated in its tidal harbour, and requires ministerial consent to deposit dredged material below high water mark (and the consent of the FHC if such deposit is within the FHC's jurisdiction.

Based on information provided by Bircham Dyson Bell (2008), the following aspects of FHC's statutory powers are relevant to the proposed Falmouth Cruise Project:

- FHC have a specific dredging power contained in section 35 of the Falmouth Harbour Order 1870, which by virtue of section 10 is only exercisable with Board of Trade (now the MFA) consent, together with express power contained by section 17 of that Order to purchase, provide, lease or hire dredges etc for the purposes of their harbour;
- FHC have a more general power contained in article 18 of the Falmouth Harbour Revision (Constitution) Order 2004 to take action they consider necessary or desirable for the maintenance, operation, management and improvement of their harbour and the accommodation and facilities (including navigation facilities) available or in connection with their harbour, including as provided for in article 18(2)(b) and (c):
- doing any other thing which, in their opinion, is in the interests of the proper carrying on or development of their harbour or can advantageously be

undertaken by them by virtue of their of their activities in relation to the harbour; and
- turning their resources to account so far as not required, for the purposes of their harbour undertaking.

The capital dredging associated with the proposed Falmouth Cruise Project falls within the areas in FDEC's jurisdiction and the FHC's jurisdiction. Advice from Bircham Dyson Bell (2008) indicates that it can be concluded that the FHC have the corporate power to enter into a dredging contract extending beyond their jurisdiction if they consider that this is in the interests of their harbour undertaking. This could include dredging in FDEC's area, but this would need FDEC's agreement and might, given the absence of express statutory authority, give rise to some ambiguity or confusion.

1.3.2 Consent Requirements

The proposed Falmouth Cruise Project will require a number of consents prior to construction and operation, as described in the following paragraphs and outlined in Figure 1.1.

Marine Works Consents

It is anticipated that the following consents will be required:
- Marine & Fisheries Agency (MFA) consent (i.e. Board of Trade consent) for FHC to undertake dredging in the FHC's harbour jurisdiction by virtue of section 10 of the Falmouth Harbour Act 1870;
- MFA consent (i.e. Ministerial approval) for FDEC to deposit dredged material below MHWS by virtue of section 26 of the Falmouth Docks Act 1959, and at least arguably (based upon dredging being a "work" and section 10 of the Falmouth Docks Act 1959 therefore applies to it) also for the dredging itself;
- consent for FDEC and FHC to undertake dredging under section 34 of the Coast Protection Act 1949 insofar as reliance cannot be placed on FDEC's and FHC's powers;
- licences to deposit materials on the seabed under Part II Food & Environment Protection Act 1985, including:
- disposal of dredged material at sea (to the Falmouth Bay disposal site);
- disposal of dredged material at sea for seabed habitat mitigation in the new navigation channel; and
- marine construction works for wharf structures.

In addition, FDEC will require FHC's consent to deposit dredged material in FHC's jurisdiction by virtue of Section 26 of the Falmouth Docks Act 1959.

Planning Approval

Planning permission may be required for the landside works, including the cruise terminal building and infrastructure improvements around the docks estate, in accordance with the Town & Country Planning Act 1990.

However, it may be possible for FDEC to rely on permitted development rights under Class A of Part 11 or Class B of Part 17 of the Town & Country Planning (General Permitted Development) Order 1995.

Advice from Bircham Dyson Bell (2008) notes that Part 11 permitted development rights are available for development authorised by a Local Act or Harbour Order "which designates specifically the nature of the development authorised and the land upon which it may be carried out". Whilst it is clear that this applies to works which are expressly authorised and shown on the plans deposited with such Acts and Orders, case law indicates that it may also apply to works more generally referred to in the Act or Order as authorised to be constructed within limits shown on those plans.

Advice from Bircham Dyson Bell (2008) also notes that harbour and dock authorities have the benefit of Part 17, Class B permitted development rights which relate to development on operational land in respect of a dock, pier or harbour where it is required for the purposes of shipping or in connection with transit of passengers, livestock or goods. However, such permitted development rights are disapplied by paragraph 3(10) of the Town & Country Planning (General Permitted Development) Order 1995 in relation to development which is required to be subject to EIA.

At the time of preparing the ES for the proposed Falmouth Cruise Project, the decision had not be taken on whether to rely on permitted development rights or to apply for planning permission for the cruise terminal building and landside infrastructure improvement works. It is possible that FDEC will undertake further consultation with Carrick District Council (and the forthcoming Cornwall Implementation Executive) to explore the basis upon which any planning application may be handled.

1.3.3 EIA Requirements

EIA will be required to support FDEC's and FHC's applications for marine works consents required under the Food & Environment Protection Act 1985 and the Coast Protection Act 1949, and planning approval if required under the Town & Country Planning Act 1989 or if permitted development is disapplied by the Town & Country Planning (General Permitted Development) Order 1995.

The requirement for EIA is established by European Directive 85/33/EEC as amended by 97/11/EC on the assessment of the effects of certain public and private projects on the environment (hereafter referred to as the EIA Directive). The EIA Directive is implemented through national law, some of which is applicable to the proposed Falmouth Cruise Project.

Marine Works Consents

All such consents are subject to the Marine Works (Environmental Impact Assessment) Regulations 2007 through the provisions of the Coast Protection Act 1949 and the Food & Environment Protection Act 1985.

Section 34 of the Coast Protection Act 1949 concerns activities that may be detrimental to the safety of navigation. Under section 34, the Secretary of State for Transport's consent is required for the following activities taking place below mean low water springs in territorial waters:

- construction, alteration or improvement of any works on, under or above any part of the seabed;
- deposition of any object or materials; and
- removal of any object or materials.

With the introduction of new law in the years since 1949 (notably Section 36 of the Merchant Shipping Act 1988), Section 34 has been extended to take account of the potential environmental effects associated with the activities listed above and can trigger the need for EIA. Under the CPA, EIA can be required via the Marine Works (Environmental Impact Assessment) Regulations 2007 which transpose into national law the requirements of the EIA Directive.

Part II of the Food & Environment Protection Act 1985 (FEPA) applies to the deposit of articles or materials in the sea and tidal waters and is in place to protect the marine ecosystem and human health and to minimise interference and nuisance to other users of the marine environment.

Planning Approval

If approval is required under the Town & Country Planning Act 1989 or if permitted development is disapplied by the Town & Country Planning (General Permitted Development) Order 1995, then EIA may be necessary to support an application in accordance with the provisions of the Town & Country Planning (Environmental Impact Assessment) (England and Wales) Regulations 1990.

1.3.4 Other Requirements

Appropriate Assessment

The proposed project would take place within the Fal and Helford Special Area of Conservation (SAC). In light of this, Natural England have advised that the proposed Falmouth Cruise Project is likely to have a 'significant effect' on the SAC – a Natura 2000 European Site - and, therefore, have advised that appropriate assessment is required in accordance with the Habitats Directive as implemented through the Conservation (Natural Habitats &c.) Regulations 1994. Accordingly, before the proposed Falmouth Cruise Project can be given any consent or approval, a competent authority must make an appropriate assessment of the project's implications for the SAC in view of the SAC's conservation objectives.

Appropriate assessment is the title given to the process of approval required under the Conservation (Natural Habitats &c.) Regulations 1994. Both FHC and FDEC are competent authorities in this context since they are the statutory undertaker for their respective jurisdictions. However, it is considered likely that the lead competent authorities for this project will be the MFA for marine works consents and the local planning authority if planning approval is required.

Normally a competent authority can only consent or approve a project if it will not adversely affect the integrity of a European Site. The only exception to this constraint is if the competent authority is satisfied that no alternative solutions are available and the project must be undertaken for imperative reasons of overriding public interest (IROPI). In which case, compensation must be provided commensurate with the adverse effect on the integrity of the designated site.

Under the Conservation (Natural Habitats &c.) Regulations 1994, the project proponent has to provide an environmental appraisal in order to inform a competent authority's decision. Section 24 on Implications for Designated Status contains the environmental appraisal required to inform the competent authorities'' appropriate assessment decision on the Falmouth Cruise Project.

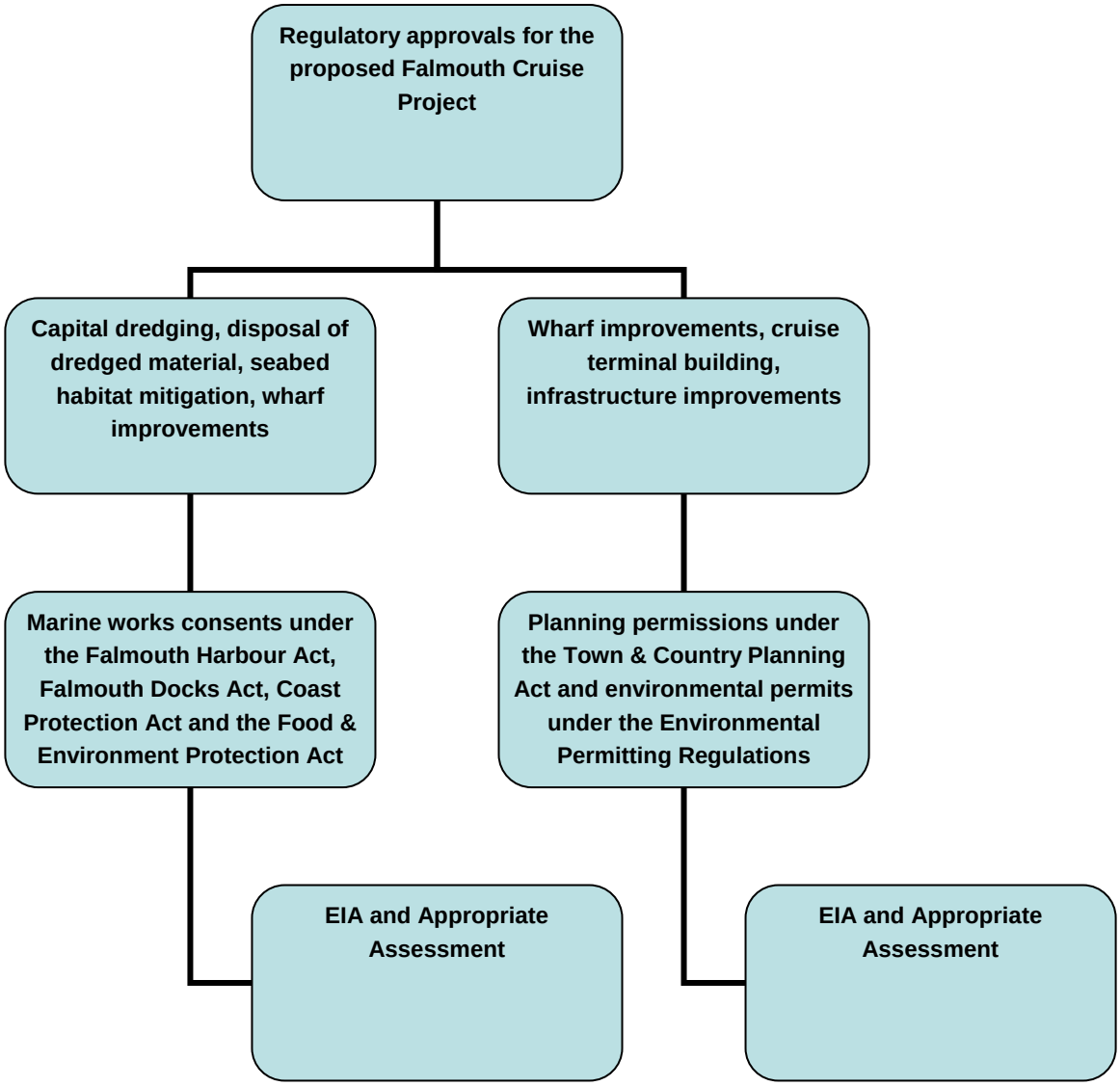
Environmental Permits

The proposed Falmouth Cruise Project includes proposals for various uses of treated contaminated dredged material for infrastructure improvements within Falmouth Docks. The uses can be exempted from the normal requirements associated with waste disposal in accordance with the options set out in Schedule 3 to the Environmental Permitting Regulations 2007. Environmental permits are available from the Environment Agency under the following relevant exemption routes:

- paragraph 9 for land reclamation or improvement, where the waste (i.e. dredging spoil) is spread for the purpose of reclamation, restoration or improvement of land which has been subject to industrial or other man-made development, and the use to which that land could be put would be improved by the spreading; and
- paragraph 19 for waste for construction, where the waste (i.e. dredging spoil) is suitable for use in drainage works in accordance with the meaning of drainage for the purposes of the Land Drainage Act 1991, but does not include land reclamation.

In both cases, planning permission or approval is required in accordance with the Town & Country Planning Act 1990 before an environmental permit can be granted.

Figure 1-1 Summary of Regulatory Approvals and Environmental Requirements



1.4 THE ENVIRONMENTAL IMPACT ASSESSMENT PROCESS

EIA is a process for assessing and taking account of potential environmental impacts associated with development as part of the approvals processes related to the legislation relevant to the project (see Section 1.3).

1.4.1 Screening

Screening is the process by which it is determined whether or not a proposed development requires EIA. Under the EIA Directive (and its application through UK law), EIA is mandatory for the types of development listed under Annex I and discretionary for the types of development listed under Annex II. A project proponent may request a formal screening opinion or direction from a competent authority, or may voluntarily decide that EIA applies.

In the case of the Falmouth Cruise Project, FHC determined (voluntarily) that EIA will be required because the proposals fall under Annex 1, Part 8b of the EIA Directive which identifies the following type of development: 'Trading ports, piers for loading and unloading connected to land and outside ports (excluding ferry piers) which can take vessels of over 1350 tonnes'. Since EIA is mandatory for development listed under Annex I of the EIA Directive, FHC did not seek a formal screening opinion or direction from a competent authority.

1.4.2 Scoping

Scoping is the process by which the issues to be addressed during the EIA and presented in the Environmental Statement (ES) are identified. A project proponent may request a formal scoping opinion or direction from a competent authority.

In the case of the Falmouth Cruise Project, FHC commissioned Royal Haskoning to undertake an environmental scoping study. The scoping study comprised a series of tasks to identify the potential environmental issues associated with the proposed project to determine the scope of work required for the preparation of the ES including:

- collation of existing environmental information by searching relevant databases and literature;
- identification of potentially significant environmental effects;
- consultation with interested parties; and
- preparation of the Environmental Scoping Study report (Royal Haskoning, 2006).

The scoping study report was submitted to the MFA (in their former guise as the MCEU) as part of a request for a scoping opinion made in February 2006. The MFA subsequently replied confirming that they were content with the proposed scope of the EIA (email, dated 16 May 2006).

1.4.3 Preparation of the Environmental Statement

A range of potential impacts have been identified for the construction and operation phases of the proposed Falmouth Cruise Project. For each of the impacts identified, an assessment has been made of the expected change to baseline conditions to predict their environmental significance. There are a number of criteria that are incorporated into the impact predictions and the assessment of their significance, including:

- assessment criteria (i.e. quantified or qualified values against which the baseline conditions and impacts are assessed (e.g. water quality standards);
- impact magnitude (i.e. quantified change or qualified scale against the assessment criteria or in terms of spatial extent and/or duration;
- impact sensitivity (i.e. value of the affected environmental receptor to the impact);
- reversibility, probability and confidence in the impact prediction.

In addition, in order to classify the significance of predicted impacts, and in an effort to provide a consistent framework for considering and evaluating impacts on different environmental parameters, the terminology presented in Table 1-1 has been used throughout the ES unless otherwise described in Sections 5 to 21.

Table 1-1 Terminology for Classifying and Defining Impact Significance

Impact	Definition
Negligible	The impact is not of concern
Minor adverse	The impact is undesirable but of limited concern
Moderate adverse	The impact gives rise to some concern but it is likely to be tolerable (depending on its scale and duration)
Major adverse	The impact gives rise to serious concern; it should be considered as unacceptable
Minor beneficial	The impact is of minor significance but has some environmental benefit
Moderate beneficial	The impact provides some gain to the environment
Major beneficial	The impact provides a significant positive gain

Where potentially significant adverse impacts have been identified, mitigating measures have been examined and recommended in order to reduce residual impacts, as far as possible, to environmentally acceptable levels.

1.4.4 The ES Report Structure

This introductory section (Section 1) briefly describes the background to and the need for the proposed Falmouth Cruise Project. It also describes the legislative context for the EIA and the EIA process as far as the preparation of the ES.

Section 2 describes in detail the construction and operation phases of the proposed project.

Section 3 describes the alternatives options considered.

Section 4 describes the planning and policy framework relevant to the proposed project.

Sections 5 to 21 describe the baseline environmental conditions and impact assessments for the following parameters representing the natural and human environment:

- hydrodynamic and sedimentary regime;
- sediment quality;
- water quality;
- marine ecology;
- terrestrial ecology;
- ornithology;
- fish resources;
- commercial fisheries;
- marine mammals;
- navigation and recreation;
- landscape;
- archaeology and cultural heritage;
- traffic and transportation;
- noise and vibration;
- air quality;
- land quality; and
- socio-economics.

The sections for each of these parameters are structured to provide the following information:

- introduction;
- assessment methodology;
- baseline environmental conditions;
- impact assessment during project construction;
- impact assessment during project operation; and
- references.

Section 22 provides a tabulated summary of the significance of the impacts predicted, the mitigation measures proposed, and the corresponding residual impacts.

Section 23 concerns potential cumulative effects of the proposed project in combination with other proposals.

Section 24 describes the implications of the proposed project for the designated status of the Fal and Helford Estuaries SAC, and provides information to inform an appropriate assessment.

Section 25 concerns the proposals for monitoring.

Additional information is appended to the ES (see Appendices A to H).

A Non-Technical Summary (NTS) accompanies this ES: provided as a separate, stand alone document.

1.5 THE PROJECT TEAM

The preparation of the ES was undertaken and managed by Royal Haskoning.

Additional work to inform the preparation of the ES was undertaken by:

- Bircham Dyson Bell (consents and approvals);
- HR Wallingford (numerical modelling and assessment of the hydrodynamic and sedimentary regime);
- Mojo Maritime Ltd (sediment quality and marine ecology - vibrocores survey)
- Macaulay Analytical Services (sediment quality – physical and chemical analyses);
- Cefas (sediment quality – biological analyses);
- SeaStar Survey Ltd (marine ecological survey);
- Cornwall Environmental Consultants (landscape and visual impact assessment); and
- Cornwall Historic Environment Service (archaeological assessment).

2 PROJECT DESCRIPTION

2.1 DESIGN VESSEL

The design vessel used to inform the proposals is the MS Freedom of the Seas. Its dimensions and operational requirements have been accounted for in the proposed Falmouth Cruise Project, including the navigation simulations and conceptual designs for the channel and berthing area. Launched in 2006, the MS Freedom of the Seas characterises the increasing size of cruise vessels being built to serve an increasing demand for cruise based tourism by accommodating more passengers. The key features of the ship are described in Figure 2-1.

The design vessel is larger than the cruise vessels that can be accommodated by the current facilities. The design vessel's length is approximately 340m. Present facilities only provide an alongside berth for cruise vessels up to 230m in length due to the restrictions of length along the either the County Wharf or the Queen's Wharf. The design vessel's draught is 8.8m. Present facilities only provide for a maximum draught for cruise vessels of 8m; this being restricted by the depth of water on the County Wharf.

Figure 2-1 Key Features of the Design Vessel

Gross tonnage (t)	154,407
Length overall (m)	338.77
Beam (m)	39.03
Draught (m)	8.80
Height (m)	63.7
Decks	15
Berths	4,375
Cabins	1,817
Passengers	4,375
Crew	1,360
Owner / operator	Royal Caribbean
Maiden voyage	2006



2.2 FALMOUTH CRUISE PROJECT

The proposed Falmouth Cruise Project comprises:

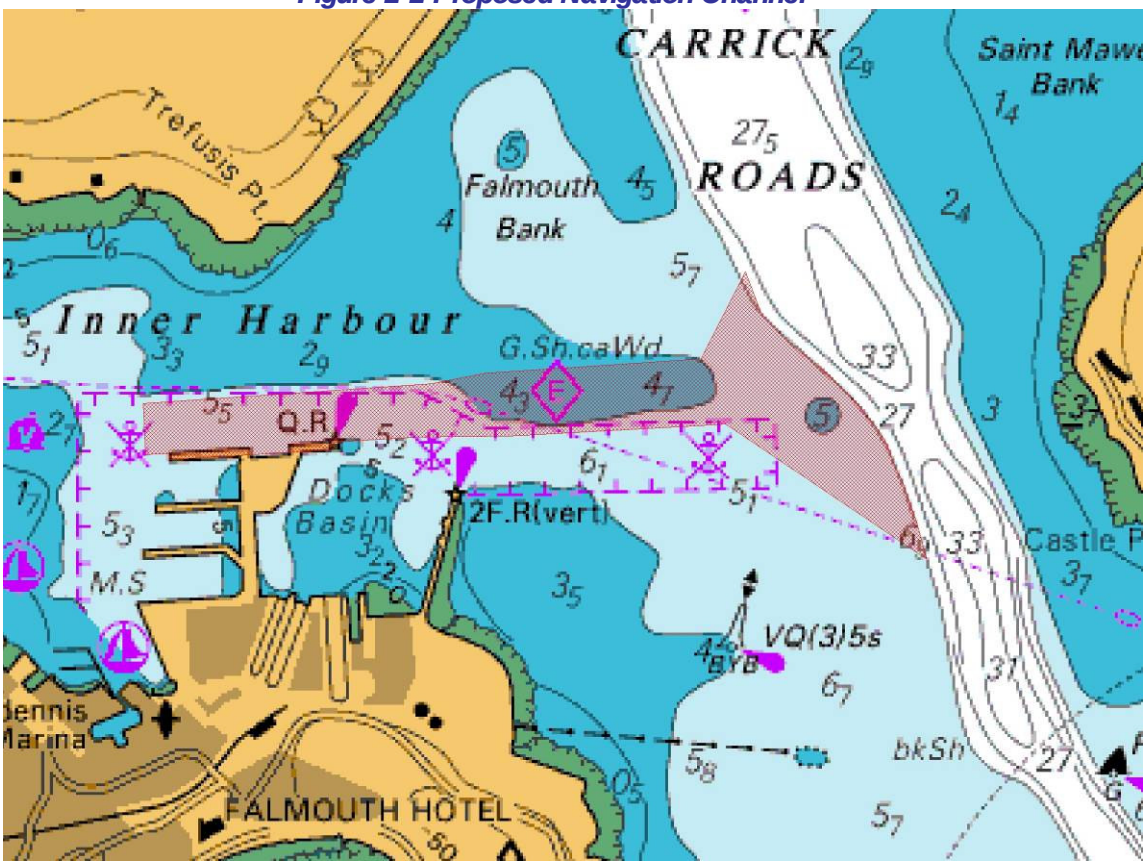
- A deeper and straighter navigation channel from Carrick Roads / The Narrows to the Queens and Northern Wharves, including a deep water berth for cruise vessels along the combined length of the Queens and Northern Wharves, and seabed habitat mitigation in the eastern navigation channel (see Section 2.2.1);
- A longer cruise quay combining the Queens and Northern Wharves (see Section 2.2.2);
- A new cruise terminal building (see Section 2.2.3); and
- A range of infrastructure improvements around the docks estate (see Section 2.2.4).

2.2.1 New Navigation Channel and Deep Water Berth

New Navigation Channel

A new navigation channel is proposed to accommodate the safe navigation of cruise vessels. The proposed channel location is shown in Figure 2-2. The conceptual channel design is principally based on guidance by PIANC (1997) and Thoresen (2003). More details are provided in Falmouth Cruise Project EIA: Channel Design and Navigation Simulations (Royal Haskoning, 2008).

Figure 2-2 Proposed Navigation Channel



The required navigable depth is 10.5m when based on the design vessel's draught (i.e. 8.8m), squat (assuming low ship speed; i.e. 0.5m), waves (allowing for some swell at the Narrows; i.e. 0.2m), dredging tolerance (i.e. 0.5m), and heel corresponding to approximately 1.5º (i.e. 0.5m). For sufficient flexibility of safe operations for the design vessel, a tidal window equivalent to 75% of a typical tide is to be provided by the proposed capital dredging (i.e. nine hours during an average tide). Therefore, the proposed new channel will have a declared depth of -8.3mCD.

The lateral channel dimensions allow for:

- a turning area for vessel manoeuvres of 540m, which is equivalent to 1.6 times the maximum design vessel length (i.e. minimum recommended diameter);
- a channel width of 155m for the eastern part of the proposed channel aligned east-west from Carrick Roads / The Narrows to the Eastern Breakwater; and
- a channel width of 125m for the western part of the proposed channel aligned east-west from the Eastern Breakwater to the Queens and Northern Wharves.

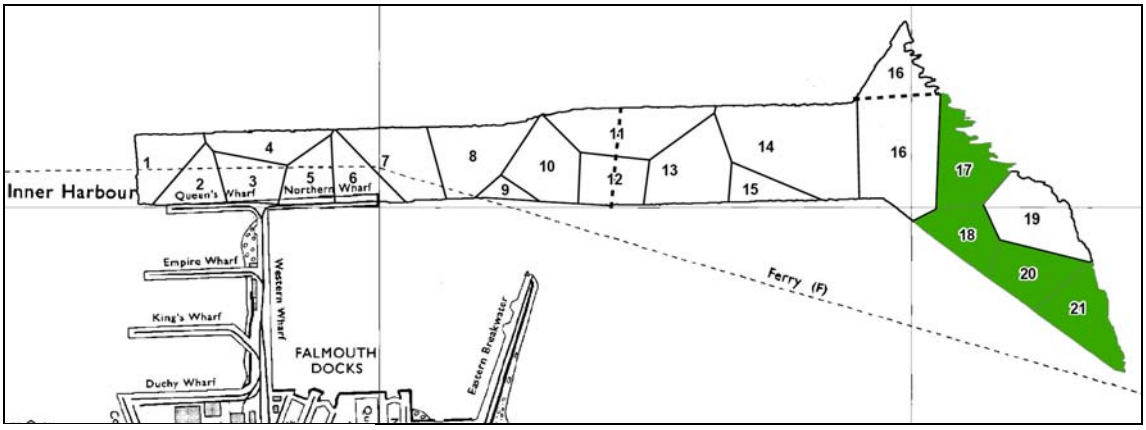
Deep Water Berth

The proposed conceptual channel design includes a deep water berthing pocket alongside the combined length of the Queens and Northern Wharves. The berthing pocket will be deepened and lengthened the berth along its proposed lateral dimensions (510m by 50m) to accommodate berthed cruise vessels on all states of the tide. The current declared depth of the berths along the Queens Wharf and the Northern Wharf is -6mCD. Based on the design vessel, the new berthing pocket will have a declared depth of -9.5mCD.

Seabed Habitat Mitigation

In order to offset the potential loss of seabed habitat associated with the capital dredging for the new navigation channel, it is proposed that an area of seabed within the eastern part of the navigation channel (see Figure 2-3) be dredged to a depth of approximately one metre more than the declared depth in order to remove non-maerl substrate, and then be filled with maerl substrate. For the purposes of nature conservation, the maerl substrate is of more habitat value than the substrate it replaces and contributes to offsetting the potential impacts associated with capital dredging.

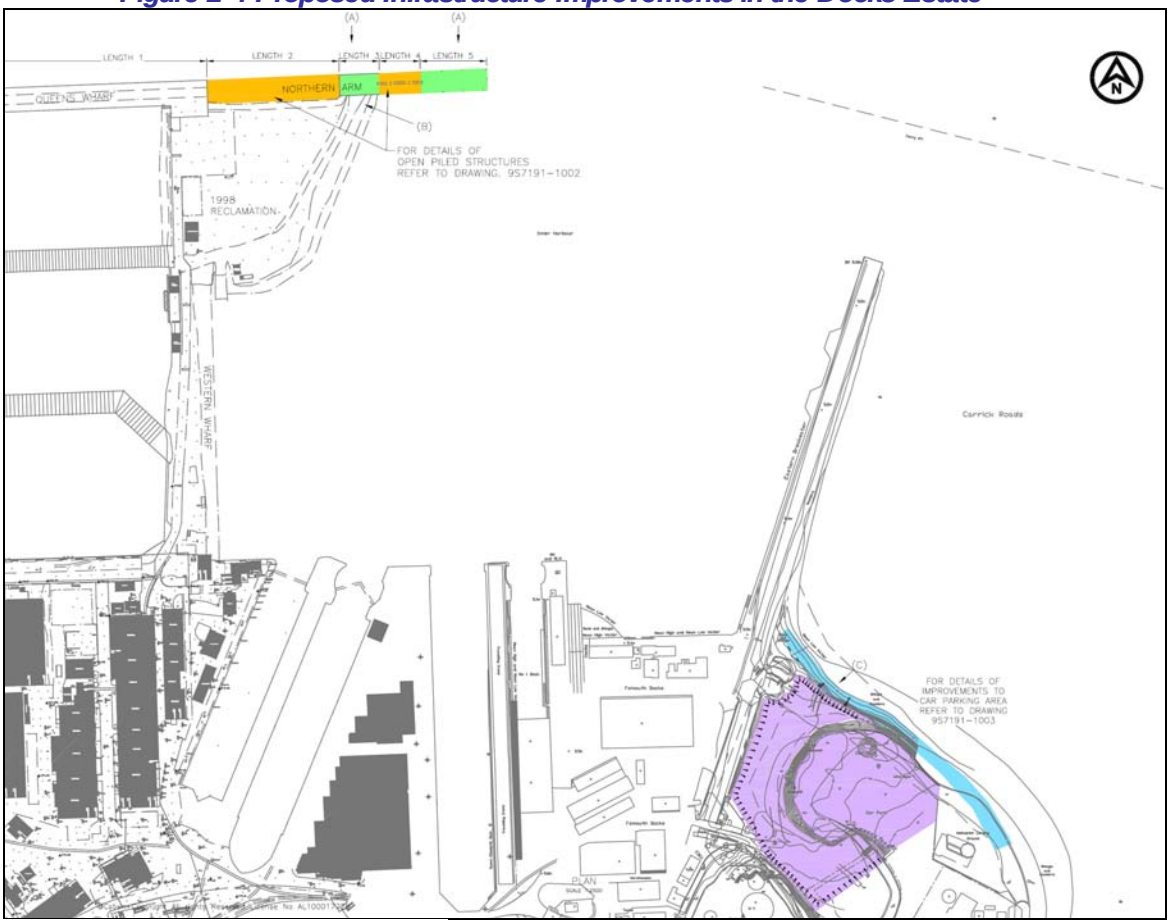
Figure 2-3 Site of the Proposed Habitat Mitigation Area within the New Navigation Channel



Disposal of Contaminated Dredged Material

Contaminated dredged material (c.100,000m^3) is to be treated to remove its contaminants to the extent that it can be used as a construction material for the proposed docks infrastructure improvements (see Figure 2-4), with the excess to be used off site and/or disposed of to landfill.

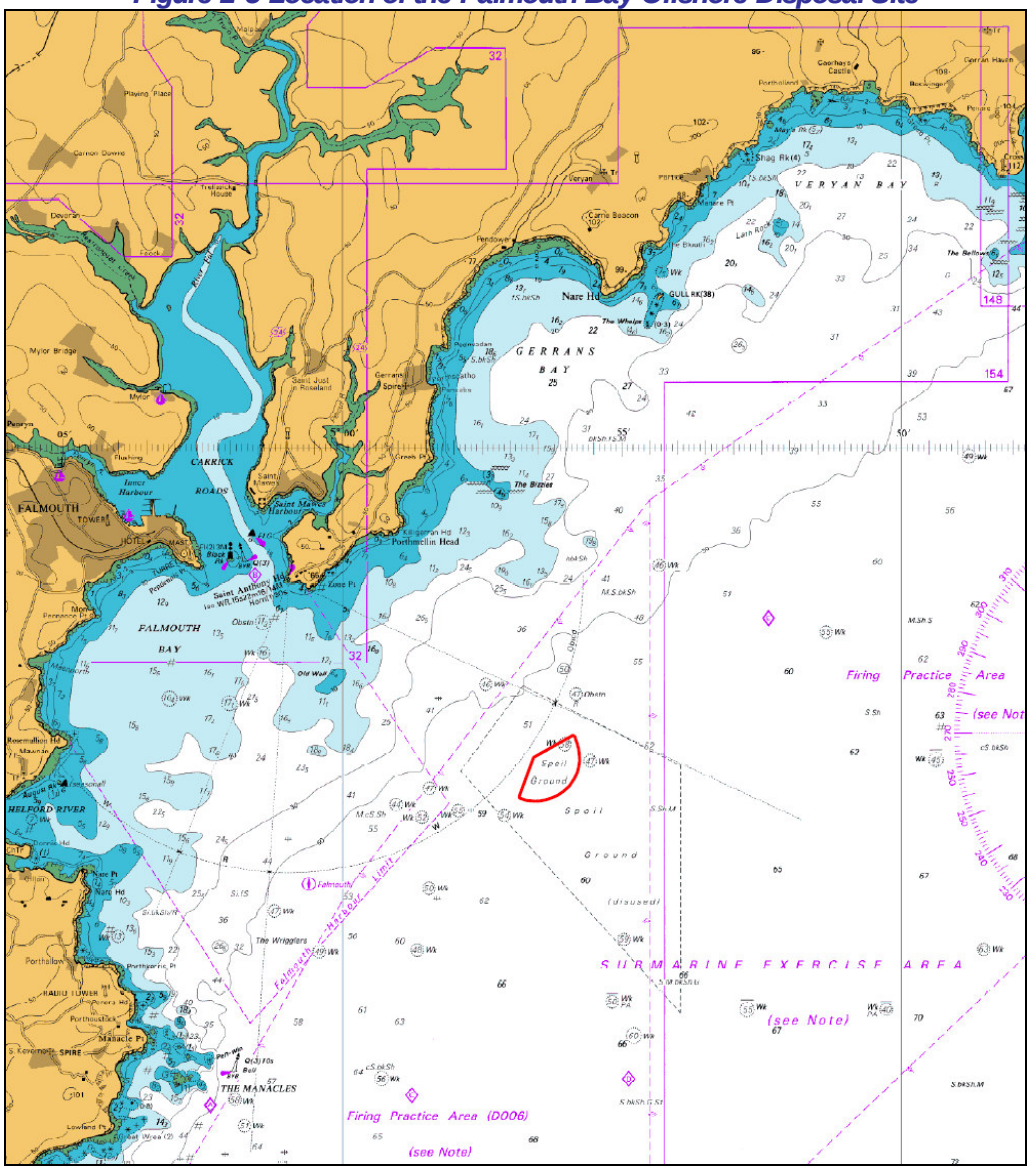
Figure 2-4 Proposed Infrastructure Improvements in the Docks Estate



Disposal of Clean Dredged Material

Clean dredged material (c. 600,000m^3) is to be disposed of at sea at the Falmouth Bay site (see Figure 2-5). It may be possible to use the maerl substrate within the dredged material as a soil improver, which would offset the need to dispose of (some of) it at sea. However, the maerl resulting from the dredge would be considered a waste material and its use would be subject to the Environmental Permitting Regulations 2008. Therefore, for the purposes of the EIA process, it is assumed that all of the clean dredged material will be disposed of to sea and the disposal of maerl as a soil improver is considered as an alternative (see Section 3.8.3).

Figure 2-5 Location of the Falmouth Bay Offshore Disposal Site



2.2.2 Cruise Quay

A dedicated cruise quay of some 430m in length is to be provided by combining the lengths of the Queens and Northern Wharves. The majority of the Queens Wharf already comprises an open piled structure that is in good condition (see Figure 2-6), having been re-constructed in 2003 following fire damage.

However, to provide a continuous quay capable of supporting cruise operations, it is necessary to:

- construct new quay infrastructure to bridge the gap between the Queens Wharf and Northern Wharf (see Figure 2-7); and
- improve the condition of the existing Northern Wharf's infrastructure, which is 55 years old and currently comprises a combination of mass concentre and timber piled structures, which are in poor condition (see Figure 2-7).

Figure 2-6 Existing Queens Wharf



Figure 2-7 Existing Northern Wharf (left) and Gap between the Queens Wharf and Northern Wharf (right)



2.2.3 Cruise Terminal Building

The new cruise terminal building is to be situated on the reclaimed land near the Queens and Northern Wharves, centrally located along the proposed cruise quay. The building will be set approximately 16m back from the seaward edge of the quay. The site covers approximately 0.8Ha, including the building's footprint of approximately 0.35ha and a hardstanding area for future expansion and arrival and departure of vehicles and coaches.

The building's conceptual architectural design is illustrated in Figure 2-8. According to CSA Architects (2008), "the building design was conceived to evoke a maritime architecture, linking directly to the ships and boats that use the Fal Estuary. This maritime theme has been echoed throughout the design of the proposed building, expressing the layered, wave form roofs, expressing the direct architectural reference to the water, and water movement. The essence of a control tower enabled another design feature, with a strong maritime link, again, using a subtle curving, wave-form roof, appearing to float over the building using a structural glazing system."

In terms of architectural style, character and materials, CSA Architects (2008) state that "the building design creates a spectacular space, in which to be welcomed to the UK and to Falmouth; the internal dynamics of the curing, wave-form roof creates a volumetric space with generous ceiling heights and high level glazing, bathing the main space with natural light. The maritime architectural style is prevalent throughout the aesthetics of the building. The palette of materials has been derived using maritime influence, with direct reference to colour and details, taken from the activity and vessels on the waterfront. The use of deep blue against stark white is one of the most associated colour palettes for a maritime use, and will enable visual international recognition, for visitors. In addition, the wave-form roofs using natural zinc will partially reflect the surrounding context, water reflections and the sky will be distorted and softly expressed within the roof, always relating to the weather, which will anchor this building within the setting and ensure continuous linkage to the character of the ever changing marine environment. The use of robust materials will ensure longevity of the building, to maintain the quality of the external aesthetics for many years, to look fresh, maintained and welcoming to visitors and onlookers from the town and active waterfront. The building is contemporary, robust and functional."

In terms of orientation, massing and layout, CSA Architects state that "the linear nature of the proposed building defines the spaces around it and their function. To the north of

the building is Queens Wharf and Northern Wharf, which will be linked, to provide, secure access to the cruise ships. The line dividing the wharf and the car park is divided by the building and a secure fence. Public access is from the south, via the car park and vehicular hardstanding area. Private, office access is on the eastern façade, directly into the control tower. The layout has been conceived, in accordance with the requirements of the brief, to allow for future expansion, addition of marquees and a new storage facility to the east of the proposed reception building. The building is therefore orientated to the north and south for public access and to maximise the outlook from the control tower. There is an opportunity for high quality hard landscaping around the proposed building, to further enforce the setting and quality of the development. Due to the exposed nature of the location, it is not considered appropriate to incorporate green landscaping."

Figure 2-8 Architectural Designs of the Cruise Terminal Building



2.2.4 Improvements to the Docks Infrastructure

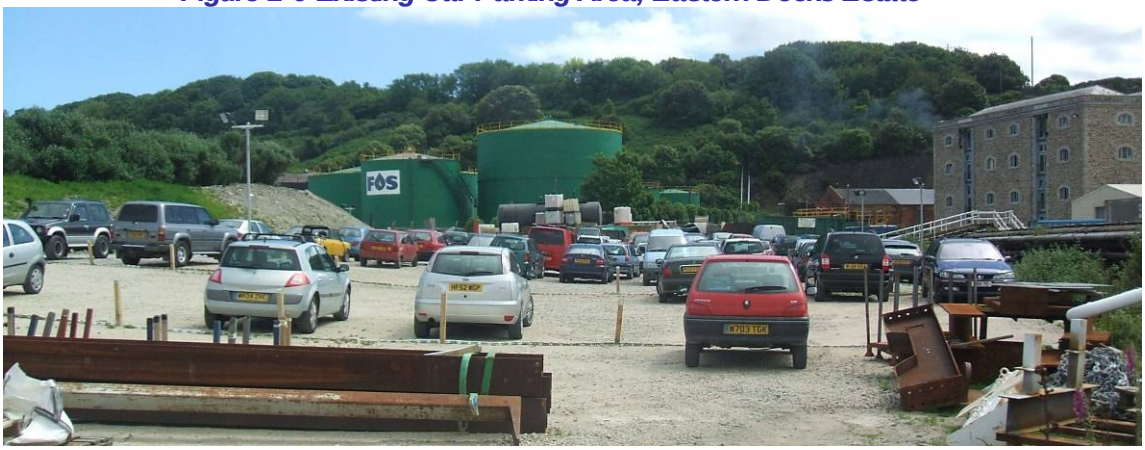
Ground Improvement for Car Parking in the Eastern Part of the Docks Estate

The proposals include for construction to improve two existing car parking areas in the eastern part of the docks estate (see Figure 2-9).

One area is the land area that surrounds the landward edge of an existing waste disposal tip (approximately 0.75ha) and currently provides car parking for turnaround cruise passenger vehicles and for the Falmouth Marine Skills Centre. This area will be raised to reduce flood risk and levelled to prevent ponding of surface water.

The other area is the land area on top of an existing waste disposal tip (approximately 0.65ha). This area will be raised to provide a cap to the top of the waste disposal tip and levelled to prevent ponding of surface water.

Figure 2-9 Existing Car Parking Area, Eastern Docks Estate



Coastal Erosion Protection for the Waste Disposal Tip in the Eastern Part of the Docks Estate

The existing waste disposal tip in the eastern part of the docks estate is subject to erosion on its seaward face to the extent that its contents appear to be exposed and potentially slumping onto the foreshore (see Figure 2-10). To arrest the erosion, it is proposed to re-grade the seaward face to reduce the slope angle, and to protect it with fill material and rock armour. The proposed work will extend east as far as the existing rock armoured structure built by South West Water in 1999.

Figure 2-10 Coastal Erosion along the Seaward Face of the Existing Waste Disposal Tip in the Eastern Part of the Docks Estate



2.3 DESCRIPTION OF THE CONSTRUCTION PHASE

The construction phase includes:

- capital dredging of the navigation channel and cruise berth (see Section 2.3.1);
- treatment of contaminated dredged material (see Section 2.3.2);
- disposal of contaminated dredged material (see Section 2.3.3)
- disposal of clean dredged material (see Section 2.3.4);
- improvement works to the cruise quay (see Section 2.3.5); and
- erection of the cruise terminal building (see Section 2.3.6).

The construction phase is defined as the period from the commencement to completion of the proposed works and capital dredging.

2.3.1 Capital Dredging

Capital dredging will be undertaken to create the proposed navigation channel and deep water cruise berth and to replace seabed habitat as described in Section 2.2.1.

Dredging Method

The proposed dredging method is predicted to utilise backhoe dredgers (see Figure 2-11) and barges (see Figure 2-12) for the reasons described in the following paragraphs. More details are provided in Falmouth Cruise Terminal: Preliminary Report on Dredging (Dredging Research, 2008).

Figure 2-11 Backhoe Dredgers with Barges (sources: Van Oord and Boskalis Westminster Dredging)



In essence, backhoe dredgers are similar to land-based excavators but are mounted on a pontoon or a vessel. Backhoe dredgers can dredge most materials including stiff materials and weak rock, and are suitable for dredging in confined areas. Backhoe dredgers use a bucket mounted to the end of the boom to remove material from the seabed and place it into a barge for transport and disposal. Bucket size depends on the nature of the material to be dredged. Backhoe dredgers can be equipped with visor grabs (see Figure 2-12) instead of open buckets. Visor grabs are mounted to the end of the boom and use a revolving visor flap enclose the material in the grab prior to its removal from the seabed. The benefits of the visor grab include maximising the excavated material's density and reducing suspended sediment during dredging (CIRIA, 2000).

Figure 2-12 Sea-going Barge and Visor Grab (sources: Boskalis Westminster Dredging and Van Oord)



Backhoe dredgers and barges will be used for the capital dredging of the proposed Falmouth Cruise Project because they offer a degree of technical capability and flexibility, and an environmental performance, that cannot be offered by other dredging methods.

Dredging Contaminated Material

A backhoe dredger supported by a tug and dumb barges (c. 1,000m^3) is predicted to be most suitable for dredging the contaminated material present in the western part of the proposed channel (aligned east-west from the Eastern Breakwater to the Queens and Northern Wharves) and loading it to treatment plant within the docks (see Section 2.3.2) prior to disposal (see Section 2.3.3). Technically, backhoe dredgers work at more suitable production rates relative to the plant necessary to treat the dredged material. In addition, environmentally, the release rate of suspended sediment during dredging with a backhoe is very low compared to other dredging methods, which is beneficial in terms of minimising the magnitude of suspended sediment dispersion and deposition (see Section 3.4.3).

Dredging Clean Material

A backhoe dredger supported by a sea-going self-propelled barge (1,000m^3) is predicted to be most suitable for dredging of clean material in the eastern part of the proposed channel (aligned east-west from Carrick Roads / The Narrows to the Eastern Breakwater) and disposing of it at an offshore disposal site in Falmouth Bay (see Section 2.3.4). Environmentally, the production rate of backhoe dredging is lower than other dredging methods, which is beneficial in terms of reducing the potential rate of disposal offshore (see Section 2.3.4).

Dredging Weathered Rock

A backhoe dredger is predicted to be most suitable for dredging any weathered rock that may be present, particularly off the Northern Wharf. Although rock strength or quality is not known, it is assumed that the rock occurs as weathered laminar material (e.g. schist) which can be excavated using a dredger without the need for blasting. This assumption is supported by existing information, which indicates that the rock takes the form of weathered schist (e.g. Posford Duvivier, 1998). Technically, backhoe dredgers are often capable of excavating this type of material compared to other dredging methods.

Dredging Maerl for Seabed Habitat Mitigation (and as a Soil Improver)

A backhoe dredger supported by barges is predicted to be most suitable for dredging of clean material containing maerl in the eastern part of the proposed channel (aligned east-west from Carrick Roads / The Narrows to the Eastern Breakwater) and either transporting and using it within the navigation channel to mitigate habitat loss (see Section 2.3.1) or transporting it to an offloading facility for washing and re-using the maerl as a soil improver (see Section 3.8.3).

Technically, backhoe dredgers are more likely to maintain the maerl material in its original condition compared to other dredging methods (see Section 3.5), which is beneficial for maintaining the re-use and/or habitat value of the maerl. Environmentally, the production rate of backhoe dredging is lower than other dredging methods, which is beneficial in terms of reducing the potential rate of disposal offshore should the material containing maerl not be re-used (see Section 2.2.1).

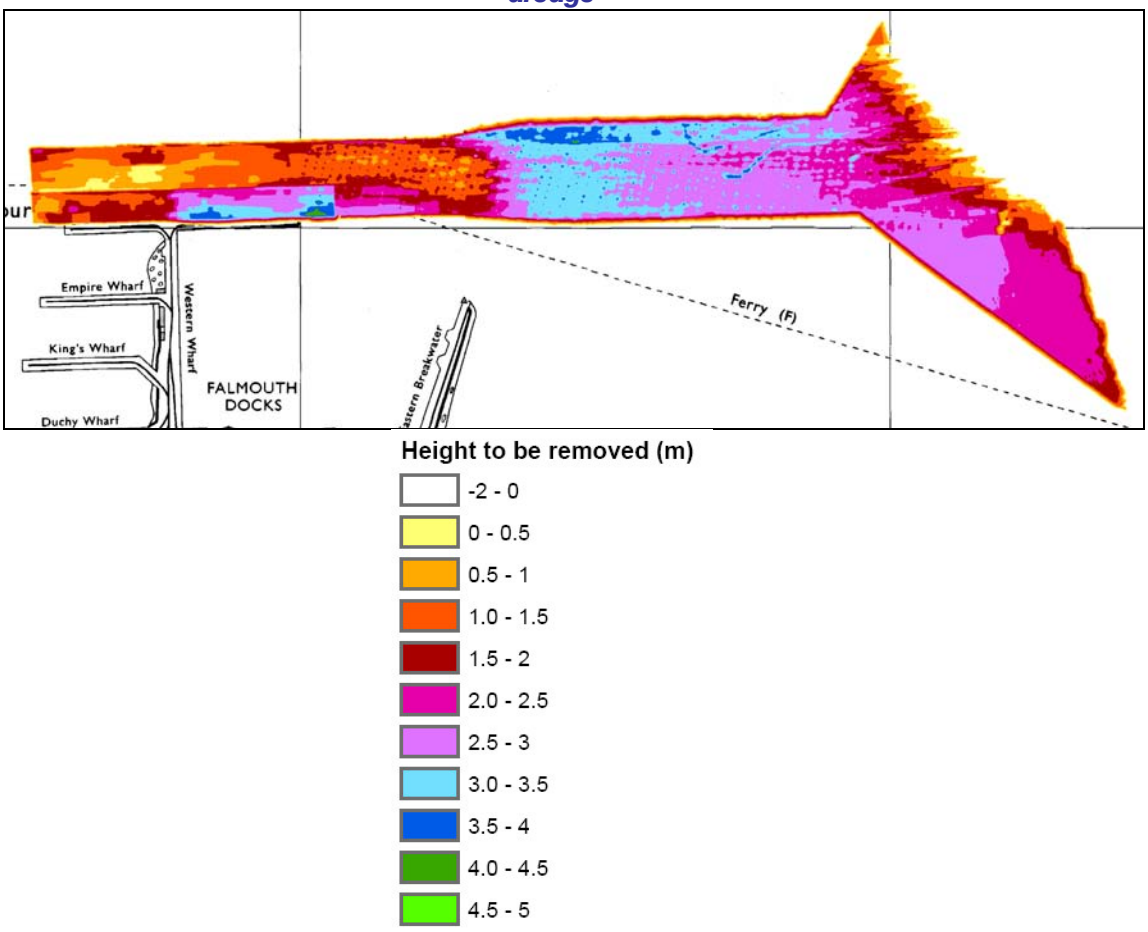
Dredging Depths

Capital dredging will achieve the following water depths:

- -8.3mCD in the navigation channel; and
- -9.5mCD in the deep water cruise berth.

This will require removal of various depths of seabed, up to approximately 3.5m, as shown in Figure 2-13.

Figure 2-13 Depths of Material to be Removed by Capital Dredging, including Over-dredge



Dredged Material Volumes and Substrates

The predicted volumes of material to be dredged from the navigation channel and cruise berth are presented in Table 2-1. These figures represent the volume of material in situ (i.e. as it is on the seabed) and do not allow for any volume changes that might occur during dredging, treatment and disposal activities. The figures also show the additional volume of material when over-dredging by 0.3m is taken into account to achieve the declared depths in the navigation channel and cruise berth. In total, it is estimated that the volume of in situ material to be dredged is 594,540m^3 without the over-dredge and 695,110m^3 with the over-dredge.

The proposed seabed habitat mitigation does not affect the dredged material volumes because the cut and fill volumes balance each other so there is no net gain or loss.

Table 2-1 Summary of Dredged Material Volumes

	Without Over-dredge		With Over-dredge	
Dredging Area	**Depth (-mCD)**	**Volume (m^3)**	**Depth (-mCD)**	**Volume (m^3)**
Cruise berth	9.5	57,690	9.8	66,880
Western navigation channel	8.3	70,720	8.6	91,740
Eastern navigation channel	8.3	466,130	8.6	536,490
Total		594,540		695,110

The dredged material composes a variety of different substrate types. Based on sediment data collected from vibrocore surveys. Table 2-2 summarises the volumes of the different substrate types predicted to arise from the proposed dredging.

Table 2-2 Summary of Dredged Material Volumes with Overdredge

	Volumes With Over-dredge			
Material	**Cruise Berth (m^3)**	**Western Navigation Channel (m^3)**	**Eastern Navigation Channel (m^3)**	**Total (m^3)**
Mud	767	514	0	866
Clay	46,591	54,476	42,084	115,171
Sand	0	0	20,518	22,416
Sand and gravel	0	0	0	0
Rock	14,082	22,706	121	25,500
Maerl	0	473	109,208	119,649
Clay with frequent maerl	530	7,253	218,288	244,004
Sand or sand and gravel with frequent maerl	0	2,984	146,271	161,933
Mud with frequent maerl	4,909	3,333	0	5,573
Total	66,880	91,740	536,490	695,110

Contaminated Dredged Material Volume

A survey of the dredged material in 2004 was used to support a previous FEPA application for disposal of dredged material at sea. As described in Section 6.2, a series of sediment samples were taken from within the proposed capital dredge area which were then sent to Cefas's laboratory and analysed for a suite of chemical contaminants. On the basis of the results, Cefas advised that the surface sediments are contaminated by metals, PAHs and PCBs at concentrations that would preclude disposal at sea for the material dredged to 1m below bed level in the western part of the proposed navigation channel but dredged to 2m in the deep water cruise berth. Cefas advised that all of the deeper dredged material in western navigation channel and the deep water berth, and all dredged material from the eastern navigation channel, would be suitable for disposal at sea.

By applying Cefas's advice to the proposed capital dredge, it is estimated that the volume of contaminated dredged material is 98,090m^3. This is summarised in Table 2-3.

Table 2-3 Summary of Contaminated Dredge Material Volumes with Overdredge

Area	Depth below seabed	Total volume (m^3)	Contaminated volume (m^3)
Western navigation channel	1m	66,880	29,340
Deep water cruise berth	1.5m	91,740	68,750
Eastern navigation channel	0m	536,490	0
Total	n/a	695,110	98,090

Construction Programme

Capital dredging is estimated to last approximately 26 weeks when based on two backhoes supported by barges (see Table 2-4). The dredgers' productivity rates under this scenario are:

- 10,000m^3 per week for a smaller backhoe dredger with a bucket of 2m^3, excavating weak material (e.g. mud, sand, maerl);
- 25,000m^3 per week for a larger backhoe dredger with a bucket of 5m^3, excavating weak material; and
- 10,000m^3 per week for a larger backhoe dredger with a bucket of 5m^3, excavating strong material (e.g. weathered rock).

The smaller backhoe dredger starts excavating contaminated material in the cruise berth (weeks 1 to 5) and moves on to excavate clean material in the cruise berth (week 6) and then contaminated material in the western navigation channel (weeks 7 to 19). The smaller dredger alternates between this activity and dredging clean material in the eastern and western navigation channel (weeks 2 to 20) on a weekly basis. This is because the treatment plant for the contaminated material operates on a throughput rate of approximately 5,000m^3 per week, which is about half the productivity rate of the smaller dredger, and hence the treatment plant restricts the dredger's productivity when excavating contaminated material.

The larger backhoe dredger starts excavating clean material in the eastern navigation channel (weeks 1 to 6) and moves on to excavate rock in the cruise berth (weeks 7 to 9) and then back to clean material in the eastern navigation channel (weeks 10 to 22).

Table 2-4 Indicative Weekly Programme for Capital Dredge

Dredging Area	Material Type	Volume (m3)	Dredger Size	1	2	3	4	5	6	7	8	9	10	11	12	13
Cruise Berth	Clean	12,040	Small													
	Cont.	29,340	Small													
	Rock	25,500	Large													
W Channel	Clean	22,990	Small													
	Cont.	68,750	Small													
E Channel	Clean	475,490	Large													
	Clean	60,000	Small													
Completion of dredging																
Dredging Area	**Material Type**	**Volume (m3)**	**Dredger Size**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**
Cruise Berth	Clean	12,040	Small													
	Cont.	29,340	Small													
	Rock	25,500	Large													
W Channel	Clean	22,990	Small													
	Cont.	68,750	Small													
E Channel	Clean	475,490	Large													
	Clean	60,000	Small													
Completion of dredging																

2.3.2 Treatment of Contaminated Dredged Material

The treatment plant (see Figure 2-14) will be brought to the docks by road on low-loaders or by sea aboard barges. The treatment plant will be set up on the reclaimed land area behind the Northern Wharf. If necessary, temporary buildings will be erected to cover the material while it is being stored.

Figure 2-14 Indicative Layout of a Treatment Facility (source: Boskalis Westminster Dredging)



After dredging, the contaminated dredged material will be left overnight in a barge. During this time, the solid material will settle leaving some of the liquid to be pumped out to an appropriately licensed mobile water treatment plant. The dredged material will be transferred from the barge onto the reclaimed land behind the Northern Wharf using a long-reach excavator with a bucket or clamshell grab.

The contaminated dredged material will be screened to remove extraneous material unsuitable for treatment (e.g. debris). After screening, the material will be dewatered by either centrifuging (i.e. spinning) or mechanical pressing (i.e. squeezing). Dewatering will reduce the dredged material's moisture content and consolidate it to facilitate handling and reduce the volume for any subsequent treatment and disposal.

If tests show that centrifuging or pressing will not be sufficiently effective, then a solidification/stabilisation agent such as hydrated lime or cement may need to be added. This mixture can have the additional benefits of physically encapsulating (i.e. by solidification) and chemically immobilising (i.e. by stabilisation) the contaminants within the resulting solid mass of treated dredged material.

Plant mobilisation and set up, pre-treatment and treatment, and plant removal and demobilisation will take place over approximately 30 weeks, with most of this time (c.25 weeks) being dedicated to treatment.

Figure 2-15 provides an indicative sequence of the main stages of the treatment process based on the use of cement to dewater and solidify contaminated dredged material.

Figure 2-15 Contaminated sediment treatment process on Tyneside: dredged material brought to site by barge (top left), material unloaded from barge by excavator (top right), cement added to material (middle left), material and cement mixed (middle right), treated material loaded into truck (bottom left), treated material taken off site to landfill by truck (bottom right (source: A&P (Tyne) Ltd)



2.3.3 Disposal of Contaminated Dredged Material

Following treatment, approximately 80,000m^3 of treated contaminated dredged material will need to be used and/or disposed of in accordance with the relevant legislation and permissions processes described in Section 1.3

As much material as possible will be used for infrastructure works within the docks estate in accordance with the restrictions on depth and volume relating to the

Environmental Permitting Regulations' exemption options. Excess material will be taken off site. This material will be disposed of at landfill sites unless alternative off site uses are found for it.

Re-use for Ground Improvement in the Docks Estate

The treated contaminated dredged material will be used for ground improvement works over two existing car parking areas within the eastern part of the docks estate (see Figure 2-4), namely:

- car parking for turnaround cruise passenger vehicles and for the Falmouth Marine Skills Centre on the land area that surrounds the landward edge of an existing waste disposal tip – placement of c.2m depth of material over 0.75ha; and
- car parking for turnaround cruise passenger vehicles on top of an existing waste disposal tip – placement of c.1m of material over 0.65ha.

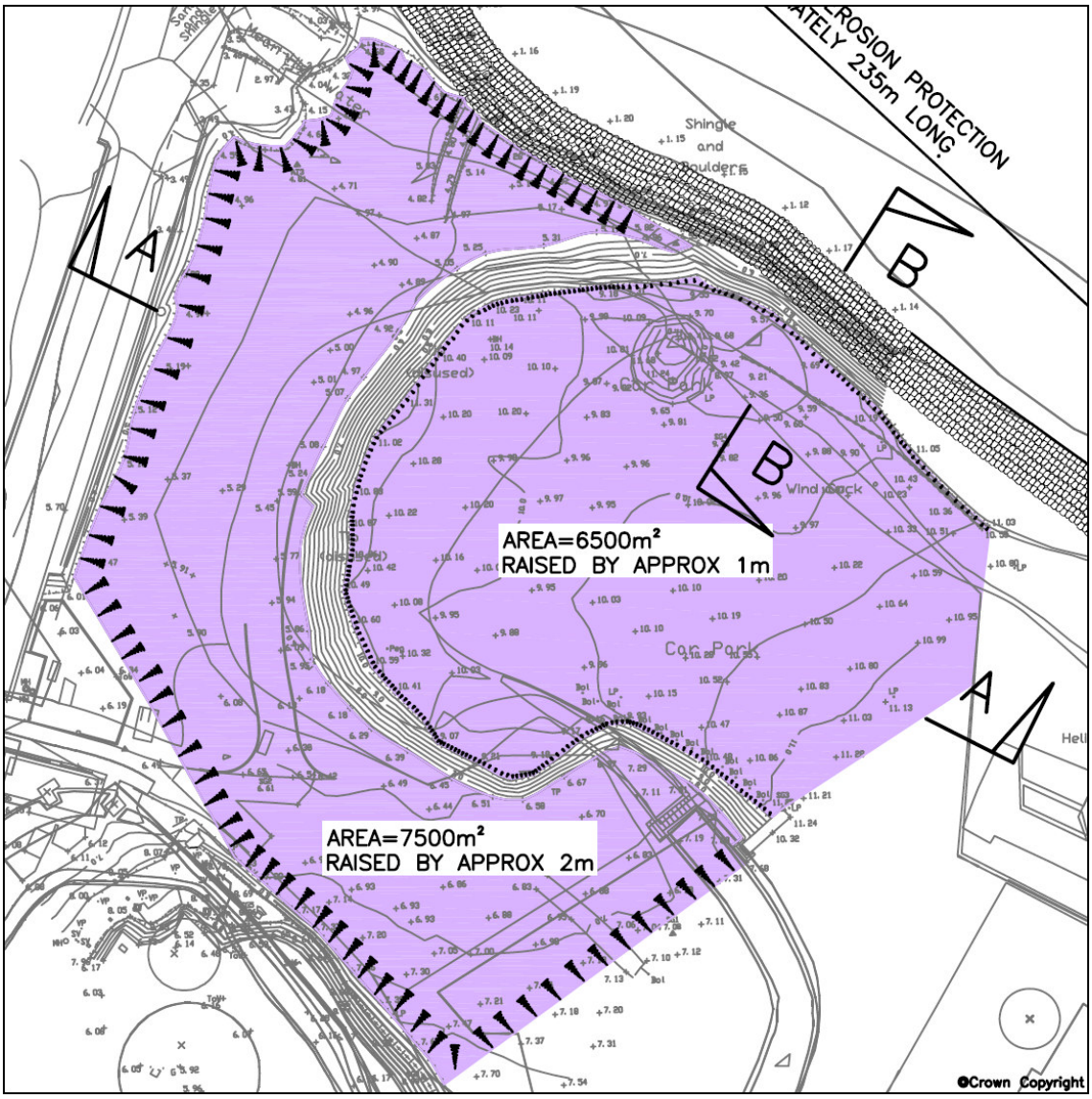
Construction consists of raising existing ground levels in these areas using treated dredged material. Ground levels will be raised by up to 2m around the existing waste tip and by approximately 1m at across the top of the existing waste tip (see Figure 2-16).

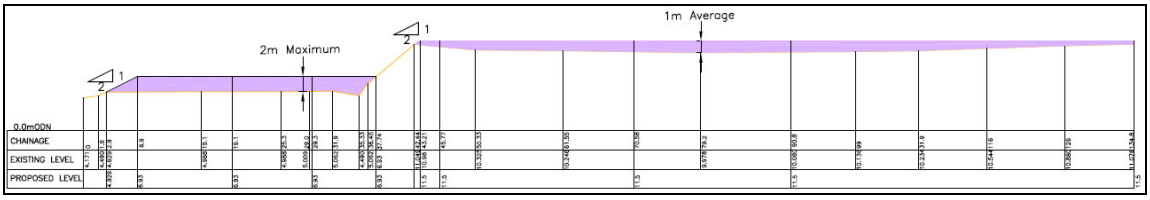
Prior to use in these areas and dependent on the results of the treatability studies, the treated dredged material may need to be improved by soil mixing. This would involve the addition of cement or other binders to achieve the required geotechnical properties.

Construction includes placement of the material in layers and distributing it with a bull-dozer and compacting it with a roller.

Approximately 17,000m^3 of treated dredged material will be required for the two ground improvements in the eastern part of the docks estate. The material will be transported from the treatment site (on the reclaimed land next to the Northern Wharf) by dump trucks, which will have a typical size of 25 tonnes (i.e. 16.5m^3). There will be approximately 1,030 loads and therefore 2,060 two-way truck movements through the docks estate to transfer material.

Figure 2-16 Plan and Cross-section of Proposed Ground Improvements for Car Parking Areas within the Docks Estate





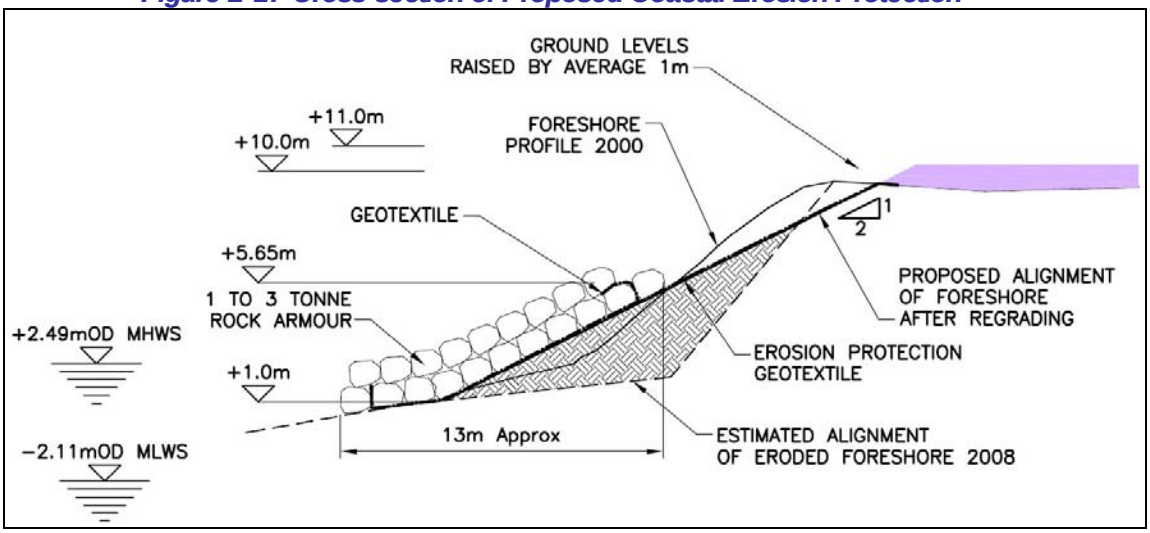
Re-use for Coastal Erosion Protection

The treated dredged material will also be used as fill material as part of the proposed coastal erosion protection for the seaward face of the existing waste disposal tip in the eastern part of the docks estate.

Construction consists of re-grading the seaward face by re-profiling some of the tip's contents and placing treated dredged material to create a stable slope (see Figure 2-

17). The slope would be re-profiled by an excavator. Rock armour would be placed over the re-graded slope using an excavator.

Figure 2-17 Cross-section of Proposed Coastal Erosion Protection



Approximately 2,000m^3 of treated dredged material will be required for fill material for coastal erosion protection in the eastern part of the docks estate. The material will be transported from the treatment site (on the reclaimed land next to the Northern Wharf) by dump trucks, which will have a typical size of 25 tonnes (i.e. 16.5m^3). There will be approximately 121 loads and therefore 242 two-way truck movements through the docks estate to transfer material.

Approximately 3,700m^3 of rock will be required for armouring the new slope. The material will be transported to the site by trucks, which will have a typical size of 25 tonnes (i.e. 16.5m^3). There will be approximately 225 loads and therefore 450 two-way truck movements to and from the docks to import material. Alternatively the rock may be delivered by barge and temporarily stockpiled on the foreshore until it is placed by excavator.

Disposal Off Site

Assuming the ground improvement and coastal erosion protection works require 17,000m^3 and 2,000m^3 of material respectively, approximately 61,000m^3 will need to be taken off site and used elsewhere and/or disposed of at a landfill site(s).

Construction Programme

The total construction programme for ground improvement works for two car parking areas in the eastern part of the docks estate is estimated to take five weeks and comprises:

- Mobilisation - 2 weeks; and
- Transport and placement of material in the eastern part of the docks estate - 3 weeks.

The total construction programme for coastal erosion protection works in the eastern part of the docks estate is estimated to take 3.5 months and comprises:

- Mobilisation - 2 weeks; and
- Regrading the existing slope, transport and placement of rock to armour the seaward slope – 12 weeks.

Transport of the excess material off site is estimated to take place over the duration of the treatment of the contaminated dredged material, and will therefore extend over 30 weeks. Assuming the treated material has a specific gravity of 1.5, then 61,000m^3 will weigh 91,500 tonnes. Assuming the use of trucks with the capacity to transport 20 tonnes of material, it is estimated that 4,575 loads and therefore 9,150 two-way truck movements will be required to take the material off site. If the material were to be taken off site over a period of six months (i.e. 26 weeks) (although this could be longer if material is temporarily stockpiled) and allowing for truck movements on six days per week and an eight hour working day, then there will be three or four loads going off site every hour, which equates to six to eight two-way truck movements per hour.

2.3.4 Disposal of Clean Dredged Material

Clean material is defined as material that does not contain contaminants at concentrations that prohibit disposal or re-use in the marine environment under the requirements of the FEPA. The preferred disposal option for the clean dredged material is to dispose of all the material at the Falmouth Bay offshore disposal site, with the additional option to re-use some of the dredged material as a soil improver.

Disposal at the Falmouth Bay Offshore Disposal Site

Dredged material is regularly disposed of in Falmouth Bay at a purposefully designated offshore disposal site that has been in use since 1988. The disposal site is referenced as Falmouth Bay B (PL075) and defined as a segment of a circle with a radius of 0.5 nautical miles centred on a point of latitude 50˚ 06.400'N and longitude 04˚56.500'W. It is situated some 7km south-east of the Fal Estuary's mouth at the location shown in Figure 2-5. The water depth is approximately -55 to -60mCD. There are no significant geomorphologic features in the vicinity of the disposal site.

Prior to 1989, the disposal site was Falmouth Bay (PL070) and covered an area of seabed comprising a full circle with a radius of 0.5 nautical miles centred on a point of latitude 50˚ 06.400'N and longitude 04˚56.500'W. In the past the site was considerably larger and received sewage sludge in addition to dredged material. The disposal of sewage sludge at this site has not occurred for many years after the cessation of sewage dumping at sea, which has been banned since 1998. The site was gradually reduced in size to the present segment in response to concerns from the local Sea Fisheries Committee regarding the impact of disposal of sewage sludge on the scallop grounds adjacent to the disposal site.

For the proposed Falmouth Cruise Project, a self-propelled sea-going barge is likely to support the use of backhoe dredgers (see Section 2.3.1) and will be used to carry out disposal at the Falmouth Bay offshore site. Typically for this type of activity, a barge sails to the offshore site and deposits the dredged material into the water via doors in the hull. The dredged material falls to the seabed within the boundaries of the offshore site, as required by disposal licensing requirements made under the FEPA. The barge then returns to the dredging area. It is anticipated that the barge will have a volume of c.

1,000m^3, which would require c.600 sailings to and from the disposal site over the six months dredging period.

Depending on the requirements of the FEPA licence, it may be necessary to zone disposal at the offshore site for reasons such as avoiding environmentally sensitive areas of the seabed within or near to the offshore disposal site, or avoiding an uneven build up of disposed material within the disposal site.

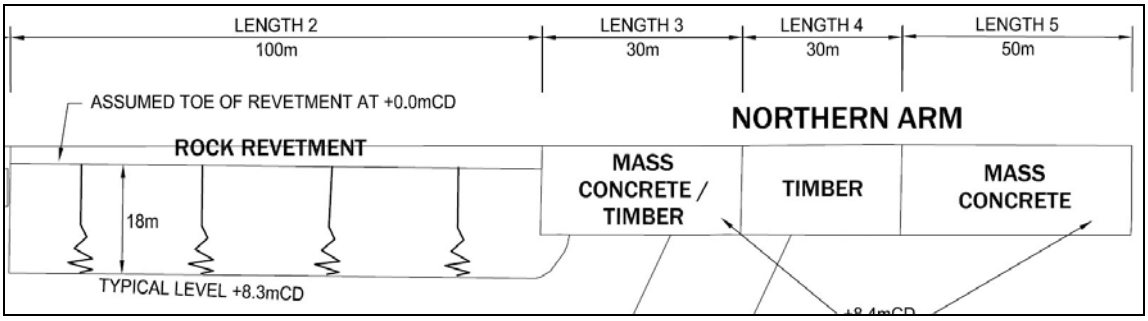
2.3.5 Cruise Quay

As described in Section 2.2.2, improvement works are proposed to provide 430m of continuous quay along the length of the existing Queens and Northern Wharves.

Based on Halcrow (2006), the wharves and their existing quay infrastructure can be divided into the following five sections from west to east (see Figure 2-18).

- Length 1 (195m) comprises a recently constructed open piled quay forming the existing structure for Queens Wharf,
- Length 2 (100m): an open area quay area at the eastern end of the Queens Wharf;
- Length 3 (30m):a concrete quay section at the western end of the Northern Wharf;
- Length 4 (20m): an old timber pile quay section in the central part of the Northern Wharf; and
- Length 5 (50m): a concrete quay section at the eastern end of the Northern Wharf.

Figure 2-18 Existing Structure of the Northern Wharf (source: Halcrow, 2006)



Existing Open Piled Structure, Queens Wharf

The existing structure of the Queens Wharf comprises an open piled structure with a deck constructed from pre-cast or in situ cast concentrate that overlies the piles and incorporates crane rails. This structure is in good condition and requires no improvement under the proposed Falmouth Cruise Project because it was re-constructed in 2003 following fire damage (see Figure 2-6).

Installation of a New Open-Piled Structure, Queens Wharf to Northern Wharf

This length currently comprises c.100m of rock revetment at the northern end of the land reclamation, which completed in 1998 (see Length 2, Figure 2-19). The revetment's condition is good although there is uncertainty concerning its slope. The preferred

improvement option is construction of an open piled structure of c.750mm vertical tubular piles with a concrete deck (see Figure 2-20). This option is similar to the existing structure of the Queens Wharf.

The construction method is predicted to be similar to that for the existing Queens Wharf, and therefore primarily comprises piling and deck construction works. The first stage of construction will include the installation of the open piles. The piling will comprise the installation of:

- a landward line of grouted raking piles;
- approximately 60 750mm diameter tubular steel piles; and
- approximately 100m of combi-wall piles to provide a toe wall to the existing revetment.

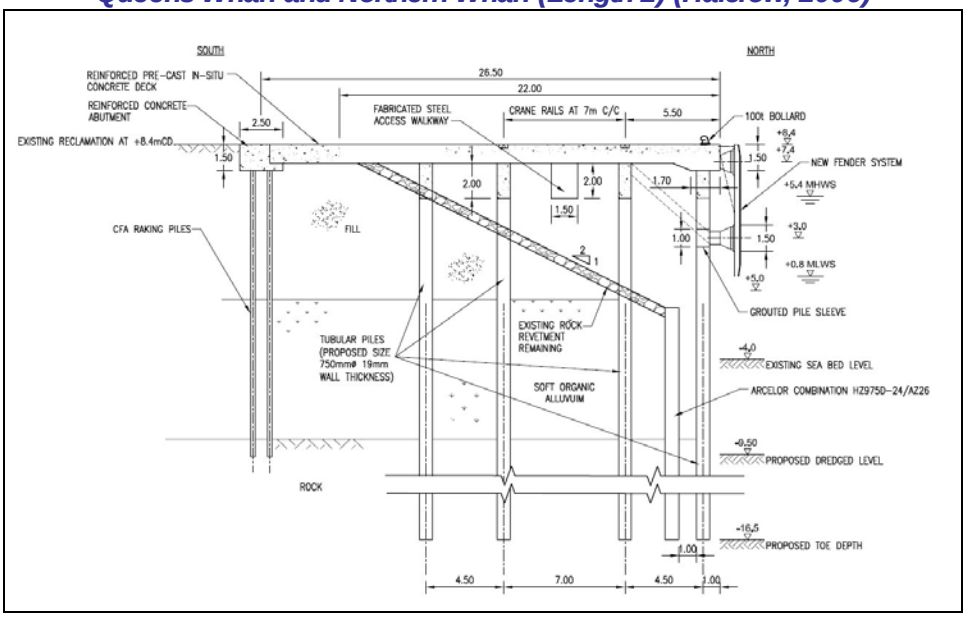
Figure 2-19 Existing Revetment between the Queens Wharf and Northern Wharf (Length 2)



Piles are likely to be delivered by sea and offloaded at the Northern Wharf. The grouted raking piles will be installed with a specialist drilling rig. The tubular piles will be driven to refusal into the underlying rock by an impact hammer operating from marine plant (i.e. a jack up barge). The combi-wall may need to be socketed into the bed rock using a rock drilling rig. Piling operations will also require a mobile crane and hydraulic power pack for the piling hammer, and a small generator will be required for welding equipment. A corrosion protection system to the steel piles is proposed to provide the required design life. This is likely to be a galvanic anode system.

The second stage of construction will be for the deck that overlies the piles. Construction of the recently re-constructed Queens Wharf included installation of pre-cast concrete beams and deck planks followed by a cast in situ concrete surface. At a volume of approximately 2,700m^3, concrete delivery from the batching plant will require approximately 450 return concrete truck movements across the docks estate. Finally, the structure will be completed by the Installation of pre-fabricated fenders, services, a walkway and furniture.

Figure 2-20 Concept Design for Installation of a New Open-Piled Structure between the Queens Wharf and Northern Wharf (Length 2) (Halcrow, 2006)



Improvement of the Existing Mass Concrete Structure, central Northern Wharf

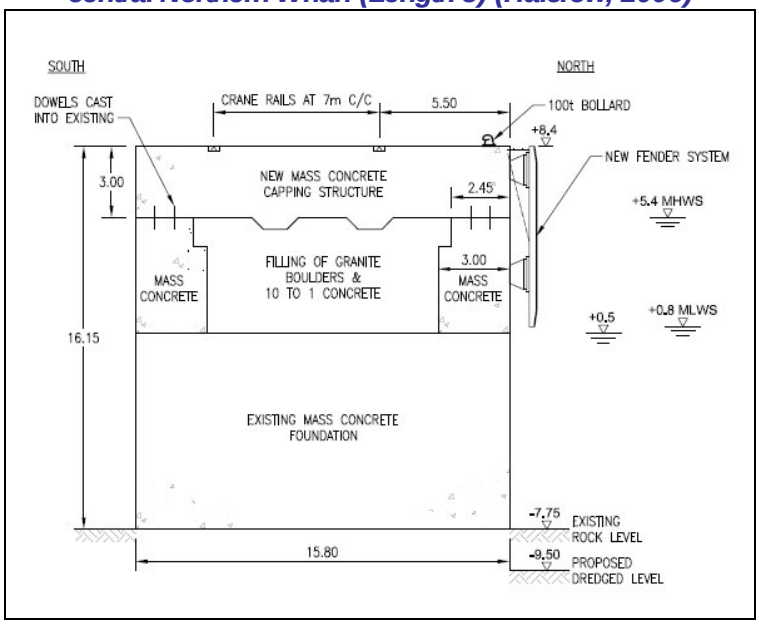
This part of the Northern Wharf (see Length 3, Figure 2-21) comprises a mass concrete structure cast in-situ around the wharf's original timber pile structure. The general condition is good, with much localised minor cracking and surface damage. However, the condition of the timber encased and the edges of the concrete is very poor.

Figure 2-21 Existing Mass Concrete Structure on the Northern Wharf (Length 3)



The preferred improvement option for Length 3 is to replace the structure's upper three metres with a mass concrete monolithic structure tying into the lower existing structure and incorporating facilities such as crane rails (see Figure 2-22).

Figure 2-22 Concept Design for Improvement of the Existing Mass Concrete Structure, central Northern Wharf (Length 3) (Halcrow, 2006)



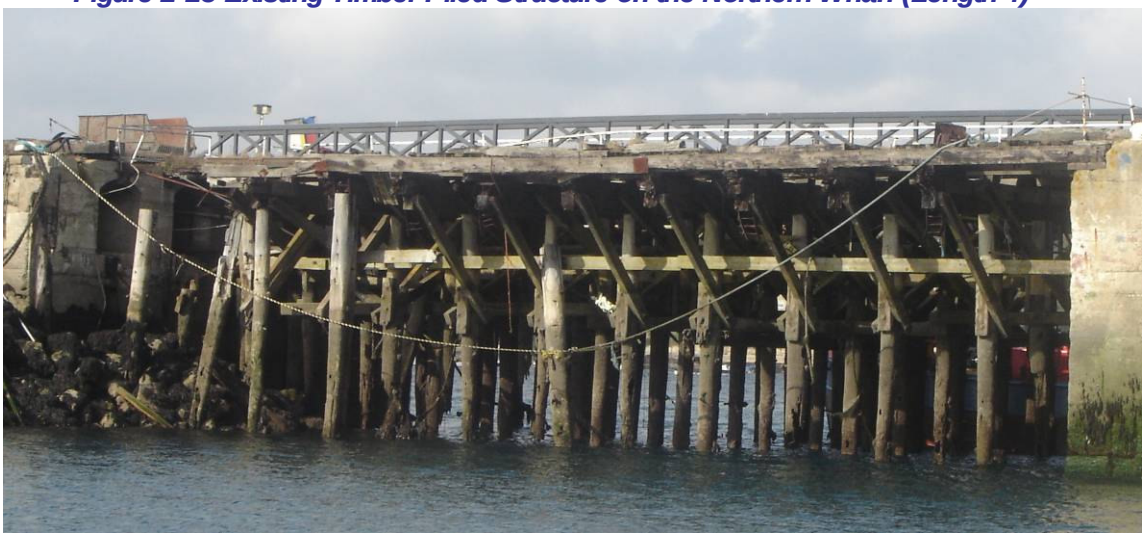
Construction will start with breaking out approximately 1,400m^3 of the existing concrete. This would be undertaken by an excavator with a pecker attachment. The quay would be reinstated to its existing level with a new reinforced concrete block. At a volume of approximately 1,400m^3, concrete delivery from the batching plant will require approximately 233 return concrete truck movements across the docks estate. Where possible the concrete that has been broken out will be crushed and reused as fill on site.

Replacement of the Disused Timber Piled Structure with a New Open Piled Structure, central Northern Wharf

This part of the Northern Wharf (see Length 4, Figure 2-23) comprises the original vertical timber piled structure. It is currently disused as its condition is very poor with a large percentage of structural members damaged or missing and the timber piles suffering from significant deterioration.

The preferred improvement option for is to replace the timber piled structure with a new open piled structure, which will have the same design and construction method as described for the open piled structure comprising the existing Queens Wharf and proposed to bridge the gap between the Queens and Northern Wharves. At a volume of approximately 750m^3, concrete delivery from the batching plant will require approximately 125 return concrete truck movements across the docks estate.

Figure 2-23 Existing Timber Piled Structure on the Northern Wharf (Length 4)



Improvement of the Existing Mass Concrete Structure, eastern end of the Northern Wharf

This part of the Northern Wharf (see Length 5, Figure 2-24) comprises concrete block work walls up to approximately MLWS with general fill placed inside. A mass concrete capping structure overlies the block work walls and fill. Its general condition is good with only localised damage to some areas of the mass concrete structure. The near surface condition is poor. The preferred improvement option for this length is to re-instate the upper 0.5m with reinforced concrete.

Figure 2-24 Existing Mass Concrete Structure on the Northern Wharf (Length 5)



The construction method is predicted to comprise breaking out the existing top 0.5m concrete cap (i.e. approximately 400m^3 of concrete). This will be undertaken by an excavator with a pecker attachment. The quay would be reinstated to its existing level with a new reinforced concrete cap to include infilling of the existing inspection passageway. At a volume of approximately 500m^3, concrete delivery from the batching

plant will require approximately 85 return concrete truck movements across the docks estate. Where possible the concrete that has been broken out will be crushed and reused as fill on site.

Construction Programme

Length 2 will require a total of six months of construction, comprising:

- mobilisation - 2 weeks;
- piling - 10 weeks;
- concrete works - 8 weeks; and
- services / furniture - 4 weeks.

Length 3 will require a total of 11 weeks of construction, comprising:

- mobilisation - 2 weeks;
- demolition - 4 weeks; and
- concrete works - 5 weeks.

Length 4 will require a total of three months of construction, comprising:

- mobilisation - 2 weeks;
- demolition – 2 weeks
- piling - 3 weeks;
- concrete works - 4 weeks; and
- services / furniture - 2 weeks.

Length 5 will require a total of 5 weeks of construction, comprising:

- demolition - 2 weeks; and
- concrete works - 3 weeks.

2.3.6 Cruise Terminal Building

Ground Works and Sub-structure

Initially, the ground where the building is to be built is to undergo site preparation in the form of general levelling, clearance and minor excavation for the sub-structure using a small excavator. The cruise terminal building is to be founded on a sub-structure comprising a concrete raft with reinforced ground beams. The raft is assumed to be 150mm thick including insulation. The concrete ground beam and raft will be cast in situ. Concrete will be supplied from a temporary batching plant located in the eastern part of the docks estate, adjacent to South West Water's sewage treatment works.

Super-structure and External Envelope

The building's super-structure comprises a steel frame, which will be prefabricated in sections and bolted together on site. Pre-cast concrete stair cases and landings will also be installed.

The external envelope comprises a mix of external walls with standard seam cladding and coloured rendering, with composite panelling for the balcony and port operations office, and powder-coated aluminium glazing for the doors and windows. The architectural metalwork includes powder-coated steel balustrades and stainless steel handrails. The roof comprises a standing seam roof with powder-coated zinc fascias and barge-boards, a rainwater drainage system and a man-safe system. Pre-cast and prefabricated items will be transported to site on a flatbed lorry and lifted into place by a

mobile crane. Mobile elevated work platforms will be used by construction personnel to enable access to higher parts of the building in order to bolt together the frame, attach cladding and install other external fittings.

Internal Structures and Fittings

The internal walls comprise a combination of blockwork walls and metal stud partitions, skimmed with plaster and decorated. Other internal features include screed and finished floors, suspended ceilings, internal doors and some internal glazing. Internal finishing includes toilet fittings, statutory signage, plumbing and internal drainage for a gas powered heating system and for a hot and cold water system, and electrical installations for lighting, power, security, fire alarms, etc. Internal fit out would be undertaken by personnel using small power tools.

It is difficult to accurately predict the construction traffic without a detailed design and specification, but it is estimated the following numbers of deliveries will be required.

- ground works and sub-structure – 25 concrete trucks;
- super-structure and external envelope -120 deliveries; and
- internal structures and fittings - 80 deliveries.

Construction Programme

An indicative construction programme for the cruise terminal building comprises:

- ground works and sub-structure - approximately 3 weeks;
- super-structure and external envelope - approximately 6 weeks; and
- internal structures and fittings - approximately 6 weeks.

Sustainable Construction Materials

The proposed cruise terminal building is based upon best practice sustainable design principles but has to be built using robust maritime construction materials. CSA Architects (2008) identify that the cruise terminal building will be constructed from "generally natural, non-toxic, durable and low maintenance materials with a low embodied energy materials and finishes throughout, locally sourced and sustainable material and labour" (e.g. use of timber from a sustainable and preferably local source, minimal use of concrete, and use of organic non-toxic paints, stains and waxes throughout). However, since the building has to be built from robust materials to withstand the maritime climate, the use of recycled materials will be minimal and generally restricted to some potential for recycled aggregate and partial recycled steel in frame and cladding components. For insulation, the use of dense polystyrene or polyurethane insulation will be avoided where intrinsic strength is not required and the preferred insulation will have a high recycled material content (e.g. recycled newsprint, glass wool, mineral wool or slag wool thermafleece, hempcrete) and be locally sourced where possible.

2.3.7 Location of Construction Plant, Materials and Site Compounds

The construction activities are expected to take place in and around Falmouth Docks as described below.

Treatment of Contaminated Dredged Material

Contaminated dredged material will be offloaded at the Northern Wharf and be stockpiled on the adjacent reclaimed land area. The treatment plant for the contaminated dredged material will be set up and operated on the reclaimed land. Treated material will be stockpiled on the reclaimed land prior to re-use within the docks estate or disposal off site.

Construction of the Cruise Quay Structures

Cruise quay construction will take place along the length of the existing Queens and Northern Wharves. Piling is likely to be carried out by a jack up barge situated in the water area adjacent to the wharves, while concrete batching plant will be set up and operated from a site in the eastern part of the docks. This set up is similar to that the occurred for the re-construction of the Queens Wharf in 2003.

Site Compound, etc.

The site compound, contractor's offices and facilities would be located on Western Wharf.

2.4 DESCRIPTION OF THE OPERATIONAL PHASE

Cruise operations already occur at Falmouth Docks and so many aspects of the operational phase of the proposed Falmouth Cruise Project are not new activities to the site and the surrounding environment.

However, the numbers and sizes of cruise vessels are predicted to increase. Accordingly, the numbers of cruise passengers are also predicted to increase. The EIA process for the operational phase is informed by the predictions of FDEC (FDEC, 2006, in FHC, 2006) and Arup (2008). These predictions include vessel calls and passengers, and use 2005 as a base year.

For the purposes of the EA process, the operational phase commences on completion of the construction phase and will comprise:

- general cruise terminal activities;
- day calls;
- turnaround calls; and
- general port operation and maintenance activities.

2.4.1 General Cruise Terminal Activities

Berthing

At present, cruise vessels either berth alongside a wharf within Falmouth Docks or moor at a dedicated sheltered deepwater anchorage within Carrick Roads from where passengers are transferred to land by tender. The point of mooring depends on the state of the tide relative to a vessel's size and its arrival and departure times.

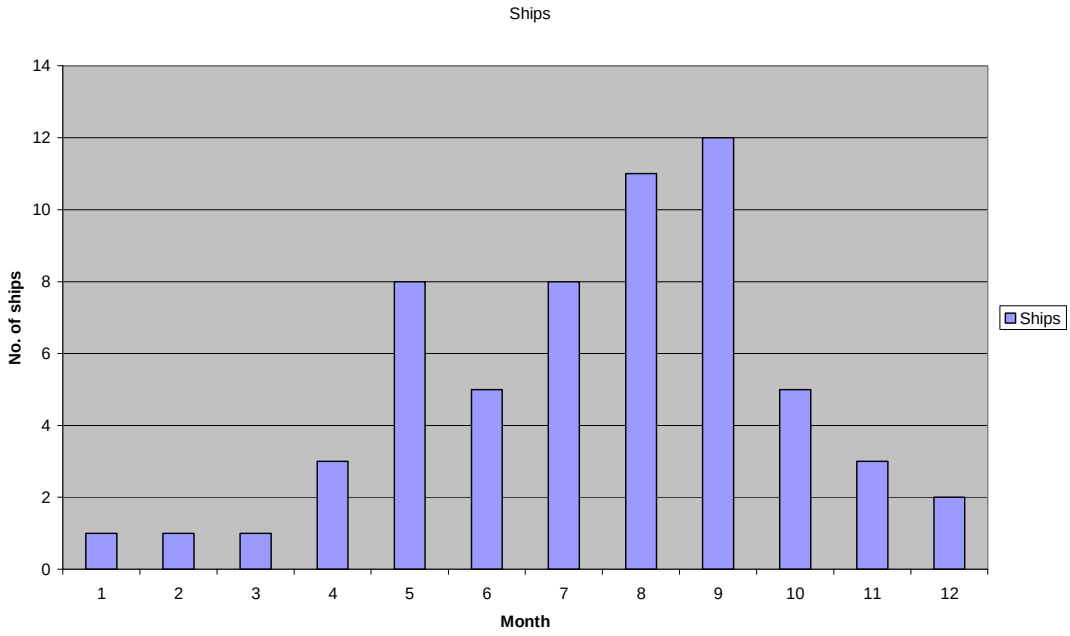
With the proposed Falmouth Cruise Project in place, cruise vessels will berth alongside the dedicated cruise quay at the combined Queens and Northern Wharves and

passengers will embark / disembark directly to the dedicated cruise terminal building. It is anticipated that there will be no or very little need for mooring at the deepwater anchorage and tendering passengers ashore.

Passenger Handling

Day calls occur when a cruise vessel visits Falmouth as part of a cruise's itinerary and tend to use Falmouth between May and September. Figure 2-25 shows the monthly distribution of cruise calls based on figures from 2006. For day calls, cruise vessels will berth alongside the cruise quay of the combined Queens and Northern Wharves. In the morning, passengers will disembark and enter the cruise terminal building where they will be allocated a coach for their shore excursion or a shuttle bus for transfer into Falmouth. For their return in late afternoon, passengers will be brought back to the cruise terminal building and will embark the cruise vessel.

Figure 2-25 Monthly Distribution of Cruise Calls at Falmouth in 2006



Turnaround calls occur when a cruise vessel uses Falmouth as its base port for the start and end of a cruise, and use Falmouth throughout the year. For turnaround calls, passengers will arrive by coach, car or be dropped off by friends and relatives. If arriving by coach, passengers will be dropped off at the cruise terminal building. If arriving by car, passengers will park in the car parking areas within the docks estate and be bussed to the cruise terminal building. The car parking areas in the eastern part of the docks estate will have been subject to ground improvement works. This will not affect their use for car parking within the docks estate, although the predicted increase in turnaround passengers will require an increased use of the improved car parking areas. All embarking passengers will be checked and pass through security as will their luggage before boarding their ship. Disembarking passengers will collect their luggage in the terminal and pass through customers before departing.

A wide range of ship supplies will be provided to the ship as requested. These will be loaded by portable conveyor. Ships waste, which includes food waste and general

garbage, is off loaded into skips and disposed off through the ports waste management system. Fuelling of the ships can be carried out if requested by the cruise operator and is delivered from fuel barges direct to the vessel while on the berth.

Port Control

Port control provided by FDEC will relocate from the temporary buildings in the dock yard and, subject to agreement; FHC will relocate their port control from the FHC main building to the cruise terminal building. Port control activities include communicating with shipping, organising pilotage and other marine assets to assist in the safe entry and exit of ships from the Port.

Like dock operations in other parts of the estate, port control activities will take place 24 hours a day and seven days a week. This will mean that there will be lighting on within the building when required. External lighting will be required for car parking areas associated with port control activities.

2.4.2 Day Calls

Recent History

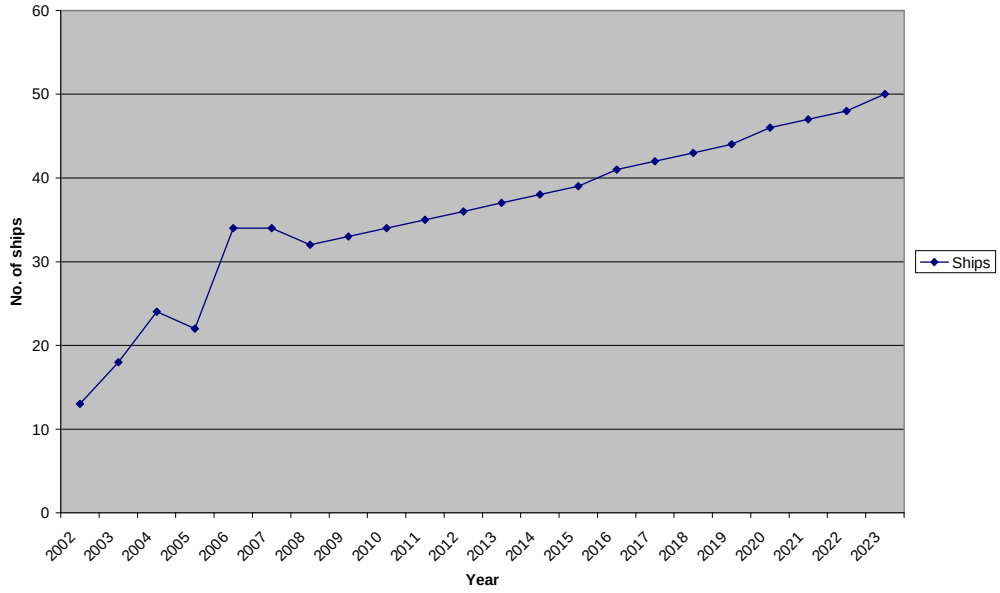
In 2005, Falmouth attracted 22 day calls bringing approximately 10,937 passengers to the town and west Cornwall. This equates to an average of 497 passengers per day call. Of the day call passengers coming ashore in 2005, approximately 50% visited Falmouth by walking or shuttle bus, while the other 50% visited other parts of west Cornwall by coach. Allowing for 45 passengers per coach, day calls generated in the region of 122 coach movements with up to 15 coach movements per day call.

Predicted Day Call Vessels

With the proposed Falmouth Cruise Project in place and operational from 2009, FDEC predict the numbers of vessels visiting Falmouth for day calls to increase from 33 in 2009 to 50 in 2023 (see Figure 2-26), which equates to an increase of three per cent per annum.

To predict the increase in day call vessels, Arup (2008) have used the proportion of day call versus turnaround ships in line with the 2008 proportion, which was 73% day call and 27% turnaround, and applied this to the predicted increase in turnaround call vessel numbers (see Section 2.4.3). This equates to day calls increasing from 22 in 2005 to 50 in 2020, as shown in Figure 2-26.

Figure 2-26 Projected Day Calls to Falmouth – Numbers of Vessels

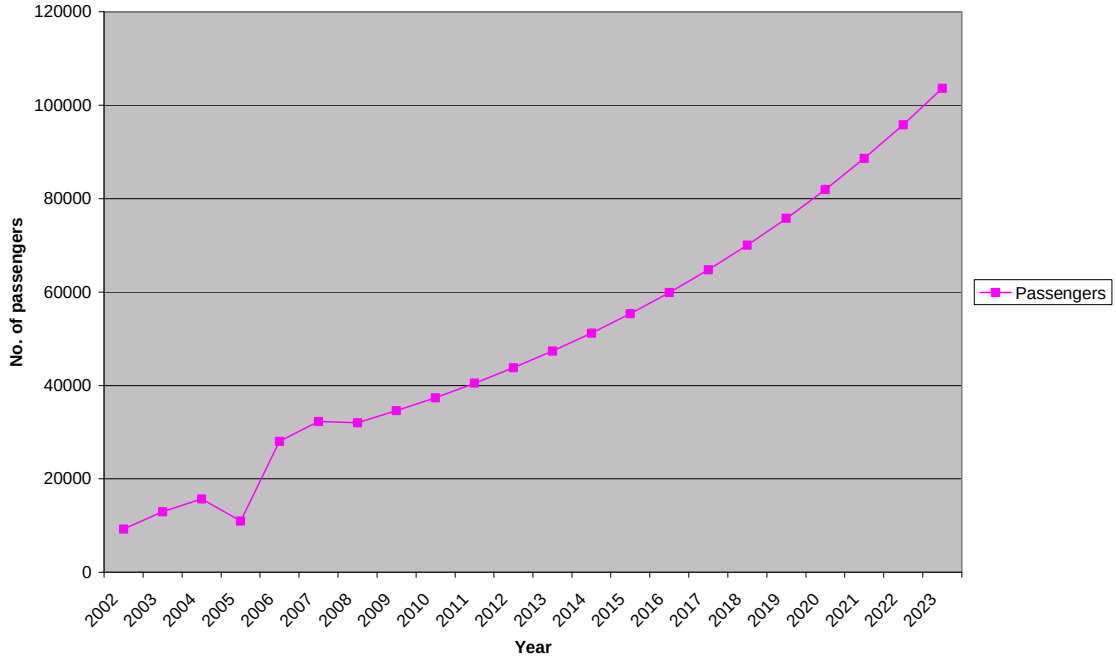


Predicted Day Call Passengers

FDEC also predict the numbers of passengers visiting Falmouth on those vessels to increase from 34,608 in 2009 to 103,645 in 2023 (see Figure 2-27), which equates to an increase of five per cent per annum. The rate of increase for passengers is higher than for vessels because FDEC's calculations assume a gradual increase in the size of cruise vessels creating an increase in the average numbers of passengers per vessel from 1,050 in 2009 to 2,079 in 2023.

Arup (2008) have forecast the number of cruise passengers increasing by 10% to 2015 and 5% thereafter. For day calls, this equates to passenger numbers increasing from 15,785 in 2005 to 69,355 in 2020, as shown in Figure 2-27.

Figure 2-27 Projected Day Calls to Falmouth – Numbers of Passengers



Predicted Day Call Coach Journeys

The distribution of day visitors between Falmouth and other Cornish destinations is not expected to change significantly, although the number of coach movements will increase. Assuming an equal distribution of day calls and passenger numbers and concentrating all calls into the main part of the season (i.e. 25 weeks from April to September), there will be an average of two day calls per week.

Allowing for 45 passengers per coach and assuming 50 per cent of passengers visit Cornish attractions by coach, then coach movements during day calls will be:

- an average of 6 coach trips per vessel (i.e. 12 two-way coach movements) per day call in 2005 (assuming an average of 497 passengers per vessel);
- an average of 12 coach trips per vessel (i.e. 24 two-way coach movements) per day call in 2009 (assuming an average of 1,050 passengers per vessel);
- an average of 24 coach trips per vessel (i.e. 48 two-way coach movements) per day call in 2023 (assuming an average of 2,079 passengers per vessel); and
- a maximum of 49 coach trips per design vessel (i.e. 98 two-way coach movements per day in any year the design vessel uses Falmouth Docks for a day call (assuming the maximum number of 4,375 passengers).

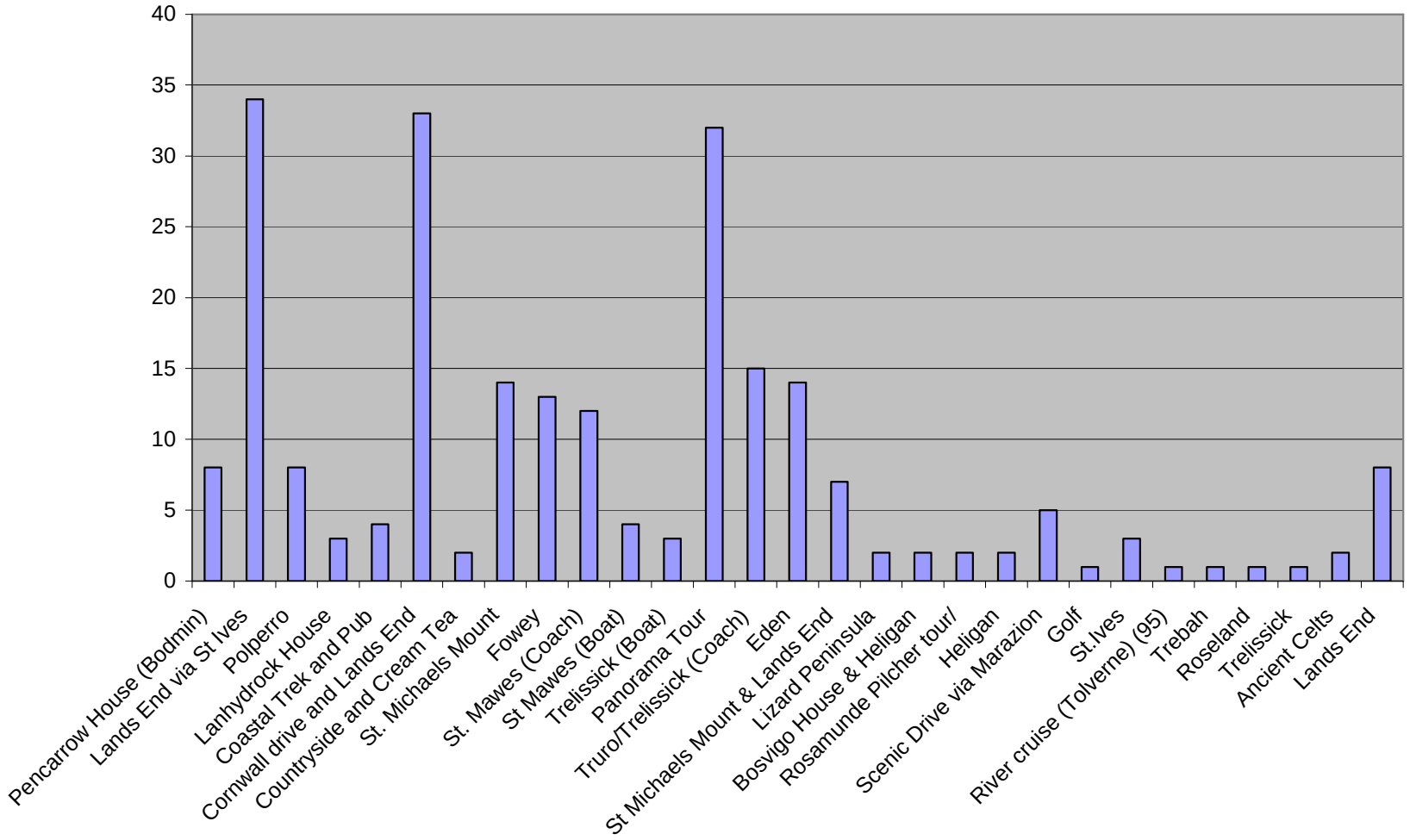
Predicted Day Call Coach Journey Destinations

Shore excursions from Falmouth cover an area of Cornwall with Lands End being the western extent and a line from Padstow to Lanhydrock to Polperro being the eastern extent.

Data from 2007 show that 23 day calls brought 17,266 passengers to Falmouth leading to 237 shore excursions (and coach journeys) from Falmouth. With an average of 40 passengers per coach, this meant 9,480 passengers took a shore excursion, equating to 55 per cent of all passengers.

A breakdown of destinations is shown in Figure 2-28. In 2007, shore excursions including a visit to Lands End were most popular and accounted for more than 30 per cent of the journeys (82 of 237 excursions). National Trust destinations accounted for more than 10 per cent of the journeys (28 of 237 excursions).

Figure 2-28 Day Call Shore Excursions from Falmouth in 2007



2.4.3 Turnaround Calls

Recent History

In 2005, Falmouth was the homeport for 18 turnaround cruises. Around 17,700 passengers embarked and disembarked for cruises to the western European seaboard, the Mediterranean and the Caribbean. This equates to an average of 983 passengers per turnaround call. Turnaround calls are made on a regular basis throughout the year.

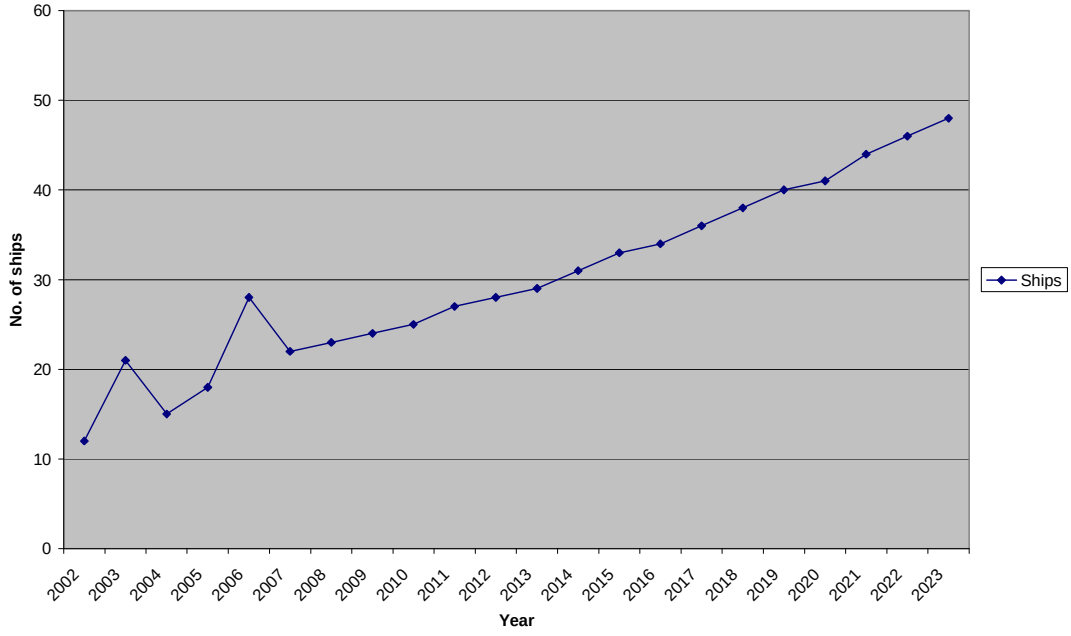
Turnaround passengers arrive and depart the existing cruise terminal by a combination of coach (50%), car (45%), which are parked at Falmouth Docks during the cruise, and public transport (5%).

Predicted Turnaround Call Vessels

With the proposed Falmouth Cruise Project in place and operational from 2009, FDEC predict the numbers of vessels visiting Falmouth for turnaround calls to increase from 24 in 2009 to 48 in 2023 (see Figure 2-29), which equates to an increase of five per cent per annum.

To reflect the larger ships in the international market and the capacity of Falmouth town to support turnarounds, Arup predict that turnaround calls will increase by five per cent per annum until 2015 and will drop to one per cent per annum after 2015, equating to a total of 18 turnaround vessel calls in 2020. This growth rate is slightly less optimistic than FDEC's prediction (five per cent per annum to 2023).

Figure 2-29 Predicted Turnaround Calls to Falmouth – Numbers of Vessels

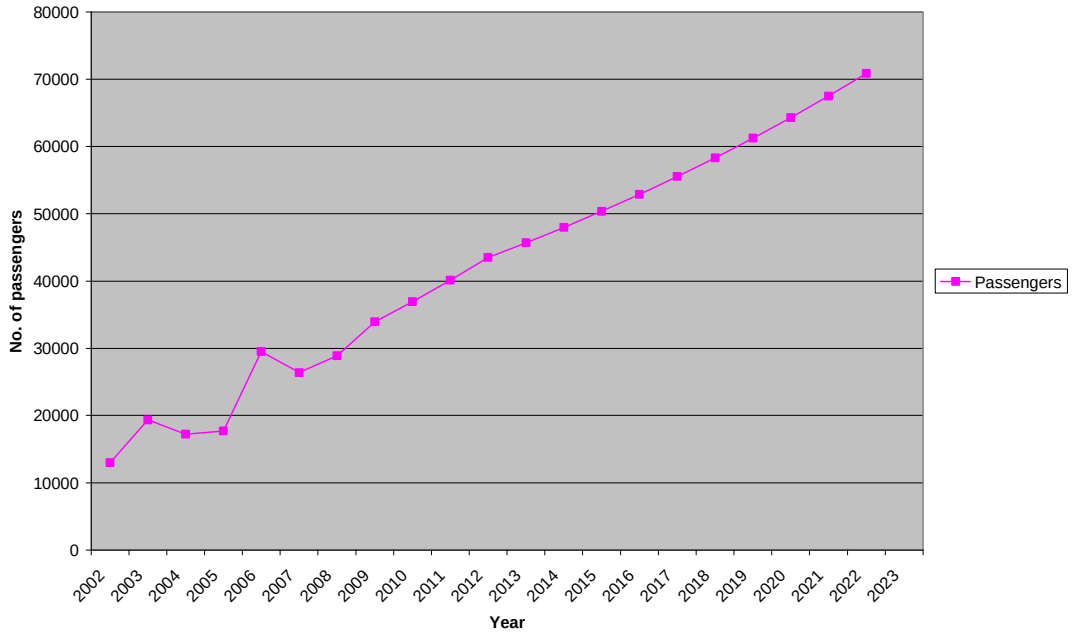


Predicted Turnaround Call Passengers

FDEC also predict the numbers of passengers visiting Falmouth on those vessels to increase from 33,957 in 2009 to 74,436 in 2023 (see Figure 2-30), which also equates to an increase of five per cent per annum. The average numbers of passengers per vessel will increase from 1,400 in 2009 to 1,550 in 2023.

Arup (2008) have forecast the number of cruise passengers increasing by 10% to 2015 and 5% thereafter. For turnaround calls, this equates to passenger numbers increasing from 12,915 in 2005 to 25,652 in 2020, as shown in Figure 2-30.

Figure 2-30 Projected Turnaround Calls to Falmouth – Numbers of Passengers



Predicted Turnaround Call Coach and Car Journeys

The distribution of turnaround passengers arriving and departing the cruise terminal is not expected to change significantly and will remain a combination of coach (50%); car (45%) and public transport (5%). It should be noted that passengers will require two trips per cruise since they will arrive and depart Falmouth either by coach, car or public transport.

Allowing for 45 passengers per coach, then coach movements for turnaround calls will be:

- 11 coach trips per vessel (i.e. 22 two-way coach movements) per turnaround call in 2005 (assuming an average of 983 passengers per vessel);
- 16 coach trips per vessel (i.e. 32 two-way coach movements) per turnaround call in 2009 (assuming an average of 1,400 passengers per vessel);
- 18 coach trips per vessel (i.e. 36 two-way coach movements) per turnaround call in 2023 (assuming an average of 1,550 passengers per vessel); and
- a maximum of 49 coach trips per design vessel (i.e. 98 two-way coach movements in any year the design vessel uses Falmouth Docks for a turnaround call (assuming the maximum number of 4,375 passengers). [Note:

the design vessel is expected to use Falmouth Docks for day calls rather than turnaround calls.]

Allowing for 2 passengers per car, then car movements for turnaround calls will be:

- 222 car trips per vessel per turnaround call in 2005 (assuming an average of 983 passengers per vessel);
- 315 car trips per vessel per turnaround call in 2009 (assuming an average of 1,400 passengers per vessel);
- 349 car trips per vessel per turnaround call in 2023 (assuming an average of 1,550 passengers per vessel); and
- a maximum of 985 car trips per design vessel in any year the design vessel uses Falmouth Docks for a turnaround call (assuming the maximum number of 4,375 passengers). [Note: the design vessel is expected to use Falmouth Docks for day calls rather than turnaround calls.]

2.4.4 Combined Day Calls and Turnaround Calls

Recent History

Table 2-5 below shows the number of day calls and turnaround calls by cruise ships to Falmouth in the past two (financial) years. While day call visits showed significant growth the number of turnaround calls reduced significantly. This reduction may well be partially related to Travelscope, a local holiday firm that went into administration in late 2007. In total, 11 Travelscope cruises were scheduled to depart from Falmouth in 2008. It should be noted that this reduction may reflect the misfortunes of one local company and the impact on a single port rather than for the general trend in cruise market demand which is more positive.

Table 2-5 Cruise ship calls to Falmouth 2006/2007 and 2007/2008

Year	Day Calls	Turnaround Calls
2006/2007	27	12
2007/2008	36	2

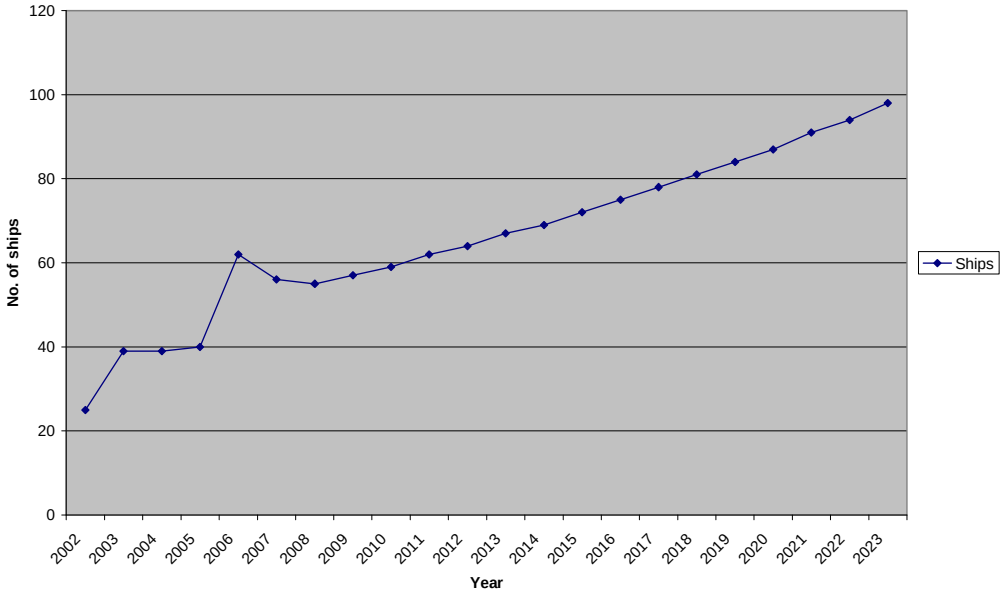
Predicted Combined Call Vessels

With the proposed Falmouth Cruise Project in place and operational from 2009, FDEC predict the combined numbers of vessels visiting Falmouth for day calls and turnaround calls to increase from 57 in 2009 to 98 in 2023 (see Figure 2-31). Arup (2008) predict combined numbers of vessels to increase from 40 in 2005 to 68 in 2020 (see Table 2-6).

Table 2-6 Predicted Calls to Falmouth – Numbers of Vessels (source: Arup, 2008)

Year	2005	2008	2009	2010	2015	2020
No. of ships (total)	40	46	49	51	65	68
Day calls	22	34	36	37	47	50
Turnarounds	18	12	13	14	18	18

Figure 2-31 Predicted Combined Calls to Falmouth – Numbers of Vessels



Predicted Combined Call Passengers

FDEC also predict the combined numbers of passengers visiting Falmouth on those vessels to increase from 68,565 in 2009 to 178,081 in 2023 (see Figure 2-32). Arup (2008) predict combined numbers of passengers to increase from 28,700 in 2005 to 95,007 in 2020 (see Table 2-7).

Figure 2-32 Projected Combined Calls to Falmouth – Numbers of Passengers

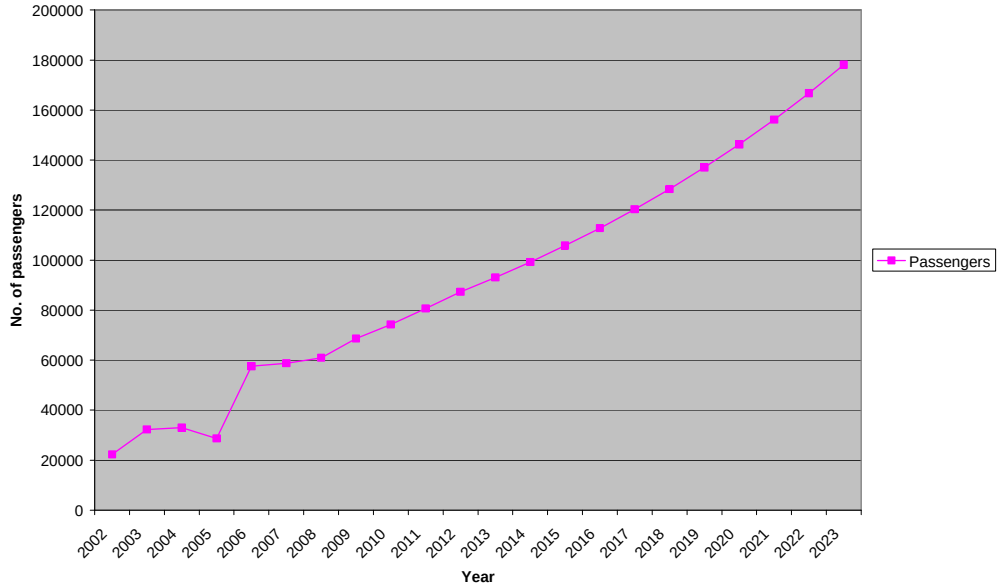


Table 2-7 Predicted Calls to Falmouth – Numbers of Passengers (source: Arup, 2008)

Year	2005	2008	2009	2010	2015	2020
Combined passengers	28,700	38,200	42,020	46,222	74,440	95,007
Day call passengers	15,785	27,886	30,675	33,742	54,341	69,355
Turnaround passengers	12,915	10,314	11,345	12,480	20,099	25,652

2.4.5 Operational Sustainability of the Cruise Terminal

The proposed cruise terminal building is based upon best practice sustainable design principles. Based on CSA Architects (2008), the following paragraphs identify a number of features that are proposed to be in effect when the cruise building is operational.

Energy consumption will be minimised by keeping space heating to a minimum through passive solar design (maximise solar gain, avoid heat loss, encourage natural ventilation and by keeping water-heating should to a minimum through water saving devices. Passive solar gain will be maximized on south side of building through large windows and thermal mass. Overheating will be avoided in summer through controllable shading devices over the large south facing glazed areas. Large roof overhangs will further protect during summer and allow direct sun in winter months. Heat loss will be avoided through glazed windows and doors. On the south side the heat loss is usually equalled with the solar gain. The north elevation only has a minimum amount of glazing. Double / triple glazed high performance low E windows and doors will be considered. The building's external envelope will be super insulated, exceeding the guidance from Building Regulations. In terms of natural ventilation, the internal design, including the wave-from profile can operate as a stack for natural ventilation. Passive ventilation louvers with thermostatic controls will be considered to avoid overheating. Air-conditioning will be avoided. Due to the design, a passive ventilation and heat recovery system with wind cowl could be considered. Energy efficient lighting and appliances will be used throughout the building. Externally, LED lights or high frequency fluorescent lighting with sensor detectors will be used. Internally, natural day-light potential is maximized through the design.

Heating will be provided by a communal solar heating system which will be linked to a gas combi-boiler for secondary back-up and will only uses gas when needed. Under-floor heating will reduce the size of the overall heating installation. In addition, a mechanical ventilation and heat recovery system will be installed to maximise heating efficiency.

In terms of water use, mains water consumption will be required for some facilities (e.g. wash-hand basins) but rainwater collection from the roof will serve all WCs by using an underground tank for rainwater collection for toilet flushing.

Beyond the building, the access road and any footpath access for the cruise terminal will be lit to County Highways adoptable standards throughout. Roadside lighting will be installed on low poles with down light luminaries to minimise light pollution. All luminaires, in accordance with the design ethos of the site as a whole, will be low-energy and light sensitive to cut-off during day light hours. Each luminaire will incorporate an individual solar collector with storage to avoid the requirement for permanent mains supply.

The cruise terminal will have a designated, secure storage for the provision of on-site waste storage, including the provision and promotion of recyclable waste. Sufficient access and turning will be provided for refuse and service vehicles.

It is proposed that a green travel plan will be produced for permanent staff, to encourage car sharing, walking/cycling to work, to minimise the use of private motor vehicles. The proposals will incorporate designed cycle storage, adjacent to offices for staff use only.

2.4.6 General Port Operation and Maintenance Activities

As at all ports, the components of the proposed Falmouth Cruise Project will be subject to the general operation and maintenance activities. These activities are ongoing at Falmouth Docks at present, and therefore there will be little day to change over existing activities. Only maintenance dredging would be a new and specific activity associated with the proposed project (see Section 2.4.6).

2.4.7 Maintenance Dredging

The future need for maintenance dredging depends on the potential for material to settle and accumulate in the new navigation channel and berth.

The following paragraphs describe the potential for fine-grained sediment (i.e. silt) and medium-grained sediment (i.e. sand) to accrete in the new navigation channel based on numerical modelling studies by HR Wallingford (2008). It is assumed that the proposed project will not alter the amount of sediment derived from fluvial sources.

Sand Accretion

Figure 2-33 shows the annual sand deposition in the proposed new navigation channel for the baseline and proposed conditions.

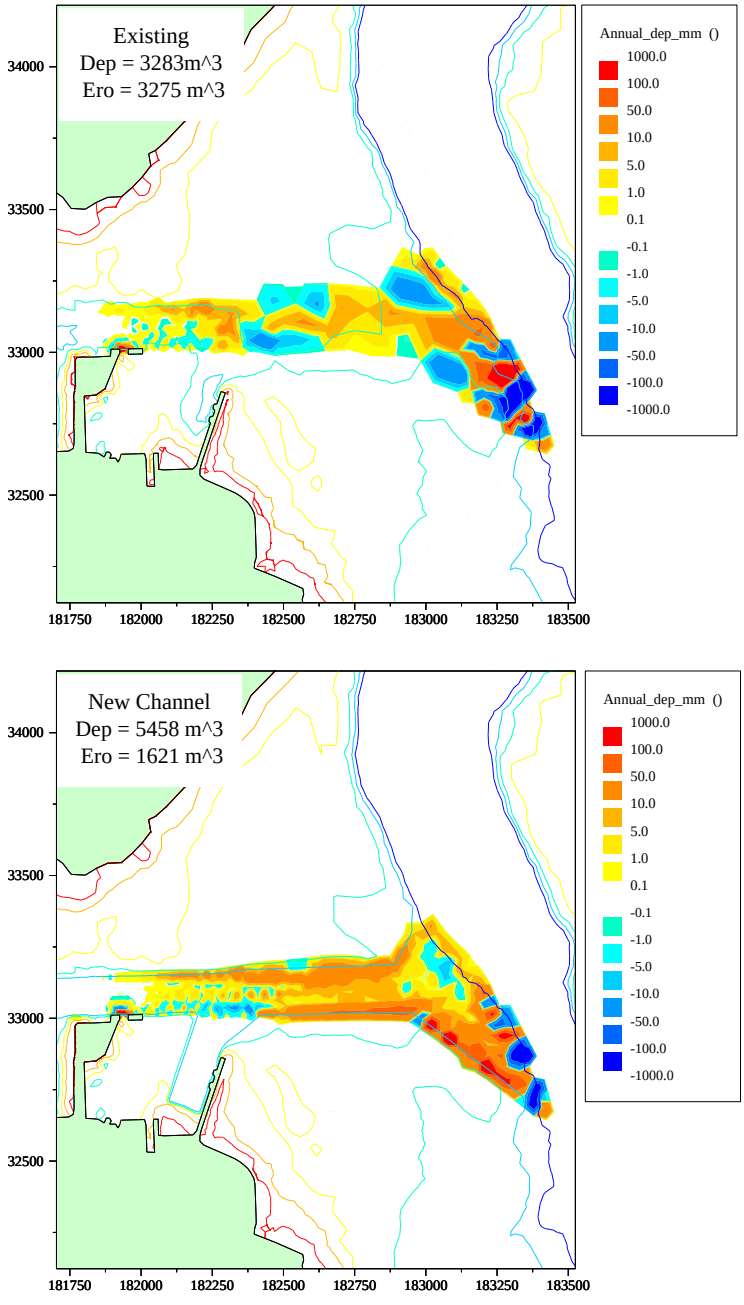
A calculation of the total volume of sand currently deposited annually (i.e. baseline conditions) in the area of the proposed channel gives a figure of less than 20m^3/year. This result suggests whilst sand is mobile in the area of the proposed new navigation channel, little can deposit overall. This insignificant amount is consistent with the present lack of need to undertake maintenance dredging in the approaches to Falmouth Docks and Harbour, and the relatively stable nature of the seabed in the longer term.

The calculation of the annual accretion predicted with the proposed new navigation channel in place (i.e. proposed conditions) gives an accretion total of 5,500m^3/year. This accretion rate is linked to the prediction of generally unchanged sand fluxes due to the channel but with deeper depths, which causes less potential for transport directly over the deeper area and, therefore, deposition. The bulk of the deposition in predicted on the south-eastern corner end of the new navigation channel, with maximum depth of deposition in the range 0.2 to 0.3m/yr. Values of less than 0.1m/yr are predicted on the southern side of the new navigation channel and less than 0.02m/yr on the northern side.

These accretion rates can be considered low enough not to require regular maintenance dredging. However, the potential depth changes on the southern side of the new

navigation channel should be monitored as some maintenance dredging in that area is possible in the medium term.

Figure 2-33 Annual Accretion of Sandy Sediment in the proposed New Navigation Channel: Pre-dredge (top) and Post-Dredge (bottom) (source: HR Wallingford, 2008)



Silt Accretion

The annual deposition of silt in the proposed capital dredge area (i.e. the baseline conditions) has been calculated as 2360m^3/yr. The deposition in the same area after capital dredging (i.e. the proposed conditions) has been calculated as 2970m^3/yr.

HR Wallingford (2008) note that as the existing channel is not currently maintained it is a usual assumption that other processes not included in the numerical model, for example ship passage, keep the channel generally clear of sediment accretion, thereby reducing the simulated baseline rate of 2360m^3/yr to zero (or negligible). Assuming the same processes will continue with the new navigation channel in place, the accretion rate for fine sediment in the new dredged areas is represented by the difference between the proposed conditions and the baseline conditions, which equates to 610m^3/yr. This total is very low and suggests that the accretion rate for fine-grained sediment in the dredged area may not be sufficient to require regular maintenance dredging of the channel.

Maintenance Dredging Regime

The predicted accretion of sand and silt is greatest in the south-east corner of the new navigation channel. Within this, accretion is predicted to be greatest on the southern edge of the flared channel entrance, while the accretion adjacent to Carrick Roads is predicted to occur in conjunction with areas of erosion.

FHC and FDEC do not envisage the need to conduct regular maintenance dredging regime for the new navigation channel and deep water berth. Instead, FHC and FDEC will monitor the seabed for changes to bathymetry and conduct maintenance dredging if necessary. It is expected that any requirement for maintenance dredging will be small, infrequent and possibly unnecessary if the channel is in regular use.

Therefore, the Falmouth Cruise Project is not expected to require maintenance dredging in the foreseeable future and it is not proposed as part of the operational phase.

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3 CONSIDERATION OF ALTERNATIVE OPTIONS

3.1 INTRODUCTION

This section outlines the alternatives to the proposed Falmouth Cruise Project by describing the options also considered, including:

- the do nothing scenario;
- alternative cruise project locations;
- alternative channel alignments;
- alternative dredging methods;
- alternative treatment methods for contaminated dredged material;
- alternative disposal options for contaminated dredged material; and
- alternative disposal options for clean dredged material.

3.2 DO NOTHING SCENARIO

Arup (2008) developed a do nothing scenario to inform their economic assessment of the proposed Falmouth Cruise Project. Under this option, the navigation channel and deep water berth would not be dredged, and the wharf improvements and cruise terminal building would not be constructed. The do nothing option would involve a gradual reduction in port and docks activities at Falmouth, with the cruise industry choosing to use other ports and the gradual silting up of the existing channel meaning that the larger ships currently coming in for repair would find it more difficult to do so.

Under the do nothing scenario, Arup (2008), predict that there will be a decline in cruise passenger numbers and ship repair contracts at the docks. Table 3-1 enumerates the predicted decline in cruise passenger numbers that will occur under the do nothing scenario, using 2005 as the base year.

Table 3-1 Forecast Passenger Numbers (Combined Day Calls and Turnarounds) under the Do Nothing Scenario (source: Arup, 2008)

2005	2008	2009	2010	2015	2020	2025
28,700	38,200	36,290	34,475	29,304	24,908	19,927

According to Arup (2008), the socio-economic implications of the do nothing scenario include a reduction in the pilotage revenue of FHC and the towage activities and ship repair activities of FDEC/A&P, as well as a loss of job creation opportunities, as shown in Table 3-2.

Table 3-2 Forecast Job Creation under the Do Nothing Scenario and Do Project Scenario (source: Arup, 2008)

Scenario	Expected Construction Employment	Expected Increase in Employment at Falmouth Docks	Expected Increase in Employment (due to increased tourist expenditure)	Total
Do nothing	0	0	0	0
Do project	118	140	124	382

3.3 ALTERNATIVE CRUISE PROJECT LOCATIONS

Only the ports of Fowey and Plymouth are able to offer alternative cruise project locations in south-west England. However, as indicated in the following paragraphs,

neither port is able to offer the navigational and/or berthing requirements necessary to accommodate the design vessel for the Falmouth Cruise Project (see Section 2.1) or the shore excursions that are viable from Falmouth. Shore excursions are important because the cruise industry and its associated ports of call - particularly day calls - are driven by passenger demand to visit interesting areas and day attractions. Shore excursions are a key factor in the choice of ports of call because they are highly profitable for cruise operators and a key selling point for the cruise (Arup, 2008).

3.3.1 *Plymouth*

With regard to Plymouth, Arup (2008) note that "Plymouth attracts calls from cruise ships and has had aspirations to become a turnaround port. The port can accommodate the largest cruise ships at its anchorages although they are some distance from the port facilities and outside of the breakwater. Although the West Wharf can provide berthing for vessels up to 200m in length this berth has limited availability which was only available on one day a week (Tuesdays) (MDS Transmodal, 2003, in Arup, 2008). Most cruise operators do not find this arrangement acceptable. Accordingly, Plymouth has some existing operational constraints and could not accommodate the design vessel at an alongside berth. In addition, Plymouth is too far east to attract day calls for cruise vessels wanting to offer shore excursions to the most popular destinations offered from Falmouth, notably Lands End and other attractions in west Cornwall (see Figure 2-28).

3.3.2 *Fowey*

With regard to Fowey, Arup (2008) note that "Fowey is limited to vessels up to 160 m in length on the swing buoy, up to 200m on the under hills flood tide and up to 200m on the outer anchorage. The lack of an alongside berth at Fowey is likely to make the port less attractive to larger ships." Accordingly, Fowey has some existing operational constraints and could not provide navigational access for the design vessel (see Section 2.1) at an alongside berth. In addition, Fowey is also too far east to attract day calls for cruise vessels wanting to offer shore excursions to Lands End and other attractions in west Cornwall, although it could offer shore excursions to some of the attractions offered from Falmouth (see Figure 2-28).

3.4 ALTERNATIVE CHANNEL DESIGN OPTIONS

3.4.1 *Existing Channel Alignment*

The existing channel was designed to provide vessels with safe access to the dry docks, but not to the Northern and Queens Wharves and hence it includes an S-bend. At present, accessing the wharves requires vessels to be lined up for the dry docks approach and then manoeuvred northwards around the wharves. The realigning of the vessels' tracks to northwards requires course alterations and a period of settling onto the new track, adding unwelcome complexity to the manoeuvre and reducing the margins of safety for large vessels.

S-bends are theoretically possible to navigate safely but require long straight sections between the bends for a vessel to safely transition from one turn to the next. There is insufficient straight section between the bends in the existing channel alignment and hence navigation of large vessels is operationally difficult and, as such, unsafe.

The preferred channel design has been made in accordance with the International Navigation Association's (PIANC) guidance and accommodates the safe handling of large vessels with minimum margins for diverging from the intended track by providing a track as straight as possible, so that the vessel can be lined up on the intended track and maintained and effectively monitored in safe water throughout the passage.

In summary, using the existing channel alignment is not appropriate for the large cruise vessels as it requires them to negotiate two turns in rapid succession, and therefore this alignment could not be taken forward for a channel design that meets the standard PIANC guidance.

3.4.2 South-East Channel Alignment

The main alternative channel alignment for the Falmouth Cruise Project comprised a channel aligned from the eastern end of the Northern Wharf towards the south-east until it connected to Carrick Roads / The Narrows (see Figure 3-1).

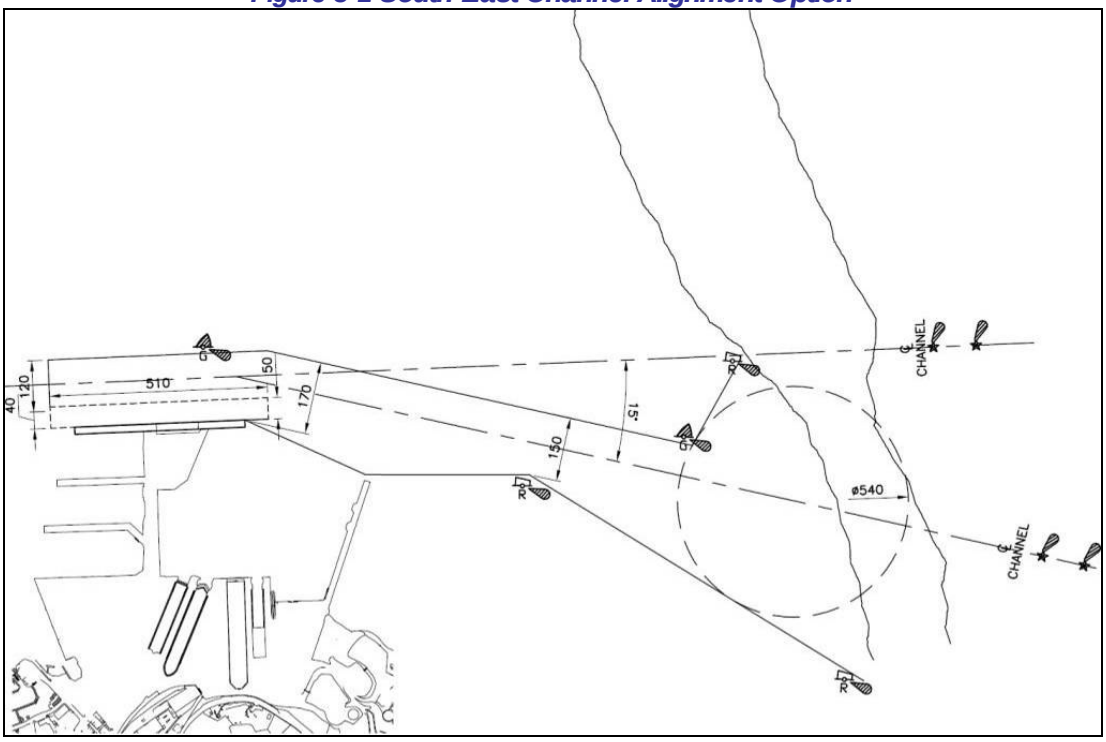
Although this option followed some of the natural channel that runs to the south of the Falmouth Bank, deepening the channel to the required dredge depth (excluding any over-dredge) was predicted to generate around 970,000m^3 of material: a significantly higher volume than the preferred option.

In addition, some of FHC's pilots and masters of Royal Caribbean International's cruise vessels were concerned about the bend in the channel alignment and the reasonably complex navigational manoeuvre it would necessitate. Although fast time simulations determined that the channel would be safe to navigate using the design vessel (Royal Haskoning, 2008), there is a risk that other vessels with less sophisticated manoeuvring capabilities would not be able to safely navigate the channel under a sufficient range of conditions affecting navigation.

In summary, this channel alignment option was not taken forward as the preferred option for the following reasons:

- the larger volume of material that would require dredging and disposal;
- FHC pilots' concerns about the navigation suitability of the channel; and
- Royal Caribbean International's concerns about the width of the channel for navigation.

Figure 3-1 South-East Channel Alignment Option



3.5 ALTERNATIVE DREDGING METHODS

Capital dredging can be undertaken by a variety of different dredging methods subject to the project's location characteristics (e.g. enclosed harbours or open seas), material to be dredged (e.g. stiff clay, soft mud or hard rock), hydrodynamic conditions (e.g. currents, waves and tidal range), disposal options (e.g. on land, at sea, for reclamation or habitat creation), sensitivity of the surrounding environment (e.g. contaminated dredged material, sediment dispersion and deposition, water quality, nature conservation, fisheries, etc), and cost-effectiveness.

The following paragraphs describe the alternative dredging methods considered for removing the material during capital dredging under the proposed Falmouth Cruise Project. Dredger descriptions are derived from CIRIA (2000). More details on how the dredgers relate to the proposal Falmouth Cruise Project are provided in ***Falmouth Cruise Terminal: Preliminary Report on Dredging*** (Dredging Research, 2008).

3.5.1 Mechanical Dredgers - Grab Dredgers

Grab dredgers typically use a crane-mounted clamshell grab to remove the material from the seabed and place it into a barge for transport and disposal. The crane can be mounted on a pontoon or vessel. Grab dredgers can dredge most materials including stiff materials and are suitable for dredging in confined areas (CIRIA, 2000). Like backhoe dredgers (the preferred dredging method), grab dredgers are classified as mechanical dredgers because they use only mechanical actions to excavate material from the seabed.

As noted by Dredging Research (2008), mechanical dredgers such as backhoe and grab dredgers are preferred to hydraulic dredgers (i.e. TSHDs and CSDs) for dredging

contaminated material because they are accurate and do not dilute the material, thereby minimising the volume of material and water requiring treatment. However, compared to a backhoe dredger, a grab dredger is less capable of removing the weathered rock believed to be present within the capital dredging area for the Falmouth Cruise Project and is therefore not the preferred dredging method.

3.5.2 *Hydraulic Dredgers - Trailing Suction Hopper Dredgers (TSHDs) and Cutter Suction Dredgers (CSDs)*

TSHDs trail a drag-head along the seabed to disturb material and then pump a sediment-water mixture from the seabed to an onboard hopper via a suction pipeline (see Figure 3-2). The sediment settles to the bottom of the hopper and the supernatant water is returned to the sea via an overflow weir. TSHDs are used to dredge all but the strongest materials but are not suitable for use in confined areas. They are typically used in the UK for capital dredging projects where the material is to be deposited offshore because TSHDs can both dredge the material and transport it to the offshore disposal site (CIRIA, 2000). Unlike backhoe dredgers (the preferred dredging method), TSHDs are classified as hydraulic dredgers because they use hydraulic suction to pump material from the seabed.

Figure 3-2 TSHDs (sources: Van Oord and Boskalis Westminster Dredging)



CSDs use a rotating cutter-head at the seabed to disturb the material and then pump a sediment-water mixture from the seabed to the desired location for transport (usually via a pipeline) and/or direct disposal. If the dredged material is pumped to a barge (which is atypical), then the sediment settles to the bottom of the barge and the supernatant water is returned to the sea via an overflow weir. CSDs can dredge all materials but are typically used to dredge stiffer sediment and weak rock materials or used when the material is to be pumped ashore for land reclamation (CIRIA, 2000). Unlike backhoe dredgers (the preferred dredging method), CSDs are classified as hydraulic dredgers because they use hydraulic suction to pump material from the seabed.

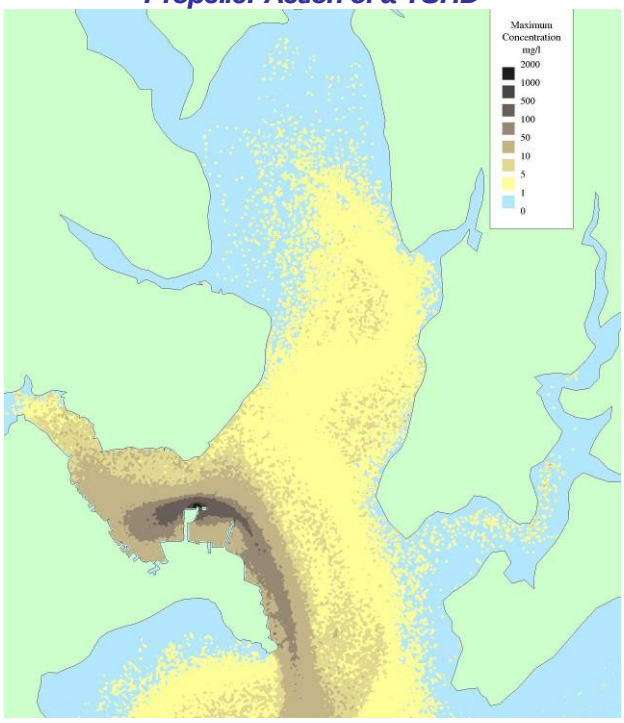
As noted by Dredging Research (2008), mechanical dredgers are preferred to hydraulic dredgers (i.e. TSHDs and CSDs) for dredging contaminated material because they are accurate and do not dilute the material, thereby minimising the volume of material and water requiring treatment. Accordingly, TSHDs and CSDs are not considered suitable for dredging contaminated material for the Falmouth Cruise Project.

As noted by Dredging Research (2008), backhoe dredgers, TSHDs and CSDs are all potentially suitable for dredging clean material, and although TSHDs or CSDs are likely to be more cost-effective than backhoe dredgers they have the following drawbacks:

- lower compatibility with the dredging of the contaminated material when related to the use of backhoe dredgers and barges;
- lower flexibility for the various disposal options in terms of material separation and access to disposal sites;
- higher production rates relative to previous disposal rates at the Falmouth Bay offshore disposal site; and
- greater potential for environmental effects due to sediment plumes, as described below.

Sediment plumes from dredging activities can be the source of significant environmental effects and therefore they are an important consideration for the selection of the preferred dredging method. Both types of hydraulic dredgers have the potential to discharge and disperse large amounts of sediment into the surrounding water due to overflowing and propeller action from TSHDs or from disposal activities when placing via pipelines from CSDs. As an example, Figure 3-3 shows a numerical model prediction of the potential for a TSHD's propeller action to cause a sediment plume while undertaking capital dredging for the Falmouth Cruise Project. The extent of this plume is much greater than the plume associated with the preferred dredging method.

Figure 3-3 Maximum Concentration and Dispersion of Sediment Suspended due to the Propeller Action of a TSHD



3.6 ALTERNATIVE TREATMENT OPTIONS FOR CONTAMINATED MATERIAL

The objective of treatment is to prepare the dredged material in order to facilitate its disposal option.

3.6.1 *Solidification / Stabilisation (S/S)*

S/S typically involves mixing cement or cement-based products with a material in order to physically encapsulate (i.e. by solidification) and chemically immobilise (i.e. by stabilisation) contaminants within the resulting solid mass of mixed material. The contaminants are locked into the material and prevented from leaching into the surrounding environment. In other words, S/S "is a remediation technology that relies on the reaction between a reagent and soil to reduce the mobility of contaminants. Immobilisation is achieved by reaction of contaminants with reagents to promote sorption, precipitation or incorporation into crystal lattices, and/or by physically encapsulating the contaminants" (Environment Agency, 2004).

This treatment method has been used previously in the Fal Estuary and at Newlyn. At Mylor, some 2,300m^3 of dredged marine sediment contaminated by TBT was subject to ***ex situ*** S/S treatment prior to disposal. The dredged material was mixed with modified clays incorporating reactive chemical reagents in 10m^3 batches. The treated material was then used as fill material as a foundation for hard-standing. Validation testing was conducted in line with requirements from the Environment Agency and demonstrated that chemical immobilisation was successful (by more than 99%) and yielded leachate levels for TBT that were well below the target (50µg/l). At Newlyn, some 7,300m^3 of dredged marine sediment was dredged from the harbour and was subject to ***ex situ*** S/S treatment. The dredged material was mixed in skips with Portland cement and a chemical (as pre-prepared treatment grout) to lock in the contaminants. The material was spread out on the reclaimed land and allowed to cure before being topped off with a clean layer of uncontaminated material. In this example, a remediation action plan was agreed with the Environment Agency and an exemption was granted so the treated materials could be re-used in land reclamation prior to create a car park and layout area with the harbour. The exemption was agreed on the basis of leaching criteria. Validation testing was conducted on leachate samples and demonstrated that leachability was reduced by up to 90% for a range of contaminants, including TBT.

Given its use on similarly contaminated dredged material at nearby locations, S/S would appear to be a technically suitable option for treating the contaminated material to be dredged from the Falmouth Cruise Project. However, based on advice from the Environment Agency, the introduction of the Environmental Permitting Regulations 2007, which came into force in April 2008, meant that dangerous substances in waste must be removed before a material can be recovered and re-used for purposes such as ground improvement and construction. Since S/S would not destroy the contaminants present within the dredged material, it is not a suitable treatment method for facilitating the creation of a new material that can be used in the Falmouth Cruise Project.

3.7 ALTERNATIVE DISPOSAL OPTIONS FOR CONTAMINATED MATERIAL

The following paragraphs describe the alternative options considered for disposing of the contaminated material present in the western part of the capital dredging area under the proposed Falmouth Cruise Project. All disposal at sea options are considered with regard to the permitting requirements under the Food & Environment Protection Act 1985, while all disposal on land options are considered with regard to permitting requirements under Environmental Permitting Regulations 2007.

3.7.1 *Disposal at Sea of Untreated Contaminated Material: Falmouth Bay Offshore Disposal Site*

This option comprises depositing the contaminated dredged material at the Falmouth Bay offshore disposal site. Consultation with Cefas indicated that the concentrations in the contaminated dredged material are sufficiently high that this disposal route would not be permitted under the Food & Environment Protection Act 1985. Accordingly, this option was ruled out for the Falmouth Cruise Project.

3.7.2 *Disposal at Sea of Treated Contaminated Material: Falmouth Bay Offshore Disposal Site*

This option comprises depositing treated contaminated dredged material at the Falmouth Bay offshore disposal site. Consultation with the MFA identified that the material becomes controlled waste when it is brought on land for treatment and, therefore, this disposal route could not be permitted under the Food & Environment Protection Act 1985. Accordingly, this option was ruled out for the Falmouth Cruise Project.

3.7.3 *Disposal at Sea of Untreated Contaminated Material: Capped Disposal in Falmouth Bay*

This option comprises placing the untreated contaminated dredged material on the seabed and capping it with clean material. The purpose of the cap is to isolate the contaminated material from the overlying the marine environment. Depending on the level of contamination and the sensitivity of the surrounding environment, the contaminated material may be placed at the disposal site by conventional discharge from barges or TSHDs, or by using a pipeline or diffuser to give more accuracy and to control dispersion. The capping material is placed with regard to the material used, water depth and the characteristics of the contaminated material, and therefore a variety of methods can be used (see Bray (ed.), 2008).

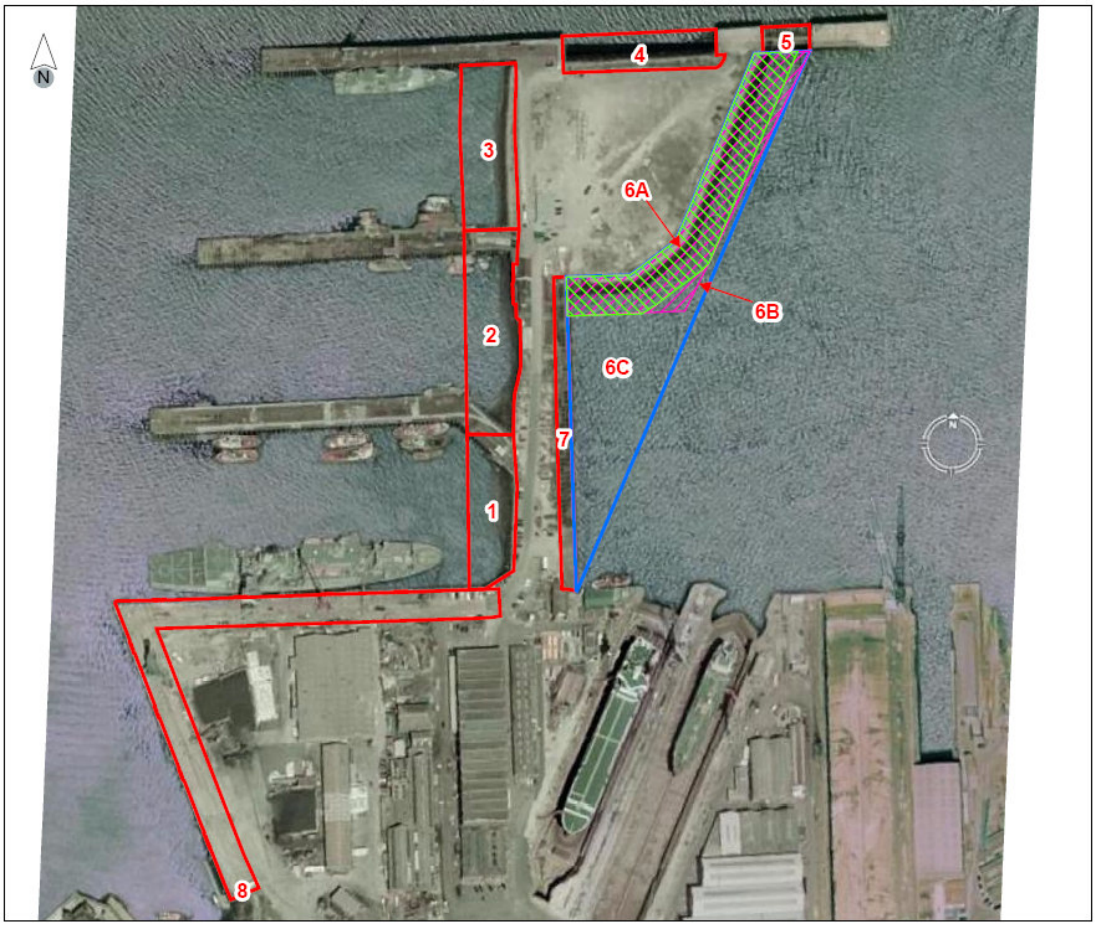
This disposal method has a history of use in countries including the United States, the Netherlands and Japan (e.g. Palermo, 1987), but in the UK experience is limited to an ongoing trial offshore of north-east England. The trial involves dredged material from the Port of Tyne which contains contaminants (including TBT) at concentrations normally unacceptable for disposal at sea. The trial allows the disposal of 60,000m^3 of contaminated material and 135,000m^3 of clean material as a cap. The cap is supposed to be 1.5m thick; however, monitoring suggests that this thickness has not been achieved despite additional capping.

The key environmental and technical (i.e. engineering) issues for successful capping include the potential dispersion of contaminants during placement of the contaminated material, the achievable precision of cap placement for achieving cap thickness, and the long-term stability of the cap due to its geotechnical properties (e.g. spreading), hydrodynamic forces (e.g. erosion) and biological activity (e.g. bioturbation) (Brannon ***et al***., 1985; Palermo, 1991; Palermo ***et al***., 1998; Clausner, 2004; Bray (ed.), 2008). Given that the trial is ongoing in north-east England, there remains uncertainty in the UK about the environmental and technical performance of capping. Accordingly, this option was ruled out for the Falmouth Cruise Project.

3.7.4 *Disposal at Sea of Treated Contaminated Material: Docks Basin – Wharf Structures*

During the course of the EIA process, a number of sites were considered for using the treated contaminated dredged material as a fill material for the wharf improvements required along the Queens and Northern Wharves, and other structures within the docks (see Figure 3.6). These sites included two locations along the Queens and Northern Wharves where improvements are required to provide the cruise quay (i.e. sites 4 and 5 in Figure 3-6). The permitting route for this option is complicated because, potentially, both the Environmental Permitting Regulations and the Food & Environment Protection Act apply given that the dredged material would have to be placed both above and below MHWS.

Figure 3-6 Potential Wharf Improvement Sites within Falmouth Docks



This option was based on the treatment of the contaminated dredged material (e.g. with cement or similar additives) to create a new infill material with suitable engineering properties. It was envisaged that this approach to recovering and re-using a waste for construction may be acceptable under Schedule 3 (19) of the Environmental Permitting Regulations, and therefore the material could be used both above and below MHWS. However, following advice from the Environment Agency, it was determined that the Schedule 3 (19) exemption route for dredged material was only available for land drainage works by land drainage authorities, and therefore not available to the Falmouth Cruise Project.

It may have been possible to have used the treated contaminated dredged material as an infill material for the wharf structure below MHWS under the Food & Environmental Protection Act (i.e. placement of a construction material), and possibly for the wharf structure above MHWS (for up to 2m of depth) under Schedule 3 (9) of the Environmental Permitting Regulations (i.e. for ground improvement works). This option was not investigated because an indicative costing exercise of the conceptual design for wharf structures identified that this option, under any of the permitting routes, was not financially feasible. Accordingly, this option was not viable and ruled out for the Falmouth Cruise Project.

3.8 ALTERNATIVE DISPOSAL OPTIONS FOR CLEAN MATERIAL

3.8.1 Disposal at Sea – Beneficial Use of Maerl Substrate for Habitat Enhancement

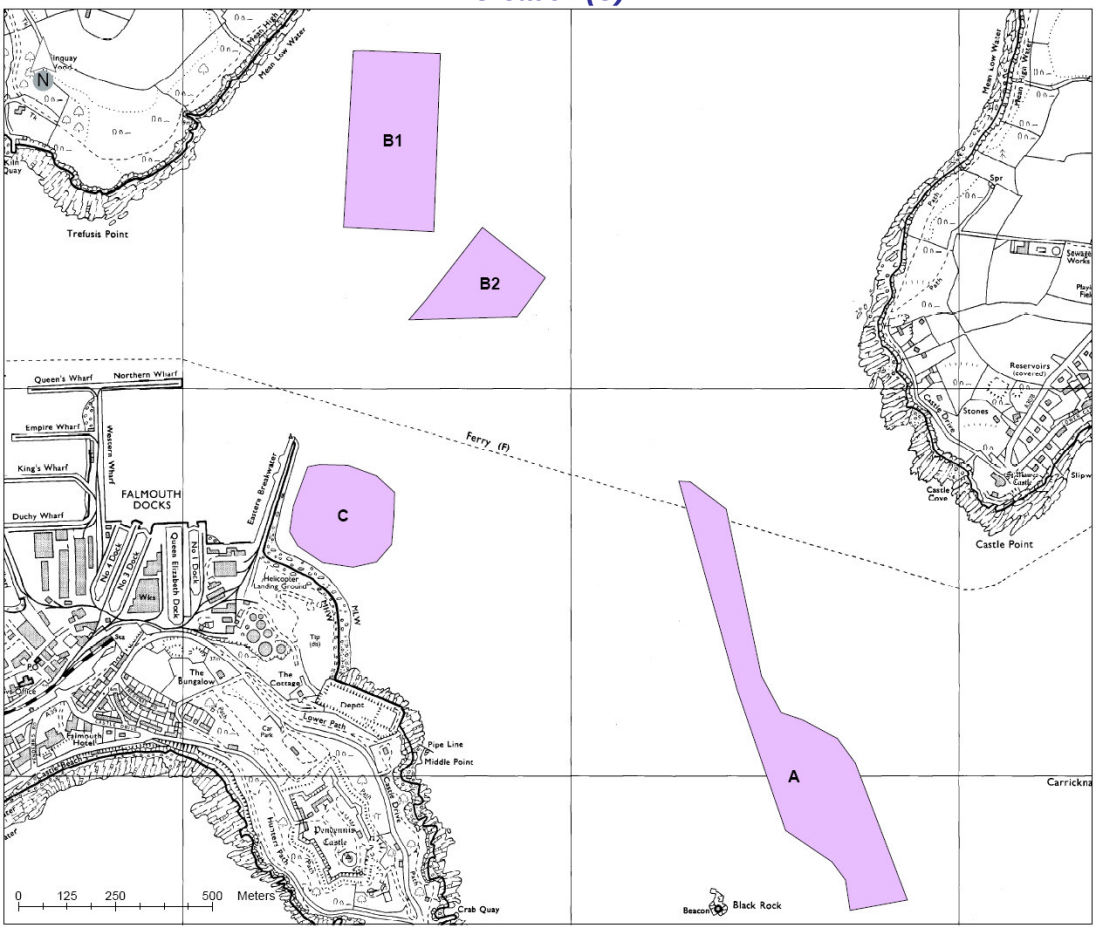
During the course of the EIA process, ongoing consultation with Natural England led to a number of options being devised for using the maerl component of the clean dredged material for habitat enhancement within the Fal estuary. Enhancement was proposed at a number of locations formally subject to commercial maerl extraction for use as a soil improver (see areas A, B1 and B2 in Figure 3-7).

As shown in Table 3-3, a number of scenarios were identified and offered the potential to beneficially use large quantities of the clean dredged material. However, consultation with Natural England ruled out this option on the grounds that habitat enhancement would increase the overall impact footprint of the proposed project within the Fal and Helford Estuaries SAC.

Table 3-3 Capacity for Beneficial Use of Maerl Substrate for Habitat Enhancement and Creation

Area id	Geological location / extent	Capacity (m^3) with varying placement depths		
		0.5m	1m	1.5m
A	Southern extraction area	75,260	150,510	225,770
B1	Falmouth bank extraction area, north section	52,490	104,980	157,470
B2	Falmouth bank extraction area, southern section	22,600	45,200	67,800
C	Eastern breakwater	28,920	57,850	86,770

Figure 3-7 Proposed Sites for Habitat Enhancement (A, B1 and B2) and Habitat Creation (C)



3.8.2 *Disposal at Sea – Beneficial Use of Maerl Substrate for Habitat Creation*

During the course of the EIA process, ongoing consultation with Natural England led to an option being devised for using the maerl component of the clean dredged material for habitat creation within the Fal estuary. Habitat creation was proposed at a location east of the Eastern Breakwater (see Area C in Figure 3-7).

As shown in Table 3-3, a number of scenarios were identified and offered the potential to beneficially use large quantities of the clean dredged material. However, consultation with Natural England ruled out this option on the grounds that marine ecology survey data (Axelsson ***et al***., 2008) indicates that the proposed habitat recreation site and its surroundings already support maerl habitat and associated marine communities, and therefore it is not considered suitable as a beneficial use site.

3.8.3 *Disposal on Land – Use of Maerl Substrate for Soil Improvement*

The extraction of dead maerl substrate in and around Falmouth dates back to the 17th century (Royal Haskoning, 2004) and was extracted from the area controlled by the FHC from1975 to 2005.

Dead maerl used to be dredged from the Fal Estuary under a licensed extraction activity, brought ashore, treated (i.e. washed) and bagged and sold as a soil improver. It

was formerly dredged by Cornish Calcified Seaweed Company (CCSC) and sold under the name 'Calseamin'. It was used by farmers to increase the pH value of the soil and to condition it by introducing minerals and trace elements. The effect on grass is an improved sward, enhanced palatability and better feed value of the grass, and, as a result, improvements to the grazing livestock (CCSC, 2003).

Since the maerl would be dredged material and brought onto land, it would become a waste material and, accordingly, its use as a soil improver would constitute a disposal activity subject to the provisions of the Environmental Permitting Regulations 2008. Since no soil improvement opportunities have been defined for the use (i.e. disposal) of the maerl, it is possible that this option may prove to be unfeasible. Therefore, this option has been excluded from the proposed Falmouth Cruise Project subject to the EIA process.

4 PLANNING AND POLICY CONTEXT

4.1 INTRODUCTION

This chapter provides an overview of current planning policies and guidance relevant to the assessment of the proposals. Policies relating to different topic areas are set out under national, regional and local policy headings. The policies identified have been taken into account in drawing up the proposals for the proposed Falmouth Cruise Project and in assessing the significance of their environmental effects. Where the policy context requires a particular form of assessment, this has been noted.

National guidance on a range of matters related to ports, for example transport and nature conservation is found in planning policy statements, white papers and other documents produced by government departments.

Planning policies and proposals for the region and the locality are set out in the Statutory Development Plan, which comprises:

I. Regional Planning Guidance for the South West (RPG10) (September 2001) - which is the Regional Spatial Strategy pending approval of an RSS by the Secretary of State – and
II. saved elements of Carrick District Council Local Plan.

It is appropriate to note two pending changes in legislation. Firstly, the Government has recently introduced into Parliament a Planning Bill, which includes a new system for approving infrastructure of national importance, the definition of which includes port expansion on the scale of the proposal. The Bill envisages that decisions on such applications will normally be made by an Infrastructure Planning Commission. The Commission will consider proposals against National Policy Statements (NPS) approved by Parliament. The Bill is expected to be enacted later this year, with the Commission beginning its work in the second half of 2009.

Secondly, in 2008 Defra published a draft Marine Bill for consultation. This envisages the establishment of a Marine Management Organisation (MMO) and the introduction of a statutory planning system for marine areas. The Bill provides heads of power for marine conservation activities, including the identification and designation of Marine Conservation Zones, fisheries management reform and streamlined enforcement powers.

The rest of this chapter outlines current policies relevant to the proposals. Common general themes are sustainable development, which PPS 1 (paragraph 3) describes as “the core principle underpinning planning”, and climate change, tackling which is a “key Government priority for the planning system” (foreword to Supplement to PPS1, 2007). The recent approach to these subjects has been influenced by reports commissioned by the Government, including the Barker review of Land Use Planning, the Stern report on climate change and the Eddington study of ‘transport's role in sustaining the UK's productivity and competitiveness’.

4.2 NATIONAL POLICY

4.2.1 Sustainable Development

The Government's most recent Sustainable Development Strategy, 'Securing the Future' (2005), builds on its 1999 predecessor, 'A Better Quality of Life'. It stresses the importance of achieving integrated solutions to problems, rather than relying on trading off different potential benefits (economic, social and environmental) when making decisions.

'Securing the Future' says the goal of sustainable development is "to enable all people throughout the world to satisfy their basic needs and enjoy a better quality of life, without compromising the quality of life for future generations". This goal is to be pursued

> "in an integrated way through a sustainable, innovative and productive economy that delivers high levels of employment; and a just society that promotes social inclusion, sustainable communities and personal wellbeing. This will be done in ways that protect and enhance the physical and natural environment, and use resources and energy as efficiently as possible" (Securing the Future, Chapter 1: Section 3).

'Securing the Future' says the goal should be achieved through five guiding principles: living within environmental limits; ensuring a strong, healthy and just society; achieving a sustainable economy; promoting good governance, and using sound science properly and responsibly. It identifies four priority areas for immediate action across the UK:

- sustainable consumption and production;
- climate change and energy;
- protecting natural resources and enhancing the environment; and
- creating sustainable communities and a fairer world.

'Planning Policy Statement 1 (PPS1): Delivering Sustainable Development', which followed, in 2005, establishes overarching policies for the delivery of sustainable development through the planning system. Planning policy statements may be material considerations in respect of decisions on individual planning applications.

PPS1 describes the important role of the planning system in achieving sustainable development and building sustainable communities. Key principles should be followed to ensure planning for sustainable development through development plans and planning applications.

The Government's four aims for sustainable development in no order of priority (at paragraph 4) are:

- social progress which recognises the needs of everyone;
- effective protection of the environment;
- the prudent use of natural resources, and
- the maintenance of high and stable levels of economic growth and employment.

PPS1 says these aims should be pursued in an integrated way. Planning is to facilitate and promote sustainable and inclusive patterns of urban and rural development by:

> "- making suitable land available for development in line with economic, social and environmental objectives to improve people's quality of life;

- contributing to sustainable economic development;
- protecting an enhancing the natural and historic environment, the quality and character of the countryside, and existing communities;
- ensuring high quality development through good and inclusive design, and the efficient use of resources; and
- ensuring that development supports existing communities and contributes to the creation of safe, sustainable, liveable and mixed communities with good access to jobs and key services for all members of the community" (paragraph 5).

PPS1 notes the Government's commitment to protecting and enhancing the quality of the natural and historic environment. Areas designated of national and international importance receive the highest level of protection (paragraph 17). Planning decisions should be based on, amongst other things, the potential impacts on the environment of development proposals and planning authorities should seek to enhance the environment as part of development proposals, and significant adverse impacts on the environment should be avoided (paragraph 19).

The Government is also committed to the promotion of a strong, stable and productive economy, which aims to bring jobs and prosperity for all is (paragraph 23). Planning authorities are required, amongst other things, to recognise that economic development can deliver environmental and social benefits (paragraph 23(i)) and that all economies are subject to change, and to be sensitive to these changes and the implications for development and growth (paragraph 23(v). They should ensure that infrastructure and services are provided to support new and existing economic development and housing (paragraph 23 viii), and identify opportunities for future investment to deliver economic objectives.

PPS: 'Planning and Climate Change' was issued in December 2007 as a supplement to PPS1. It describes how spatial planning should contribute to reducing emissions and stabilising climate change (mitigation) and take into account the unavoidable consequences (adaptation). It builds on Government Energy Policy and targets for reducing carbon emissions, including encouraging businesses to improve the efficiency with which they use energy; and stresses that climate change considerations need to be integrated with almost all areas of planning practice,

The PPS1 supplement advises that local authorities should consider climate change in spatial planning concerns. It sets out how, in providing for the new homes, jobs and infrastructure needed by communities, planning should help shape places with lower carbon emissions that are resilient to climate change as part of an overall development plan framework. At the local level, development plan documents (DPDs) are to set policies on the provision of low carbon and renewable sources of energy.

The supplement advises that new development should be located and designed to optimise its carbon performance and limit its likely contribution to carbon emissions. It should consider the capacity of existing and potential infrastructure (including energy supply, waste management, water and sewerage, and community infrastructure such as schools and hospitals) and service the site or area in ways consistent with cutting carbon emissions and successfully adapting to likely changes in the local climate. Climate change considerations should be integrated into spatial planning concerns,

including transport, housing, economic growth and regeneration, water supply and waste management, and not considered separately.

4.2.2 *Transport*

The emphasis of Government transport policy, which is set out in PPG13 (supplemented by subsequent white papers and Government responses to commissioned studies) is on integrated and sustainable transport. Local authorities are required to produce Local Transport Plans (LTP). The most recent discussion document, 'Towards a Sustainable Transport System Supporting Economic Growth in a Low Carbon World' DfT (October 2007) brings together recent thinking on a range of transport matters. It provides the Governments' response to the Eddington Study to improve transport's contribution to economic growth, and deliver the overall level of reductions in carbon emissions recommended by the Stern Review of the Economics of Climate Change.

The white paper also sets out policy and investment plans up to 2013/2014 and proposes a longer term transport strategy, building on Eddington's recommendations. It identifies five goals:

- to maximise the competiveness and productivity of the economy by making best use of the existing network, targeting new infrastructure investment (in airports, ports, rail and road), with smaller projects to unlock pinch points potentially offering very high returns, and adapting the delivery chain to meet changing demands;
- to address climate change;
- to protect people's safety, security and health;
- to improve quality of life, including through a healthy natural environment, and
- to promote greater equality of opportunity.

Paragraph A39 notes the identification by RDAs and other regional stakeholders of the accessibility of international transport links (ports and airports) as "critical to their economic growth prospects. Eddington recognises that this aspect of international connectivity is important. The challenge is to identify economically efficient ways of delivering it. These are more likely to involve improving access to ports and airports than redirecting aviation or shipping movements, which is not (in any case) within the gift of either central or local government."

The strategy of the 2004 white paper 'The Future of Transport, A Network for 2030', is built around three central themes of sustained investment, improvements in transport management and planning ahead. The white paper charts a course for the next 30 years which a transport network that can meet the challenges of a growing economy and the increasing demand for travel, but can also achieve our environmental objectives. This, it says, means coherent transport networks including ports and airports providing improved international and domestic links (Executive Summary paragraph 6).

The 2004 white paper aims to "ensure that our shipping industry remains a major player globally to support the success of the UK economy" (paragraph 7.24). Although, it says, shipping is often recognised as a sustainable and relatively environmentally friendly form of transport, it is important that efforts are made to reduce the negative impacts it can have on the environment (paragraph 7.27); such as measures to tackle ballast water, anti-fouling coatings, atmospheric emissions and an international oil pollution compensation regime.

Planning Policy Guidance Note 13 (PPG13): Transport (2001) is relevant to the assessment of the traffic implications of port proposals. The objectives of PPG13 are to integrate planning and transport at the national, regional, strategic and local level. In particular to:

- promote more sustainable transport choices for both people and moving freight;
- promote accessibility to jobs, shopping, leisure facilities and services by public transport, walking and cycling; and
- reduce the need to travel, especially by car.

PPG13 says that well-designed traffic management measures are important in terms of reducing community severance, noise, local air pollution and traffic accidents, helping to avoid or manage congestion pressures as well as producing better and safer local road conditions in rural areas and reducing the impacts of traffic in sensitive locations, while facilitating the access that is important to maintaining a vibrant rural economy. Paragraph 1 of Annex C of PPG13 repeats that need to avoid or minimise the environmental impact of any transport infrastructure project, including the impact of construction and requires the implementation of appropriate mitigation measures where possible.

4.2.3 Nature Conservation

The proposals extend into and adjoin the Fal Estuary, which is designated as a Special Area of Conservation (SAC) under the European Union Habitats Directive (92/43/EEC), implemented in Britain by the Conservation (Natural Habitats & c.) Regulations 1994.

The main aim of the Habitats Directive is "***to contribute towards ensuring biodiversity through the conservation of natural habitats and of wild fauna and flora***" and sites protected by the directive, known as Natura 2000 sites; form a European-wide network designed to promote the conservation of habitats, wild animals and plants, on land and at sea.

The Conservation (Natural Habitats, &c) Regulations 1994 (usually referred to as the Habitats Regulations) implement the Habitats Directive in the UK. The Regulations restrict the granting of planning permission for development which is likely to have a significant effect on a SAC (either alone or in combination with other plans or projects) and which is not directly connected with or necessary to the management of the site. They also provide for the control of potentially damaging operations, whereby consent may only be granted once it has been shown through appropriate assessment that the proposed operation will not adversely affect the integrity of the site. However, an operation may proceed where it is or forms part of a plan or project with no alternative solutions, which must be carried out for reasons of overriding public interest (Regulation 49). In such instances the Secretary of State must secure compensation to ensure the overall integrity of the Natura 2000 system (Regulation 53).

Planning Policy Statement 9 (PPS9) on Biodiversity and Geological Conservation (2005) establishes the Government's policies on the protection of biodiversity and geological conservation through the planning system. It says the Government's broad aim is that planning, construction, development and regeneration should have minimal impacts upon biodiversity and enhance it wherever possible.

PPS9 states that regional planning bodies and local planning authorities should adhere to a number of key principles to ensure that the potential impacts of planning decisions on biodiversity and geological conservation are fully considered.

Planning decisions should prevent harm to biodiversity and geological conservation interests. Where development considered likely to result in significant harm to such interests is to be granted consent, then the planning authority:

- will need to be satisfied that the development cannot reasonably be located on an alternative site resulting in less or no harm;
- if there is not a more suitable alternative site, ensure that adequate mitigation is put in place;
- if the harm cannot be prevented or adequately mitigated, seek appropriate compensation measures, and
- if the significant harm generated cannot be prevented, adequately mitigated or compensated, refuse planning permission (paragraph 1(vi)).

In the context of sites of local or regional significance, PPS9 says that criteria based policies in local development documents should be established against which proposals for development will be judged. It says these policies should be distinguished from those applying to nationally important sites. PPS 9 also advises planning authorities to refuse planning permission where harm to a protected species or their habitats would result unless the need for, and the benefits of the development clearly outweigh that harm.

Circular 06/05 – Biodiversity and Geological Conservation supports PPS9 and gives guidance to Local Planning Authorities on how to deal with proposals that may affect internationally and nationally designated sites, conservation habitats, and conservation of species protected by law, including the requirement for Appropriate Assessment under the Habitat Regulations.

The ecological assessment reported in Sections 8 to 10 has taken full account of the policy requirements outlined above, specifically in relation to the SAC.

4.2.4 Industrial and Commercial Development

One of the key Government aims is to encourage economic growth in a way to which is compatible with environmental objectives and the challenge is to integrate the two. The Barker Review of Land Use Planning (December 2006) identified that planning authorities do not always give sufficient weight to economic considerations when drawing up plans and determining planning applications.

Currently policy guidance is in PPG 4: Industrial, Commercial Development and Small Firms (1992). PPG4, which is being updated (see below), promotes a positive approach to the location of development. It says Local Development Plans are the main mechanism by which major new development proposals can be assessed alongside the transport improvements needed to serve them, and which can link transport proposals to the development opportunities they create.

The guidance encourages development plans to focus location of development in areas that can be served by more energy efficient modes of transport - such as water (PPG4 paragraph 11). It identifies a number of factors that should be considered including the demands of customers, access to suppliers, links with other businesses, the workforce

catchment area, and various transport considerations. Paragraph 10 commends the following criteria or approaches:

- favouring locations which minimise the length and number of trips, especially by motor vehicles;
- favouring locations that can be served by more energy efficient modes of transport;
- discouraging developments that would be likely to add unacceptably to congestion; and
- locating development requiring access mainly to local roads away from trunk roads, to avoid unnecessary congestion on roads designed for longer distance movement.

At paragraph 13, PPG4 says local planning authorities should not obstruct development that is necessary to provide investment or jobs, or to meet wider national or international objectives, though decisions must balance necessary development with environmental protection and other relevant policies.

Draft Planning Policy Statement 4: Planning for Sustainable Economic Development (December 2007) aims to integrate economic growth in an environmentally sustainable way and to achieve a balance between economic, environmental and social considerations. The draft PPS proposes that local and regional planning bodies should plan effectively and proactively to ensure economic growth and create and maintain sustainable communities. To achieve this aim, authorities should, for instance (paragraph 18):

- "Take account of the different locational requirements of businesses, such as the size of site required, site quality, access and proximity to markets, as well as the locally available workforce "; and
- "Identify, protect and promote key distribution networks, and locate or co-locate developments which generate substantial freight movements in such a way as to minimise carbon emissions. Such networks and development should be in sustainably sited locations, so as to avoid congestion and to preserve local amenity interests as far as possible whilst ensuring accessibility (including to rail and water transport where feasible)".

The ES considers the proposals against advice in PPG 4 and emerging Government guidance through providing improved access for energy efficient transport, taking account of locational requirements and environmental considerations.

4.2.5 Coastal Planning

Advice and guidance in PPG 20: Coastal Planning (1992) details the Government's approach to planning policy for the UK coast and describes the coast as "an important national resource. A range of economic and social activities require coastal locations, and certain natural and historic landscapes and habitats are particular to coastal areas" (PPG20 paragraph 1.1). It says, in the context of the coast, the overarching aim is for the planning system to "development requirements with the need to protect, conserve and, where appropriate, improve the landscape, environmental quality, wildlife habitats and recreational opportunities" (PPG20 paragraph 1.2).

The guidance acknowledges the special value of parts of the coastline. In making reference to the European Directives 85/337/EEC and 92/43/EEC, the Habitats Directive

PPG20 says: “there is a series of international obligations which affect the coastal zone. Of particular relevance are sites designated under international conventions, such as “Wetlands of International Importance, especially as Waterfowl Habitats” under the Ramsar Convention. Certain European Community Directives are relevant to the planning and management of the coastal zone” (PPG20 paragraph 1.13).

Where new development requires a coastal location, the guidance is that the developed coast will usually provide the best option, provided that due regard is paid to the risks of erosion or flooding (paragraph 2.11). PPG20 recognises that there are some major developments, including ports, require a coastal location. It says, “before major developments are permitted it will be essential to demonstrate that a coastal location is required. Proposed developments of national or regional importance (including ports) that require a coastal location will normally be included in structure plans” and will normally require environmental assessment. Once this has been demonstrated, the planning application for a port development should be determined in accordance with the relevant development plan policies. Therefore, in order for this to be undertaken, the development plan policies should be formulated on a well grounded understanding of natural processes in the coastal zone.

The need to reconcile development requirements with the need to protect, conserve and where necessary improve the coastal landscape, environmental quality, wildlife habitats and recreational opportunities on the coast is stressed.

4.2.6 Noise and Vibration

Planning Policy Guidance Note 24 (PPG24) outlines the issues to be considered in determining planning applications for both noise-sensitive developments and for activities which will generate noise. It introduces the concept of noise exposure categories for residential development, encourages their use and recommends appropriate levels for exposure to different sources of noise. It also advises planning authorities on the use of conditions to minimise the impact of noise.

The guidance states that noise impacts can be a material consideration in determining planning applications. It describes that new development involving noise-generating activities (including traffic-induced noise) should, where possible, be sited away from noise-sensitive locations and land uses. However, it identifies that development necessary for the creation of jobs and for the improvement of essential infrastructure should not be unduly obstructed, though Planning Authorities must ensure that unacceptable noise disturbance is not caused by a development (PPG24 paragraph 10). This requirement also arises for the intensification of activities, such as the indirect increase in traffic. Mitigation measures can be incorporated in a proposed development to minimise the potential increase in noise impacts, and these can also be included as planning conditions.

The guidance also states that special consideration should also be given in relation to the noise disturbance upon designated sites, such as SACs, AONBs, National Parks, and Heritage Coasts, as well as on livestock.

The guidance identifies particular methodology to be used in calculating and assessing the impacts of noise and vibration from developments, in particular that emitted during

construction, from commercial and industrial development, and road and rail traffic, which is contained in Annex 3.

The proposals have been assessed in terms of potentially significant noise impacts in Section 16

4.2.7 Control of Pollution

Planning Policy Statement 23 (PPS23): Planning and Pollution Control provides guidance on the relationship between the separate but complementary systems of pollution and planning control. PPS23 is relevant to the proposals insofar as it is concerned with the planning aspects of pollution, including light pollution, and ground contamination. Paragraph 10 of PPS 23 advises on the relationship between the separate but complementary systems of pollution and planning control, and states:

> "***Pollution control is concerned with preventing pollution through the use of measures to prohibit or limit the release of substances to the environment from different sources to the lowest practicable level. It also ensures that ambient air and water quality meets standards that guard against effects to the environment and human health. The planning system controls the development and use of land in the public interest.... The planning system should focus on whether the development itself is an acceptable use of the land, and the effect of those uses, rather than the control of the processes or emissions themselves. Planning authorities should work on the assumption that the relevant pollution control regime will be properly applied and enforced***".

PPS 23 identifies the key role of the planning system in determining the location of development which may give rise to pollution, and in ensuring that other uses and developments are not, as far as is possible, affected by major existing or potential sources of pollution. It states "***any consideration of the quality of land, air or water and potential impacts arising from development, possibly leading to an impact on health, is capable of being a material planning consideration, in so far as it arises or may arise from any land use***" (PPS23 paragraph 2). Advice in PPS 23 has been considered in relation to general construction impacts of the proposals which may give rise to additional pollution in terms of air quality and is included in Section 18.

PPS 23 advises that development control decisions can have a significant effect on the environment, and that close cooperation with the Environment Agency and/or pollution control authority and other relevant bodies is required to ensure that potential releases can be adequately regulated under the pollution control framework.

This issue is considered further in Appendix A to PPS 23, which refers to material considerations in determining planning applications where the effects of pollution consideration arise. These include:

- the potential sensitivity of the area, including designated sites;
- the environmental benefits that the development might bring - for example, improvements to transport infrastructure, remediation of past contamination;
- the economic and wider social need for development (including potentially polluting development) such as the provision of a product or service, the creation of new jobs and meeting regional and local objectives, the availability of alternative sites; and

- effects on air and water quality; and, the need to limit and, where possible, reduce the adverse effect of light pollution, e.g. on local amenity, rural tranquillity and nature conservation.

PPS 23 includes two annexes. Annex 1 explains the background of the pollution control legislation, how it interacts with the planning system and how these interactions are dealt with in planning. It also provides detail on the Air Quality Management Areas as established by Part IV Environment Act 1995. Annex 2 relates to development on land affected by contamination and paragraph 2.17 states that it is the responsibility of the developer to determine whether land is suitable for a particular development or can be made so by remedial action.

4.2.8 Areas at Risk from Flooding

The Strategic Flood Risk Assessment prepared by Royal Haskoning (2008) show the proposal site to be within flood zone 3, a high flood risk area. Advice in PPS25 Development and Flood Risk provides current Government guidance on development in such areas. A full Flood Risk Assessment has been undertaken and is included in the ES.

PPS 25 seeks to ensure that flood risk is taken into account at all stages in the planning process, so as to avoid inappropriate development in areas at risk of flooding and to direct development away from areas at highest risk. Where new development is, exceptionally, necessary in such areas, PPS 25 says planning policy should to make it safe without increasing flood risk elsewhere and where possible, reducing flood risk overall.

In determining planning applications, Planning Authorities are advised to:

- have regard for PPS 25 and its policies;
- ensure that planning applications are supported by a site-specific Flood Risk Assessment (FRA);
- apply a sequential approach to site-selection;
- give priority to the use of Sustainable Urban Drainage Systems (SUDS), and
- ensure that development is flood resilient and flood resistant, and manage its residual flood risk.

On Flood Control the Environment Agency has a tabular format categorising areas by 3 zones of risk and cross referencing to uses e.g. industrial, residential etc. This format might be referred to or Table D1 in Appendix D to PPS25. Although the proposal is within an area classified by the Environment Agency as ‘High Probability’ for flooding, advice in Annex D of PPS25 notes that docks are considered to be ‘water compatible development’ and appropriate in this zone. Essential infrastructure, including transport infrastructure, in this zone should be designed and constructed to remain operational and safe for users in times of flood and should only be permitted in this zone if the Exception Test is passed. Paragraph D9 sets out the Exception Test to be passed including that it must be demonstrated that the proposed development provides wider sustainability benefits to the community that outweigh flood risk; that the development should take place on developable or previously developed land (unless no reasonable alternatives exist), and a flood risk assessment must demonstrate that the development will be safe and not increase flood risk elsewhere.

When a FRA is carried out, consultation should be undertaken with the Environment Agency. The FRA should also incorporate climate change factors during its production, including sea level rise and increased storminess/rainfall. As a result the FRA will identify the likely effects on flooding and flood risk, and any loss of floodplain resulting from a proposal.

4.2.9 Archaeology

The Falmouth area is potentially rich in archaeological deposits and remains. As part of the EIA process a desk-based archaeological assessment was undertaken to ascertain the known and potential archaeological and cultural heritage resources on land and at sea that could be affected by the proposed development. The results of the assessment are included in Section 14 of the ES.

Advice in PPG 16 Archaeology and Planning (1990), sets out Government policy on archaeological remains on land, and how they should be preserved or recorded both in an urban setting and in the countryside. It advises that archaeological remains are finite and non-renewable resources, which are often fragile and vulnerable to damage and destruction. It is therefore important that steps are taken to ensure avoidable damage is prevented. There should be a presumption in favour of the preservation of nationally important archaeological remains, scheduled or not. PPG 16 also provides guidance for developers if archaeological remains are unexpectedly discovered during construction. PPG 16 also advises that consideration should be given at the early stages of a proposed development to the presence of possible archaeological remains.

Paragraph 22 adds: ***'Local Planning Authorities can expect developers to provide the results of such assessments …as part of their application for sites where there is good reason to believe there are remains of archaeological importance'***. In addition paragraph 25 advises: '***Where planning authorities decide that the physical preservation in situ of archaeological remains is not justified in the circumstance of the case…it would be entirely reasonable for the planning authority to satisfy itself, before granting planning permission, that the developer has made appropriate and satisfactory provision for the excavating and recording of the remains. Such excavation and recording should be carried out before the development commences, working to a project brief prepared by the planning authority and taking advice from archaeological consultants'***.

4.3 REGIONAL POLICIES

4.3.1 Regional Planning Guidance Note 10

Regional Planning Guidance for the South West (RPG10) (September 2001) comprises the Regional Spatial Strategy for the South West and contains the Regional Transport Strategy. The overall vision (Policy VIS1) is, in essence, to promote sustainable development, and includes minimising the need to travel and to develop on Greenfield sites. There are four underlying aims for sustainable development within the vision:

- protection of the environment;
- prosperity for communities and the regional economy;
- progress in meeting society's needs and aspirations; and
- prudent use of resources.

RPG10 explains that in achieving the government's 'central economic objective', which is 'to achieve high and stable levels of growth and employment, whilst ensuring that

everyone can share the benefits of that economic growth and so deliver a better quality of life', it is necessary to take 'the long-term view' and look at 'ways in which economic growth can go hand in hand with ensuring a fairer society and protecting the environment to achieve sustainable growth and economic prosperity' (Paragraph 1.5).

Recognising the 'great diversity of the region in terms of planning, environmental, social, and economic issues', RPG10 identifies four sub regions, the proposals that are the subject of this ES are in the 'western sub region'. Policy SS1 identifies the need for strong policies and action to tackle long term and deep seated economic and social problems, which are particularly accentuated by its peripherality in relation to the SW region and the Country as a whole.

The strategy objectives for the western sub region, on which the planning of development and infrastructure investment should be based, identifies the best opportunities for sustainable development and priority of investment to the Principal Urban Areas (PUA). Further objectives are set out in Policy SS3. They are to:

- ***"alleviate remoteness through investment in transport infrastructure and other communications networks;***
- ***create the conditions for growth, regeneration and diversification in the sub-region by promoting economic development and environmental improvements and, in Cornwall and the Isles of Scilly, maximising the opportunities afforded by Objective 1 funding;***
- ***focus major new employment, social and cultural investment at Plymouth, Camborne and Redruth (where the area forms a significant potential area for growth and is a focus for regeneration), Barnstaple, St Austell, Newquay and Bodmin and maintain Truro's role as a sub-regional shopping and administrative centre;***
- ***encourage appropriate investment in tourism in accordance with Policy TCS1;***
- ***encourage appropriate housing, employment, retail and social facilities in sustainable locations to reduce social exclusion and rural need;***
- ***conserve and enhance the coastline, landscape, historic and industrial heritage of the sub-region and recognise them as major assets in the drive to encourage regeneration;***
- ***maintain and enhance the physical and cultural distinctiveness of Cornwall and Devon;***
- ***conserve and enhance important environmental assets.***

Many coastal areas, including several long established resorts, some ports and many rural areas have seen serious economic decline with the run down of traditional industries such as tourism, defence, agriculture and fishing. There is a need for regeneration schemes and partnerships in many of the coastal settlements.

Policy SS21 identifies that coastal towns in the region should be the focal points for development and service provision in the coastal areas and this role should be supported and enhanced. Where such towns are not already identified as either PUAs or other designated centres for growth, they may need to be identified in the spatial strategy as coastal market towns. Development in such towns should be small scale and take place primarily within or adjacent to existing settlements, avoiding scattered forms of development. Local authorities in their development plans should:

- ***locate development to support the coastal areas primarily in coastal market towns, identified and designated in development plans through a balanced mix***

of homes, jobs, services and facilities suitable to the scale and location of such settlements;

- ***adopt policies which support the restructuring of the coastal economies and the provision of jobs to satisfy local needs;***
- ***set out policies for supporting sustainable diversification schemes which help to maintain the viability of the fishing sector and coastal economic vitality;***
- ***seek ways of providing for essential shops and services to serve the coastal areas;***
- ***promote improved and integrated public transport, communications and service delivery and support innovative community based solutions to public transport and communications, in order to increase access to jobs, housing and facilities.***

RPG10 says a key objective is ***"to safeguard and enhance the quality and diversity of the natural, cultural and built environment across the region, giving the highest level of protection to designated areas and features of national and international importance"***. For advice on achieving such protection, RPG defers to PPG9 (now PPS9) (RPG10 Paragraph 4.3).

4.3.2 Draft Regional Spatial Strategy for the South West 2006 - 2026

A Draft Regional Spatial Strategy (dRSS) for the South West 2006 - 2026 was submitted to Government in June 2006, and an examination in public (EiP) has been held (July 2007). The EiP panel submitted its report to the Secretary of State in January 2008 and proposed changes were put forward for consultation in July 2008.

There are no proposed policies which refer specifically to Falmouth in the dRSS, EIP or response from the Secretary of State.

4.3.3 Regional Economic Strategy for South West England 2006 - 2015

The draft RSS has been developed in parallel with the Regional Economic Strategy (RES) produced by the South West Regional Development Agency (RDA). Improving Transport networks is seen as a key regional priority of RES. Connectivity particularly the reliability and resilience of access routes to major markets such as London and the South East, are consistently identified as an essential component to support a successful economy.

Several goals are set out in the delivery framework. Many of these delivery actions can be applied to the proposals and the Bristol area. The following are particularly relevant:

- Delivery Activity 1D.1 - Encourage and support regional businesses to trade Internationally.
- Delivery Activity 3A.1 – Enhance connectivity providing access to markets and tackling peripherally. Through supporting the region's main port, Bristol, to enable more sustainable distribution of freight and lobby for the region to be connected directly by rail to key infrastructure in London, particularly Heathrow and Crossrail.
- RES Proposed Activity supports appropriate development of the region's key seaports, including improvements to surface access.
- Delivery Activity 3B.2 – Build on existing strengths to develop the South West as the leading region for sustainable development.

- Delivery Activity 3C.1 Encourage an integrated approach to economic development.

4.4 LOCAL POLICIES

4.4.1 Cornwall Structure Plan, 2004

Under Policy 13 it is stated that 'Development should seek, in the first instance, to improve existing tourism and recreation sites and infrastructure in sustainable locations, [it] seeks to reflect the overarching aim of improving the quality of tourism development. The emphasis is, therefore, on improving and adapting much of what we already have to meet changing circumstances and modern requirements before making new provision, particularly in rural areas.'

Under Policy 18 Falmouth-Penryn it is stated that 'Development should support and sustain the prosperity of the maritime, industrial and tourist economy while protecting important aspects of the marine environment. It should also accommodate and capitalise on deep water facilities as a port.'

Under Policy 27 it is recognised that 'The County's Strategic Transport Network underpins the majority of travel and includes the Strategic Public Transport Network (SPTN), Strategic Road Network and the major ports. The transport approach to support the spatial strategy includes improvements at key ports to improve links beyond the County.' Strategic Transport Proposals include 'Improvements at Falmouth Port' with an anticipated completion date of 2011.

4.4.2 Carrick Local Plan/Local Development Framework

The Carrick Local Plan (CLP) was adopted in April 1998. The CLP (1998) makes reference to the limited control over development that the District Planning Authority (DPA) have due to the Falmouth Docks and Harbour Acts. Although the DPA have control over forms of development other than port and dock related activities, the CLP emphasises that 'encouragement and support in principle be given to development wholly within the docks site for port related uses'.

The CLP is currently being reviewed and will be replaced by a Local Development Framework (LDF). A draft Core Strategy Development Plan (CSDP), which is the cornerstone of the LDF, was submitted to the Secretary of State in October 2006 and is available online.

The CSDP references development of the docks and harbour area under economic policy FP2:

- 'Develop Falmouth's role as a maritime centre and the retention of the docks for marine/industrial related uses and continued development as a centre for marine industry';
- 'Protect marine leisure and employment sites and so support the development which enhances their maritime role, whilst ensuring the character of the estuary is protected';
- 'Promoted the role of the Port of Falmouth as an International destination for cruise liners'; and
- 'Protect and enhance the biodiversity of the Fal Estuary and in particular ensure that development has no adverse impact upon the Fal/Helford Special Area of Conservation'.

A number of other Local Plan Policies should be considered during the proposed development of Falmouth Cruise Terminal which are summarised in Table 4-1. These saved policies will be carried forward to inform the LDF.

Table 4-1 Carrick Local Plan Saved Policies which apply to Falmouth

Policy Name and Number	Description
3A Protection of Countryside	Seeks to protect the countryside for its own sake and the character and setting of settlements from inappropriate development.
3D Character and Setting of Settlements	Seeks to preserve and enhance Areas of Outstanding Natural Beauty from inappropriate development.
3F Trees and hedgerows	Seeks to incorporate new tree planting and the retention and incorporation of important existing trees, hedgerows and Cornish hedges within development proposals.
3H Regionally and locally important nature conservation sites	Protects Regionally Important Geological/Geomorphological Sites, Areas of Great Scientific Value and Local Nature Reserves from the direct and indirect impact of development proposals.
3HH Wildlife Corridors	Protects the integrity of wildlife corridors from inappropriate development.
3J Local Habitats	Seeks to avoid damage to locally important habitats.
4D Setting of Listed Buildings	Provides guidance for development proposals affecting the setting of listed buildings.
4F Character of Conservation Area	Provides guidance for development and demolition proposals in Conservation Areas.
40 Development in AONB	Seeks to promote high standards of design and layout within Areas of Outstanding Natural Beauty, Areas of Great Landscape Value and the Heritage Coast.
4S Protection of Archaeology	Seeks to protect nationally important archaeological remains from inappropriate development proposals.
4T Retention of archaeological remains	Seeks to protect sites of local archaeological importance from damage and ensures that adequate archaeological records are prepared if their retention is not justified.
4U Interpretation of archaeology	Promotes proposals which encourage and develop the cultural, recreational, educational and tourist potential of archaeological and historic sites and monuments.
5A Major Highway Schemes	Protects programmed major highway schemes from inappropriate development proposals.
5K Impact on 'opes' in Falmouth	Protects 'Opes' and walkways from conflicting development proposals and seeks to improve to the Falmouth and Penryn waterfronts.
6C Housing provision in Falmouth and Penryn	Identifies settlements within the Falmouth/Penryn sub area where there is a presumption in favour of residential development, redevelopment or conversion proposals subject to certain criteria.
6CB Housing provision	Provides guidance for small-scale residential development within the built up areas of Falmouth and Penryn.
8EE Waterside Industrial Uses	Seeks to protect against the loss of identified waterside industrial uses.

Policy Name and Number	Description
10L Marina Development in Falmouth/Penryn	Provides guidance for marina-type developments in Falmouth and Penryn.
10W Leisure development adjacent ships and castles, Falmouth	Provides guidance for the development of a recreation/leisure or tourist facility on land adjoining the Ships & Castles centre, Falmouth.
13K General Infrastructure	Seeks to ensure that adequate local infrastructure is in place before development is commenced.
13L Transport	Seeks to resist development within or adjoining settlement boundaries which is not fully accessible by public transport, pedestrians and cyclists or which creates an unacceptable impact upon the overall highway network.

5 HYDRODYNAMIC AND SEDIMENT REGIME

5.1 INTRODUCTION

This chapter describes the studies undertaken to assess potential changes to the hydrodynamic and sediment regime of Falmouth Harbour, the Fal Estuary and Falmouth Bay arising from the proposed Falmouth Cruise Project. It draws its information from the Falmouth Cruise Terminal Hydrodynamic and Sedimentary Studies Technical Report by HR Wallingford (see Appendix A).

5.2 ASSESSMENT METHODOLOGY

5.2.1 Study Area

The study area covers the lower Fal Estuary and Falmouth Bay, as shown in Figures 5-1 and 5-2. In essence, the study area covers the geographical extent to which hydrodynamic and sedimentary regime changes could be affected by the proposed project.

5.2.2 Baseline Data Collection

Data were collected for bathymetry, tides and water levels, currents, waves, seabed sediment types and suspended sediment concentrations (see Section 2, Appendix A).

5.2.3 Surveys

Data from previous surveys were also collated to inform the EIA process (see Section 2, Appendix A).

5.2.4 Assessment Technique

The following computational (numerical) models have been used to predict the changes in hydrodynamic and sediment conditions due to the proposed Falmouth Cruise Project:

- Simulating Waves Nearshore (SWAN) for waves(see Section 3 in Appendix A);
- TELEMAC-2D for flows(see Section 4 in Appendix A);
- SUBIEF-2D for mud transport(see Section 5 in Appendix A);
- SANDFLOW for sand transport(see Section 6 in Appendix A); and
- SEDPLUME for dredging induced sediment dispersion and deposition (see Section 7 in Appendix A).

5.2.5 Assessment of Impact Significance

The chapter defines predicted ***changes*** to the physical regime of the estuary (e.g. flow regime, sediment transport, etc**.**) and does not assess such changes – which in themselves do not necessarily represent impacts - in terms of their impact significance in the way that is described in Section 1.4.3 and used in subsequent chapters.

The approach adopted in this chapter is to describe and, where possible, quantify the predicted changes to the hydrodynamic and sedimentary regime in order to inform the subsequent chapters which consider other environmental parameters (e.g. water quality, marine ecology, fisheries, etc.) where any impacts due to changes in the hydrodynamic

and sedimentary regime would be realised. Accordingly, no mitigation measures are recommended and no residual impacts are identified.

5.3 BASELINE ENVIRONMENTAL CONDITIONS

5.3.1 Morphology

The Fal Estuary is located on the south coast of Cornwall, where it extends 18km inland from its entrance between Pendennis Point and St Anthony Head to the tidal limit at Tresillian. It is reputedly the world's third largest natural harbour and with a total shoreline length of 127km, is the county's largest estuary. As such, it is extremely important in terms of industry, tourism and conservation. The total area of the estuary is some 2482ha. This includes a 1736ha subtidal area, 653ha intertidal mudflats and 93ha saltmarsh.

The Fal Estuary is a drowned river valley or ria. Its main channel dates back to the last Ice Age when sea levels were considerably lower than the present day. The estuary may be divided into two main sections: the inner tidal tributaries and the outer tidal basin. This outer basin is known as Carrick Roads and this makes up over 80% of the main body of the estuary.

Thick, alternating sandstone and mudstone sequences of Middle and Upper Devonian age are present in Falmouth Bay. These originated in a deep water basin to the south and were transported northwards in the last Devonian period within thick thrust sheets (nappes), onto shallow shelf deposits. At Falmouth, they rest upon younger, Upper Devonian mudstones and siltstones, which are visible along the western side of Carrick Roads. The estuary is heavily influenced by the Carnmellis granite and surrounding metamorphic aureole to the west of the estuary.

Carrick Roads is characterised by a deep meandering channel with depths up to 34m at the seaward end. The channel narrows and becomes shallower as it moves inland. Broad, shallow platforms flank both sides of the main channel. The northern part of the estuary comprises six main tributaries and 28 minor creeks and rivers, all of which eventually discharge into Carrick Roads. Significant sediment deposition and anthropogenic activity (including discharge of mining waste) have caused many of the creeks to silt up.

5.3.2 Bathymetry

Bathymetry has been derived from Admiralty Chart data and survey data. The bathymetry of Fal Estuary and Falmouth Bay is shown in Figures 5-1 and 5-2.

Figure 5-1 Computational Model Bathymetry – Local Study Area

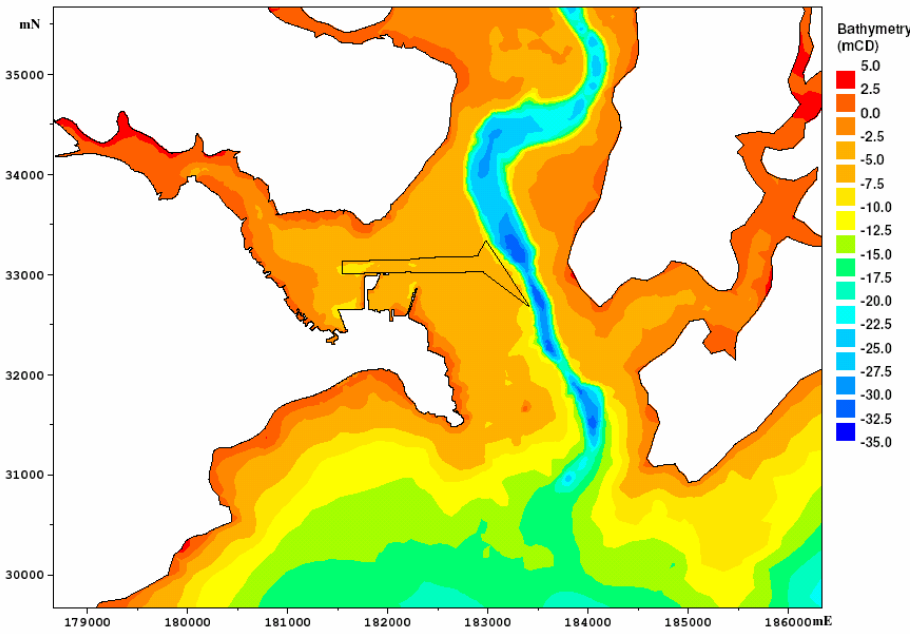
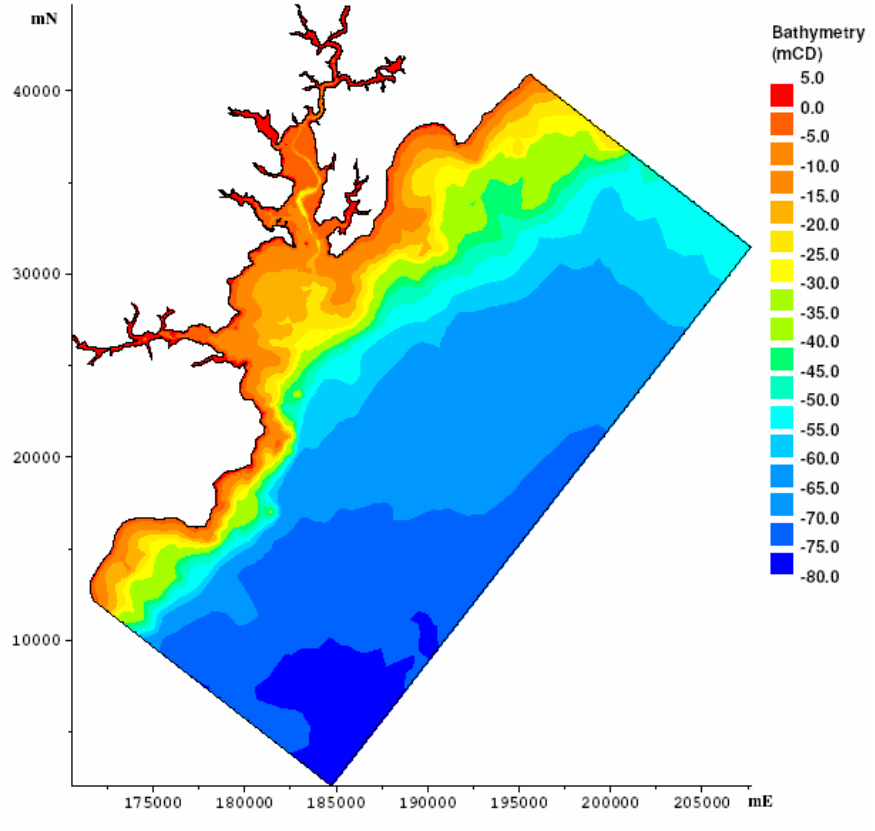


Figure 5-2 Computational Model Bathymetry Wider Study Area



5.3.3 Hydrodynamics

Tides and Water Levels

The estuary is macrotidal with a mean spring tidal range of 4.6m and a mean neap tidal range of 2.2m. High water for mean spring tides is 2.49m above Ordnance Datum (Newlyn). The estuary becomes mesotidal at Truro, which has a mean spring tide of 3.5m. The tide is semi-diurnal in character. The tidal parameters for Falmouth are presented in Table 5-1 below. The values are quoted to Chart Datum, which is 2.91m below Ordnance Datum (Newlyn).

Table 5-1 Tidal Levels for Falmouth (source: UKHO, 2008)

Description	Level (m CD)
Highest astronomical tide	5.8
Mean high water spring tide	5.4
Mean high water neap tide	4.3
Mean sea level	3.2
Mean low water neap tide	2.1
Mean low water spring tide	0.8
Lowest astronomical tide	0.0

Tidal Currents

Peak spring tidal currents in the vicinity of the proposed cruise terminal are 0.8ms^{-1}, whilst peak neap tidal currents are 0.2ms^{-1}. Tides at this location are flood dominant and the flow patterns are largely rectilinear. Figures 5-3 and 5-4 show the current patterns. The figures show that peak spring tidal currents on both flood and ebb tides occur adjacent to Pendennis Point, where the flows are constricted between headlands. The flow in and out of Falmouth harbour entrance is complicated by a series of eddies during both the flood and ebb tides as the flow in and out of the inner harbour interacts with that in and out of Carrick Roads.

Figure 5-3 Existing Peak Flood Tidal Flows – Spring Tide

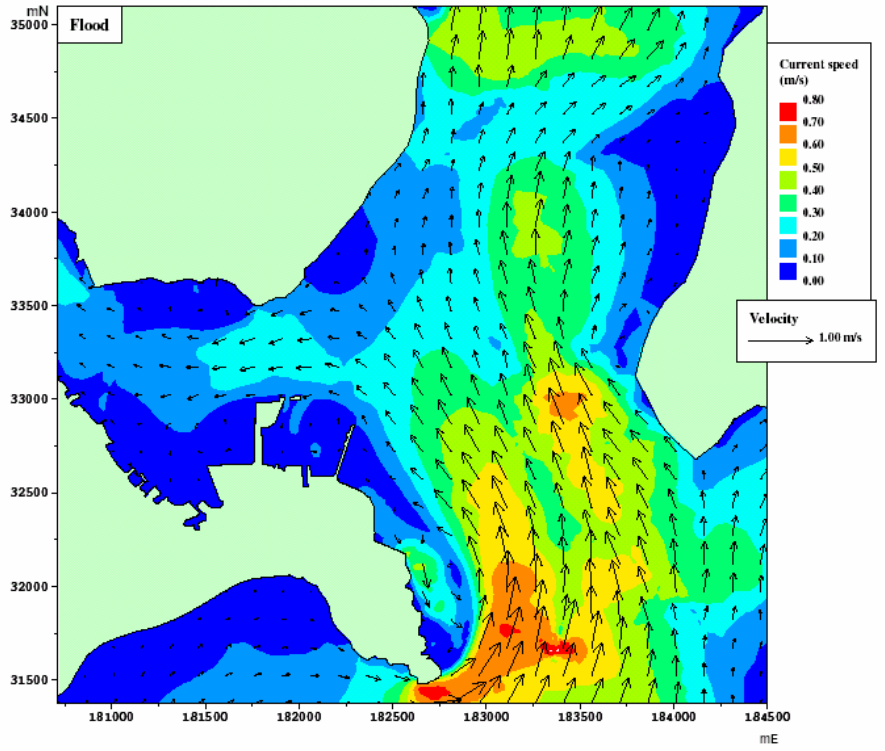
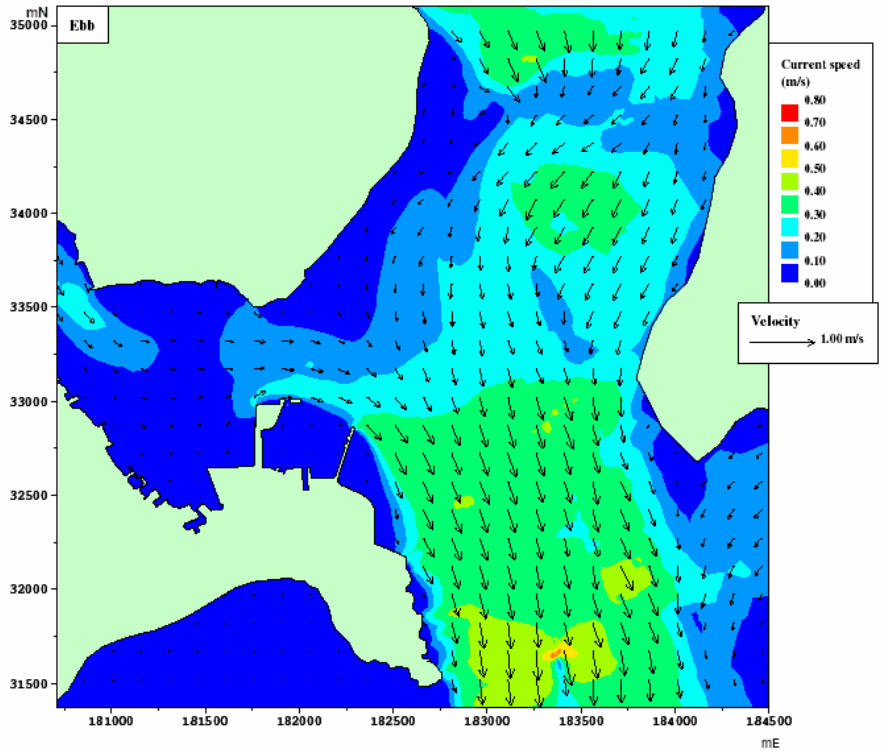


Figure 5-4 Existing Peak Ebb Tidal Flows – Spring Tide



Fluvial Flows

The mean gauged discharge of the Fal Estuary (measured at Tregony) is $2m^3s^{-1}$ (NRFA, 2008). The highest daily mean flow recorded is $48.2m^3s^{-1}$. Fluvial flows may be modified due to industrial abstractions and returns.

Waves

Wave conditions around Falmouth are a combination of offshore swell and locally generated wind-waves. The wave modelling required data to evaluate both of these. Extreme wind conditions have been derived from measured winds at Culdrose from 1978 to 1997. They are presented Table 3.1 in Appendix A. The most common and largest observed winds are in the sectors 225^o to 285^o, accounting for 47% of the observed wind data.

The offshore wave climate in the approaches to Falmouth was assessed using time series from the Met Office's European wave model, spanning from 1986 to 2006, as shown in Table 3.3 in Appendix A. The distribution of the offshore wave climate is, as might be expected at this location similar to that for the winds with the most common waves in the sectors 255^o – 285^o (63%). Most of the largest waves are also shown in those sectors.

5.3.4 Seabed Sediments

Information on the types of bed material used for modelling came from the 1985 survey, which included approximately 40 bed grabs with visual identification, summarised in Figure 5-5. For ten of these bed samples a particle size distribution was undertaken. The data shows for the analysed samples the % less than 63µm and the median grain size D_{50}. The full grain size distribution for these samples is shown in HR Wallingford (1985). Mud distribution is shown in Figure 5-6.

A feature of the bed sediments at St Mawes Bank, adjacent to Falmouth Docks, is a large maerl bed consisting of live and dead coralline algae. Deposits of dead plants throughout Carrick Roads indicate that maerl formerly covered a much wider area. The distribution of maerl is thought to be governed by water movement and turbidity. Until recently, up to 30,000 tonnes of maerl were extracted each year and sold as a soil improver.

Figure 5-5 Seabed Sediment Types

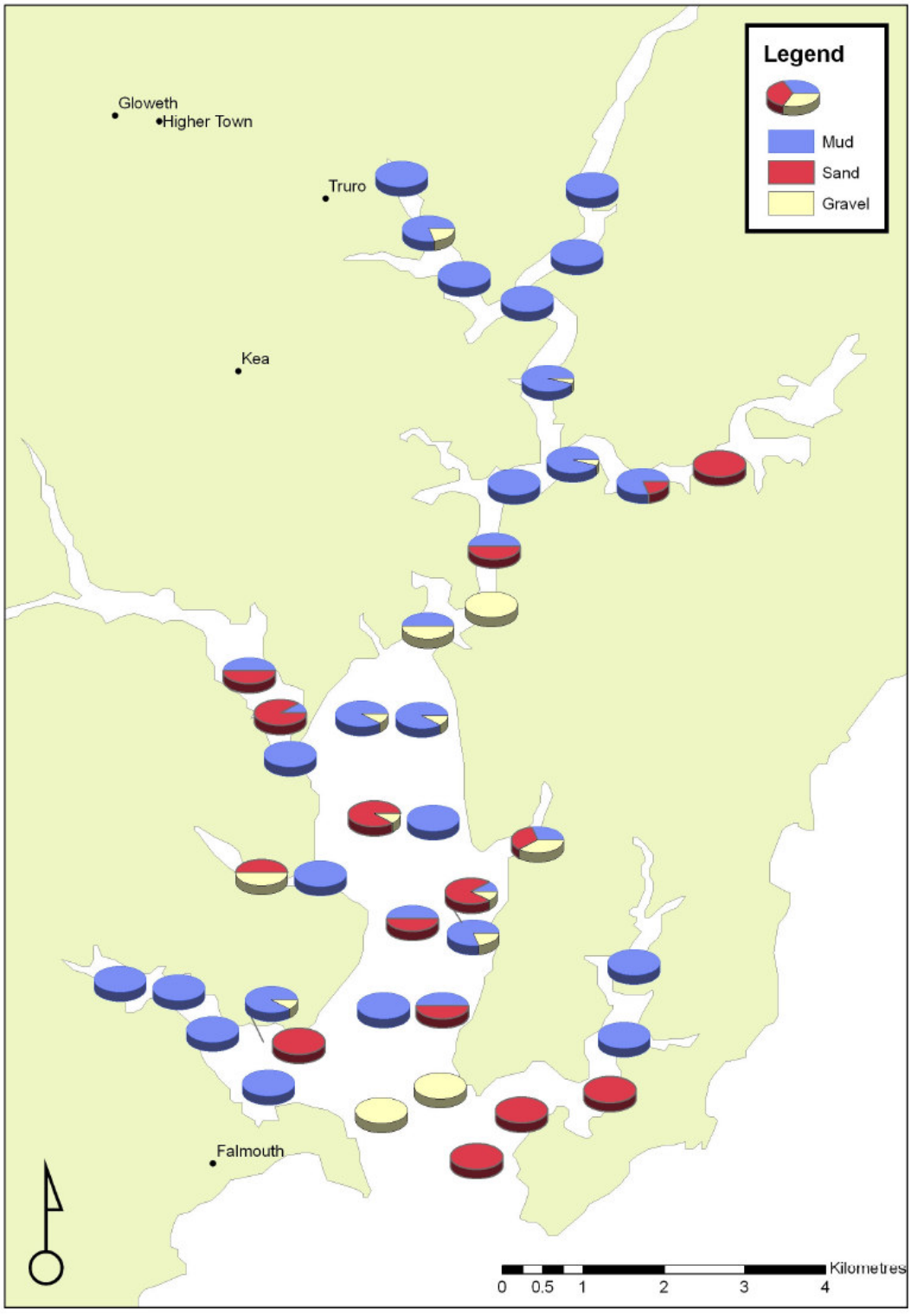
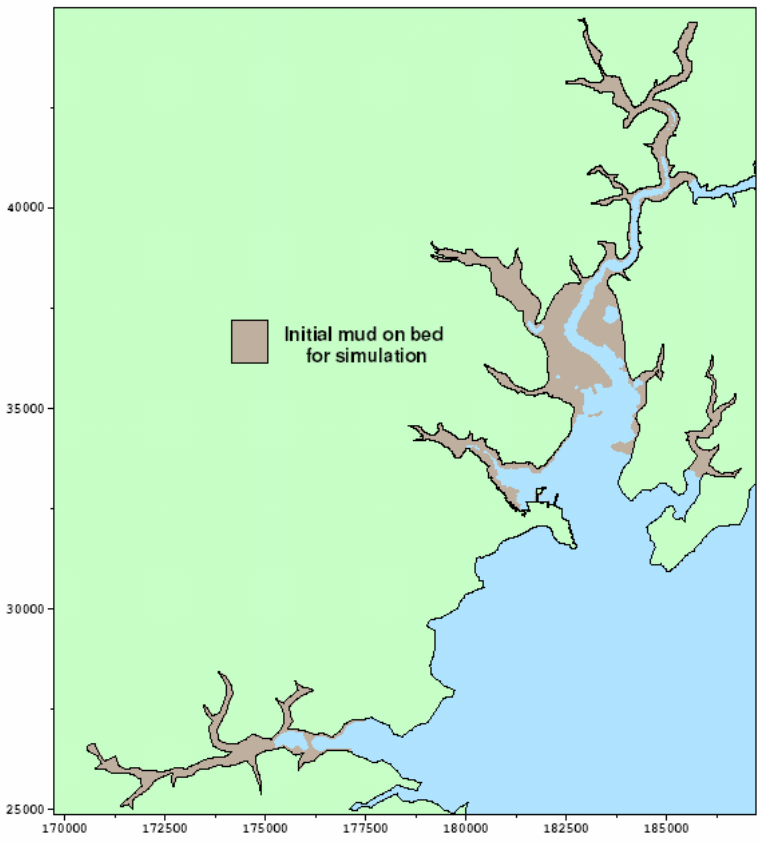


Figure 5-6 Existing Distribution of Mud

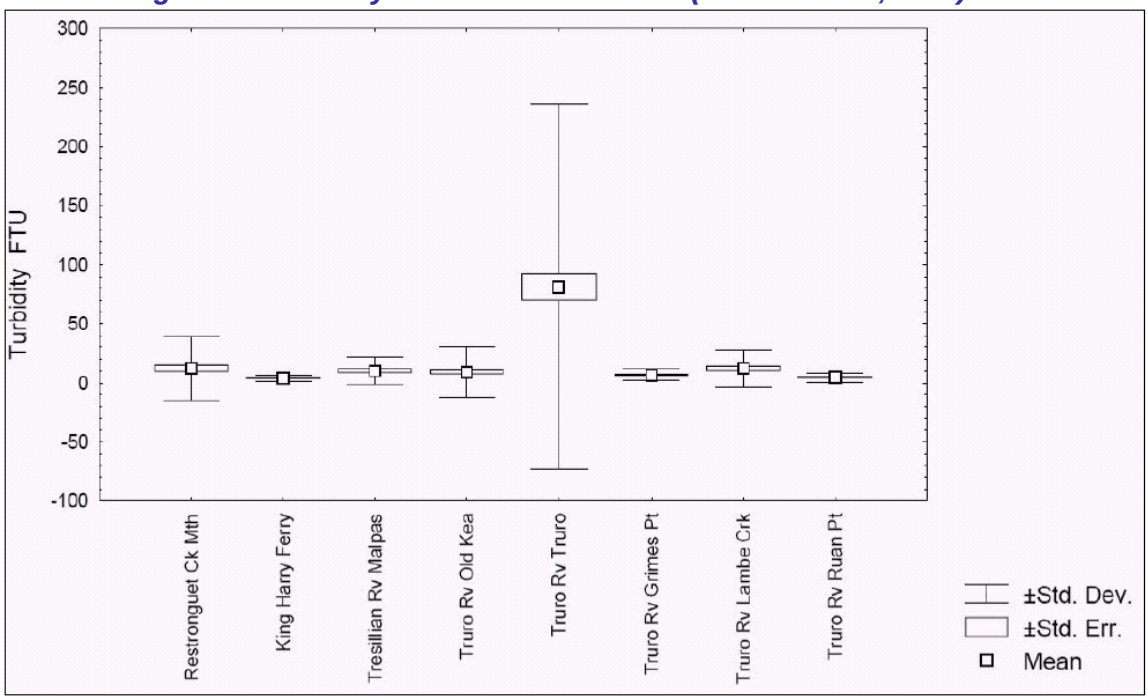


5.3.5 Suspended Sediment Concentrations

The water sampling undertaken during the 1985 survey found very low average suspended sediment concentrations (<10mg/l) at all the anchored vessel stations. One or two of the samples showed near bed concentration of up to 100mg/l but these were very much outliers compared to the majority of the readings. Water sampling in the Truro and Tresillian Rivers undertaken by HR in 1988 showed similar average concentrations of about 10mg/l for neap tides and 20mg/l for spring tides. The spring tide measurements had significant peak concentrations around low water on spring tides of 100-400mg/l, related to sediment resuspended from intertidal areas by wind waves being confined to a narrow low water channel in addition to any input from the treatment works.

These observations were in line with EA water sampling summary presented in PMSP (2003) shown as Figure 5-7. These observations presented in turbidity units FTU showed very low values in the southern half of the Fal (1-3FTU), increased levels in the upper half of the Fal and in the various creeks (4-12 FTU) and a peak at Truro (mean 81FTU). This peak was thought to be influenced by discharges from a nearby sewage treatment works.

Figure 5-7 Summary of Observed Turbidities (source: PMSP, 2003)



5.4 CHANGES DURING THE CONSTRUCTION PHASE

5.4.1 Change to Suspended Sediment Concentrations during Capital Dredging

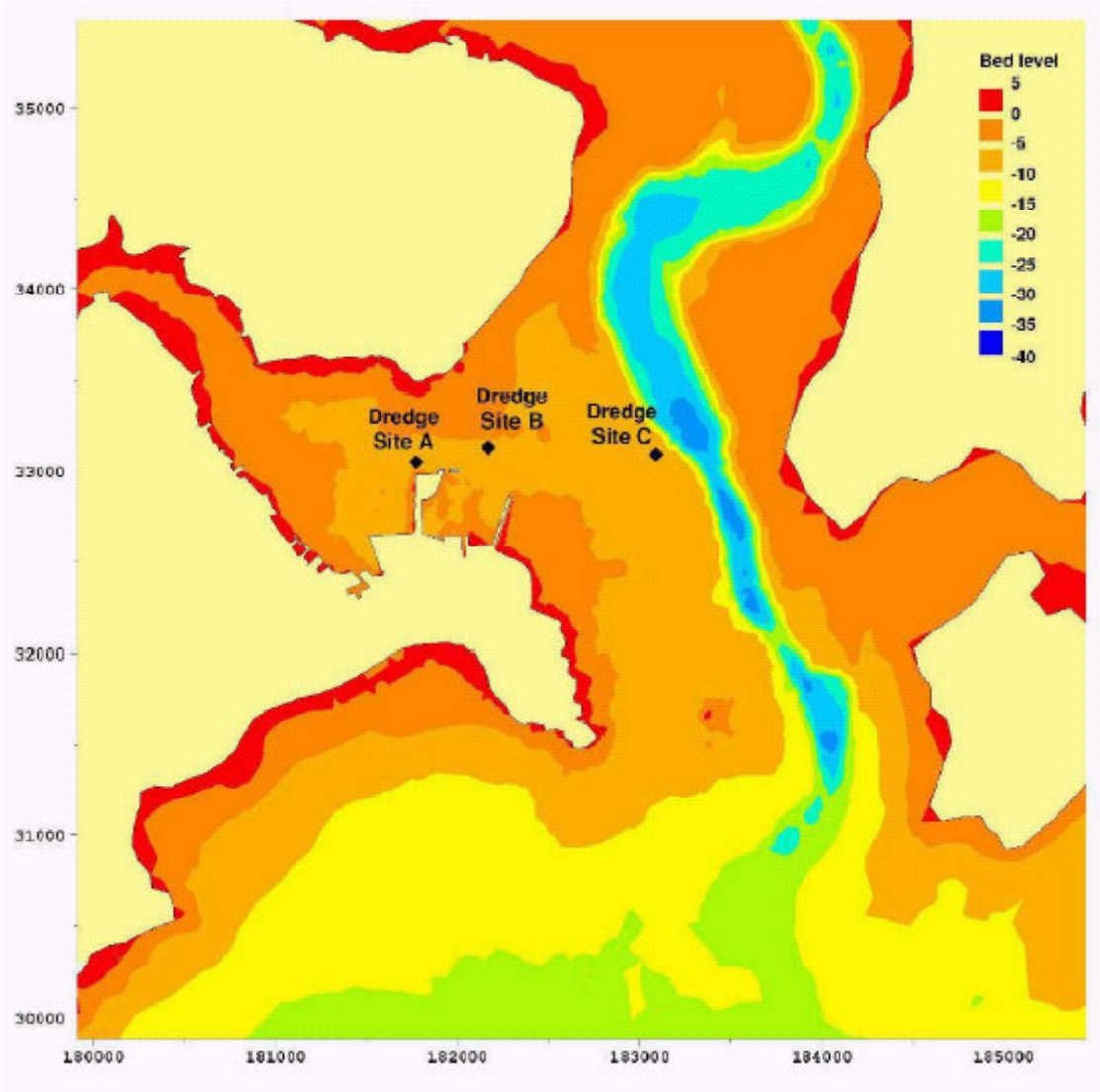
For the simulations run, the backhoe dredger used to dredge the potentially contaminated material had a 2.5m^3 bucket. For the other sites, dredging clean material a backhoe dredger with a 5m^3 bucket was used. During its operation it was assumed that the dredger would work continuously. If these activities were undertaken over a typical working week of 130 hours the rate of removal of material would be of the order of 20,000m^3 dredged per week.

The action of the backhoe dredger in digging into the sea bed then lifting its bucket full of sediment and water to the surface before placing it into a barge releases sediment in proportion to the rate of activity. For this type of plant loss rates are typically of the order of 17kg sediment released for each m^3 dredged. This amount of loss could be reduced by the use of various mechanical means (e.g. a visor) but for the purpose of assessment a precautionary view was taken with the backhoe bucket unconfined giving a largest likely loss rate. The loss rate of sediment to the water column of used for the simulation was 1kg/s for the 2.5m^3 bucket and 2kg/s for the 5m^3 bucket, released continuously. These values are a reasonable worst case for the materials expected to be dredged since they assume the materials to be dredged are mostly clay and silt and some layers of clay, which are known to be present.

In the numerical model, the released material was distributed evenly throughout the water column and the simulation was run for four tides, tracking the sediment plume and amount deposited on the bed. Simulations were undertaken for spring and neap tides: the spring tides transport the concentrations further whereas the neaps tend to result in higher rates of deposition in the immediate area of the release point.

Following consultation with Natural England, three locations for dredging were simulated covering the whole length of the dredge. Figure 5-8 shows the release locations.

Figure 5-8 Locations of Dredging Simulated by Numerical Modelling



Figures 5-9 to 5-14 show some of the results of the plume runs for spring tide conditions due to dredging at sites A, B and C, showing the predicted changes to total suspended solids (TSS) concentrations in milligrams per litre (mg/l) and changes to sediment deposition depths in millimetres (mm)..

Figures 5-9, 5-11 and 5-13 show a general confinement of suspended sediment concentrations associated with the plume to the western side of Falmouth Harbour with even the plume from the easternmost release point keeping to the western side of the deep water channel in Carrick Roads. The plumes from the release points further west are confined between Falmouth's inner harbour area and the western side of the harbour entrance.

Figure 5-9 Peak Suspended Solids Concentration from Dredging at Site A on a Spring Tide

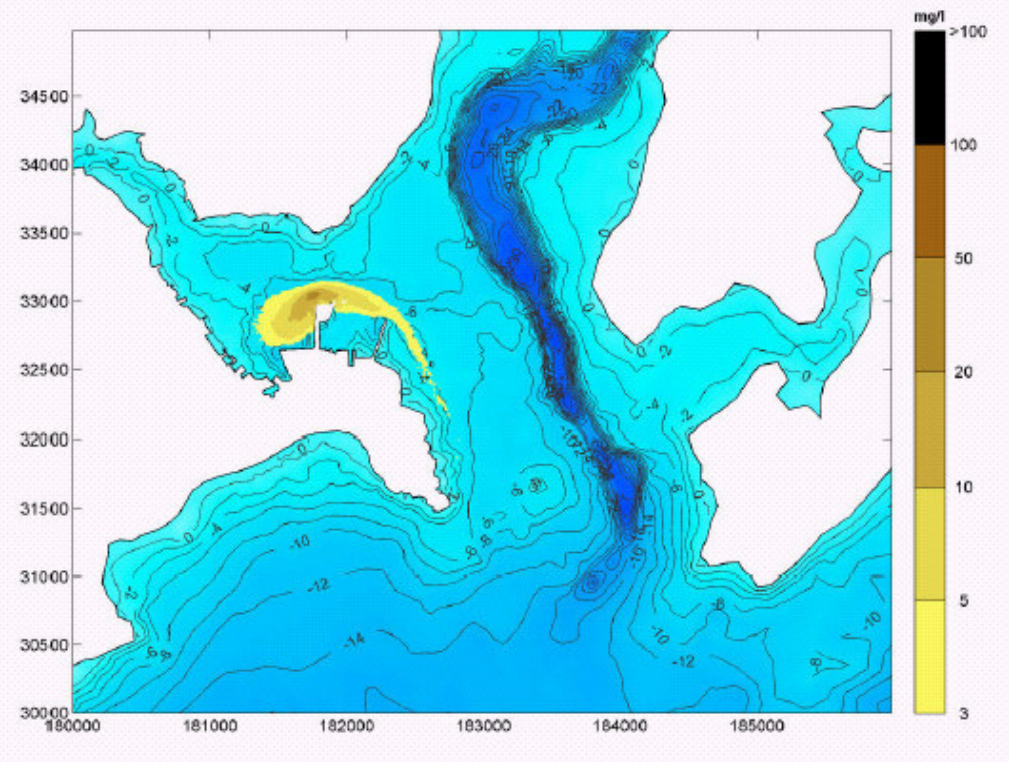


Figure 5-10 Peak Sediment Deposition from Dredging at Site A on a Spring Tide

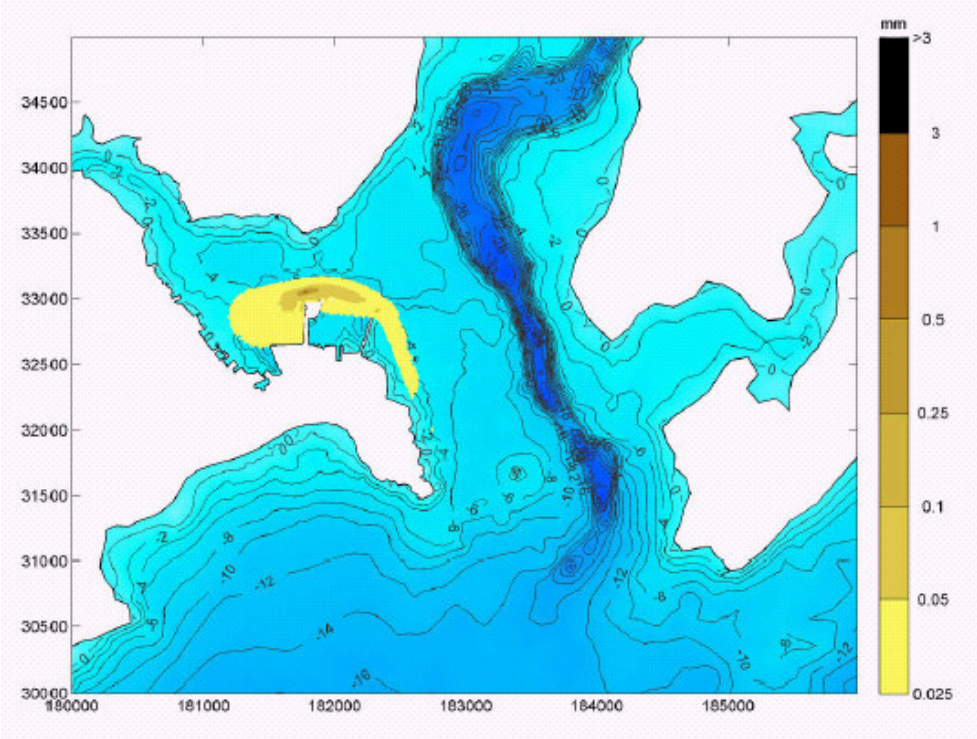


Figure 5-11 Peak Suspended Solids Concentration from Dredging at Site B on a Spring Tide

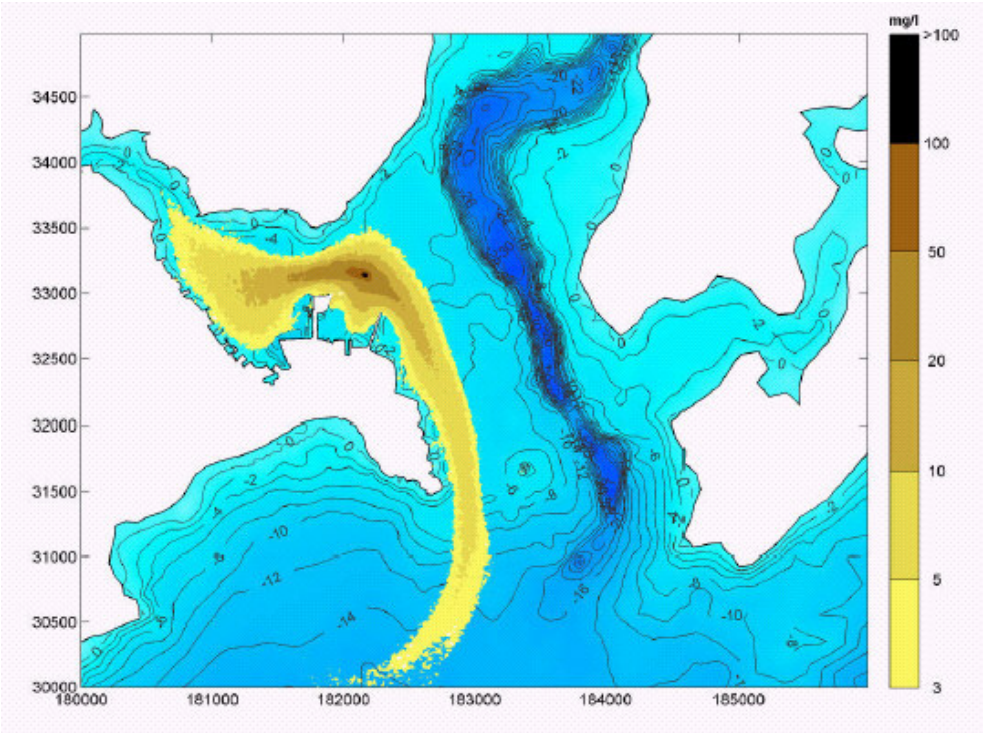


Figure 5-12 Peak Sediment Deposition from Dredging at Site B on a Spring Tide

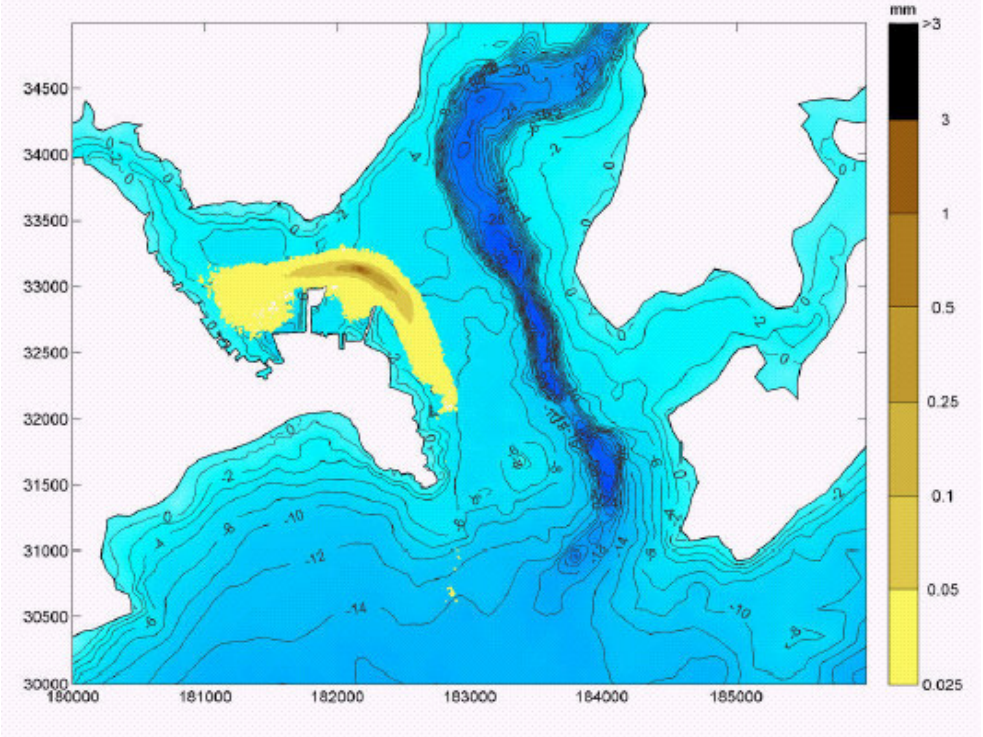


Figure 5-13 Peak Suspended Solids Concentration from Dredging at Site C on a Spring Tide

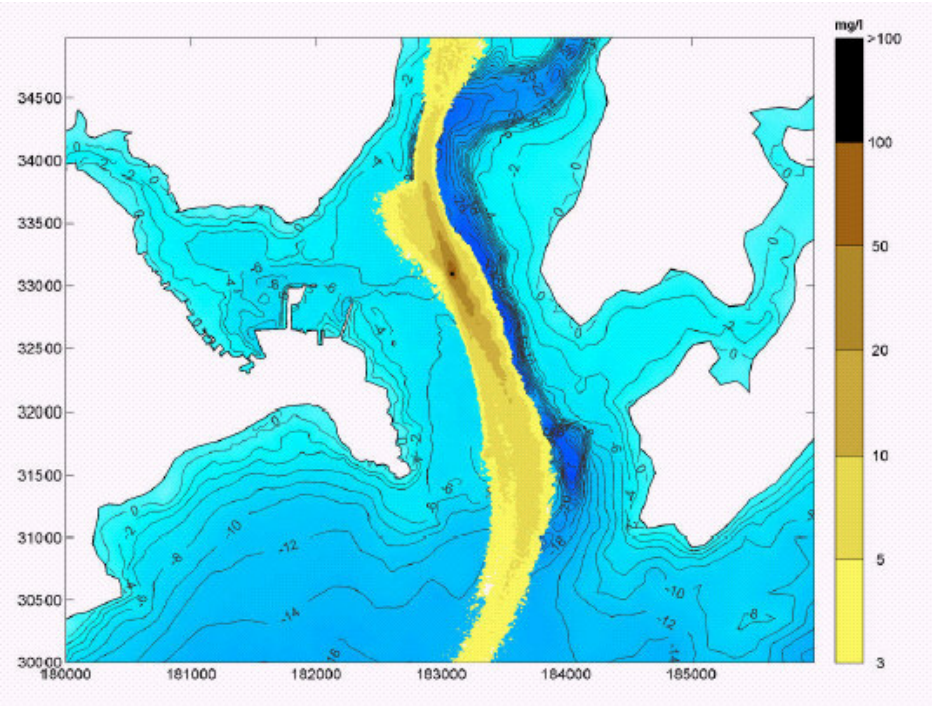
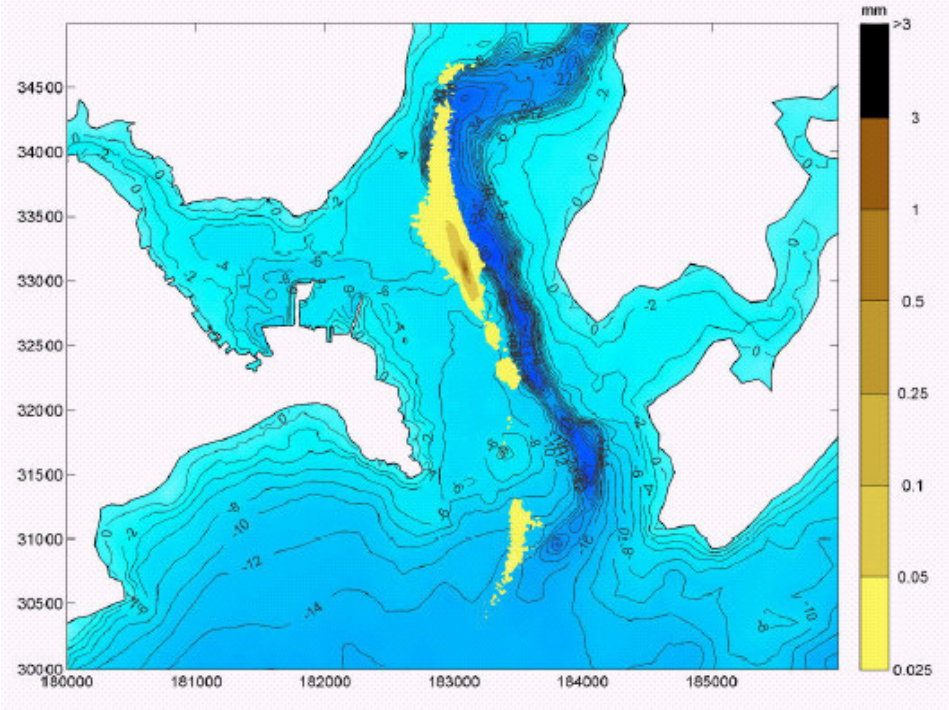


Figure 5-14 Peak Sediment Deposition from Dredging at Site C on a Spring Tide



The low release rates from the backhoe results in very low excess concentrations away from the immediate area of the dredger. Near the dredger, peak concentrations of up to 20mg/l are shown. These concentrations would be in excess of the naturally occurring levels of 5-10mg/l observed in the area (HR Wallingford, 1985). Whilst without longer-term data in Falmouth inner harbour it is difficult to know if these concentrations occur in

the system naturally (e.g. during storm events), they are comparable to turbidity observations made by the Environment Agency elsewhere in the system (e.g. Restronguet Creek, as shown in Figure 61 of PMSP, 2003).

Overall, there is predicted to be a minor change to TSS concentrations (50mg/l) around the dredger and a negligible change with increasing distance from the dredger (3-5mg//l). This change will be temporary (i.e. it will only occur during the dredge) and reversible (i.e. it will generally return to baseline conditions after the dredge).

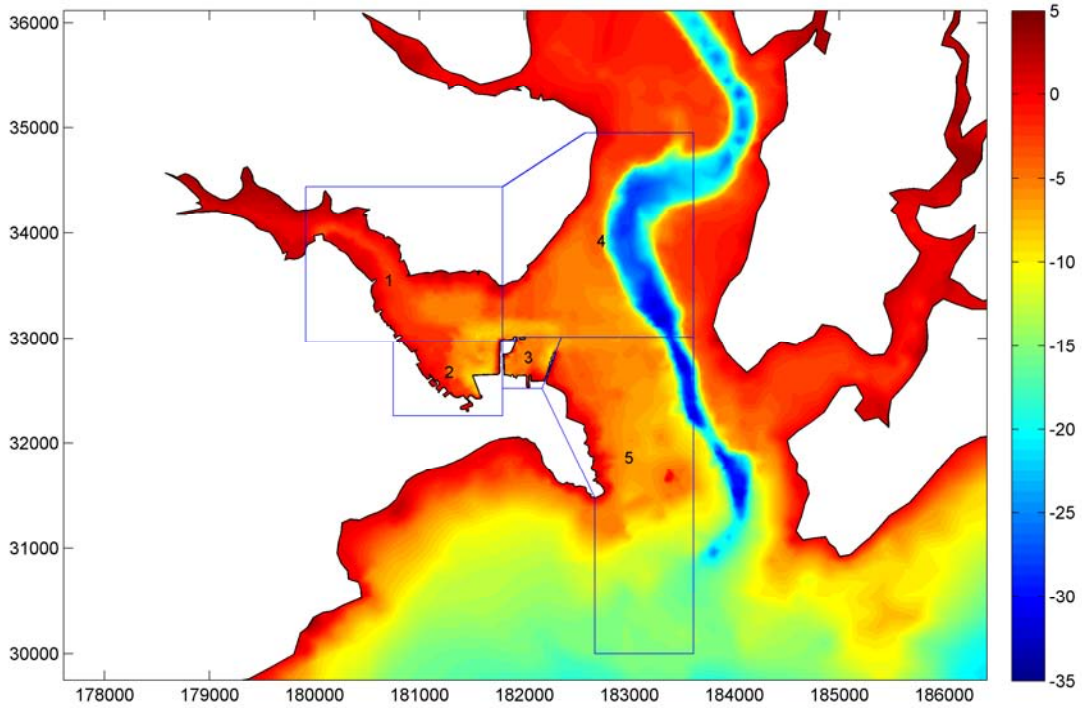
5.4.2 Change to Sediment Deposition due to Capital Dredging

The numerical modelling results described in Section 5.4.1 predicts the short-term effects of the capital dredging as those are the times when excess suspended sediment concentrations would be expected to be at their largest. Direct, detailed modelling of the whole dredge is not practicable because it is expected to take about six months and other meteorological effects would be expected to change the detail of the distribution. However, an overall estimate of the total amount of sediment depositing in various areas can be made from the short-term sediment plume simulations.

As for suspended sediment, Figures 5-10, 5-12 and 5-14 show a general confinement of sediment deposition associated with the plume to the western side of Falmouth Harbour with even the plume from the easternmost release point keeping to the western side of the deep water channel in Carrick Roads. The deposition from the release points further west are confined between Falmouth's inner harbour area and the western side of the harbour entrance.

In addition, number of areas were defined (see Figure 5-15) and the proportion of the total material released depositing in them was calculated for each of the dredging simulations undertaken (i.e. three locations for spring and neap tides). From these proportions, an estimate of the total supply of material released by the dredging to these areas was made.

Figure 5-15 Deposition Areas



To take a reasonable worst case for the release of fines due to the whole dredge an assumption can be made that all the volume identified as containing fine sediments (clay and mud) mostly comprise fine material. The assumption gives a total volume of fine material to be dredged of 365,000m^3. Using the assumed loss rate of 17kg per m^3 dredged gives an estimate of the total mass of material lost during the whole dredge of 6,200 tonnes.

If the total volume dredged is assumed to be undertaken equally during spring and neap tides, then a total mass deposited in each area shown on Figure 5-15 can be calculated using the proportions calculated from the modelling simulations of sediment plumes. This total mass can then be converted into an average accretion using the surface area of each area shown on Figure 5-15 and a typical density of deposited fine material of 500kg/m^3, to give the depths identified in Table 5-2.

Table 5-2 Calculation of Average Deposition due to Capital Dredging

Area	Total Mass Deposited (kg)	Total Volume Deposited (m^3 at 500kg/m^3)	Area (m^2)	Average Depth of Deposition (mm)
1	292,000	600	1,101,000	0.5
2	195,000	400	329,000	1.2
3	106,000	200	162,000	1.3
4	2,160,000	4,300	2,488,000	1.7
5	1,633,000	3,300	2,909,000	1.1

The average deposition rates identified in Table 5.2 are very small, especially considering the duration of the dredge. These deposition rates are unlikely to change

the nature of the bed in the areas studied, although the presence of finer factions of sediment may be detectable in particular areas. The use of average depths of accretion is a useful parameter to understand the overall supply of fine material into a particular area, however, it should be noted that these are average values calculated for a typical density of deposited material. Both the density and distribution of sediment will be liable to vary in a particular area due to the details of the area, for example, small-scale bed features or particular quiescent areas.

Overall, there is predicted to be a minor (1.7mm) to negligible (0.5mm) change to sediment deposition due to capital dredging. This change will be temporary (i.e. it will only occur during the dredge) and reversible (i.e. it will generally return to baseline conditions after the dredge).

5.4.3 Change to Suspended Sediment Concentrations due to Disposal of Clean Dredged Material at Sea

To simulate the dispersion of material from the disposal operation undertaken at the existing licensed disposal site SEDPLUME was again applied. The site is located just outside the Falmouth Harbour limit, approximately 5.5 km from the dredging areas, in over 50 m of water.

Over the last 21 years a total of 231,250 tonnes of dredged material have been placed at this site from both capital and maintenance projects. In no year did the total amount deposited exceed 50,000 tonnes. This weight would equate to a volume of around 28,000m^3, if converted at 1.8 tonnes/m^3. One benefit of a backhoe dredger is the minimised the rate of sediment input to the disposal site.

The simulation assumed the use of 1000m^3 capacity self-propelled barges, making a placement every two hours during a spring - neap cycle. This rate of disposal is considered precautionary: typically a placement every 3 – 5 hours is more likely. In general, for disposal in deep water the disposed material falls very rapidly though the water column entraining water as it goes. This results in nearly all of the sediment reaching the bed before pan-caking out radially. For the numerical simulations, two runs were undertaken: firstly to simulate the effect of the five per cent of material lost to suspension during the decent of the disposed material, and secondly to simulate the fate of the 95 per cent material which gets to the bed.

Figure 5-16 shows a series of snap shots of the depth averaged TSS concentrations at times throughout the simulations. The simulation at day 1 shows the plumes associated with each placement. As time proceeds and the plume become dispersed, some of them become integrated into larger more diffuse parts. The larger amount of material released at the bed shows some dispersion of sediment towards the southeast, although much of the dispersion is along a southwest – northeast axis. Simulated TSS concentrations of up to 10mg/l are shown with some spots greater of up to 20mg/l in the immediate area of the disposal site.

Figure 5-16 Snap Shots of TSS Concentration for Material Released at the Seabed during Disposal

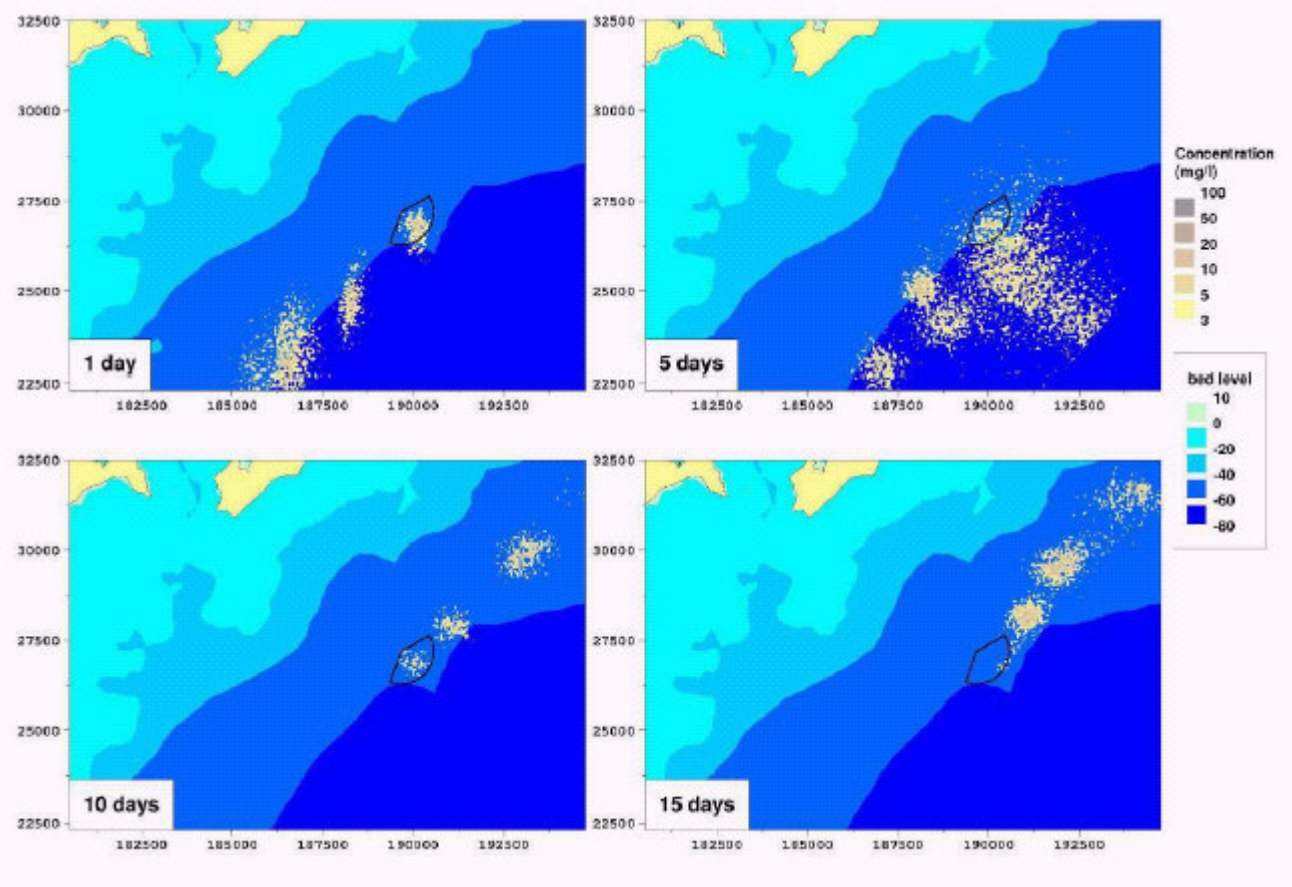
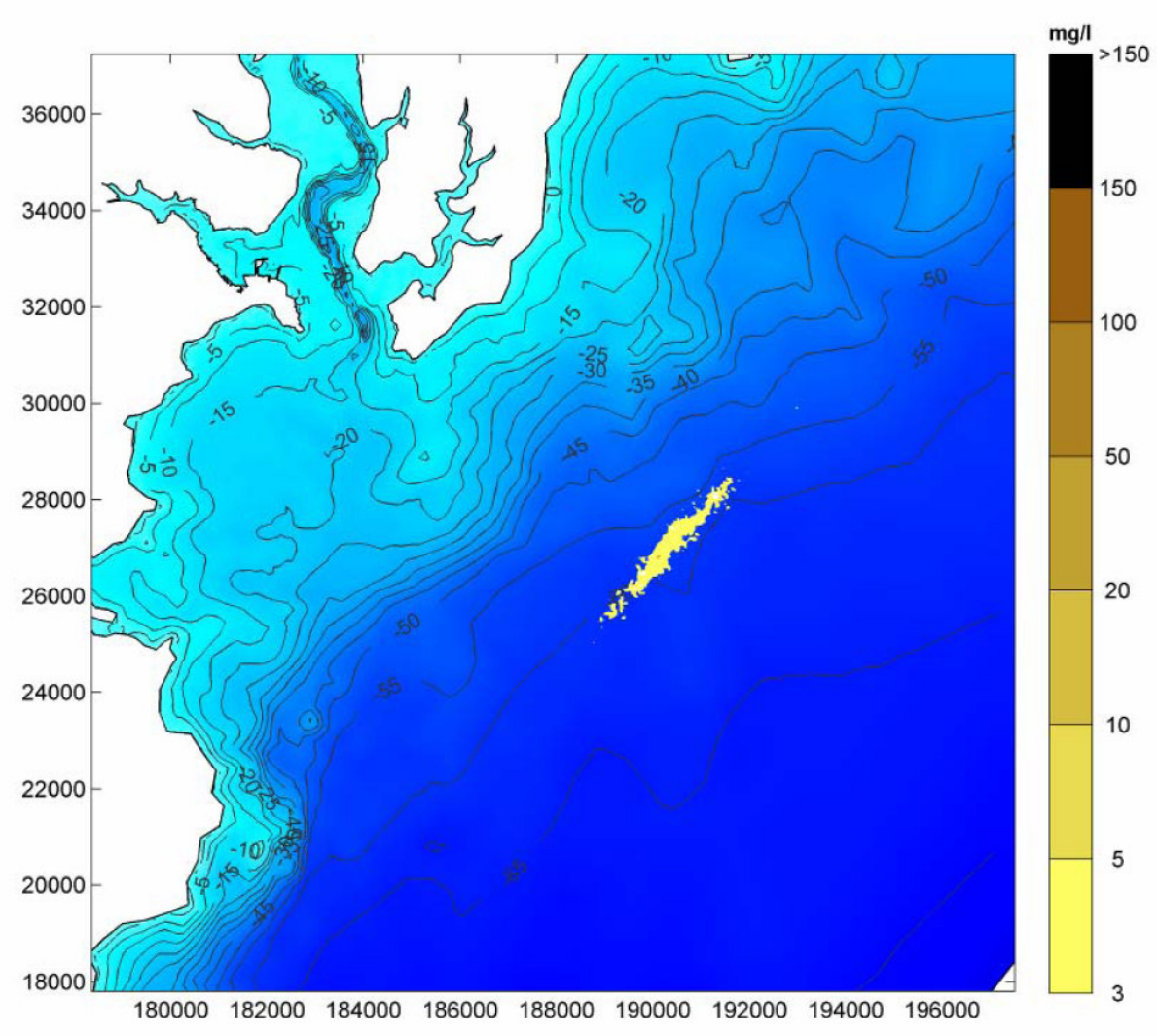


Figure 5-17 shows the peak TSS concentrations occurring during the whole simulation. The larger values, greater than 10mg/l are confined to the disposal site. The peak deposition occurred during neap tides before a proportion was eroded by the following set of spring tides.

Figure 5-17 Maximum Suspended Solids Concentrations for Material Released at the Seabed during Disposal



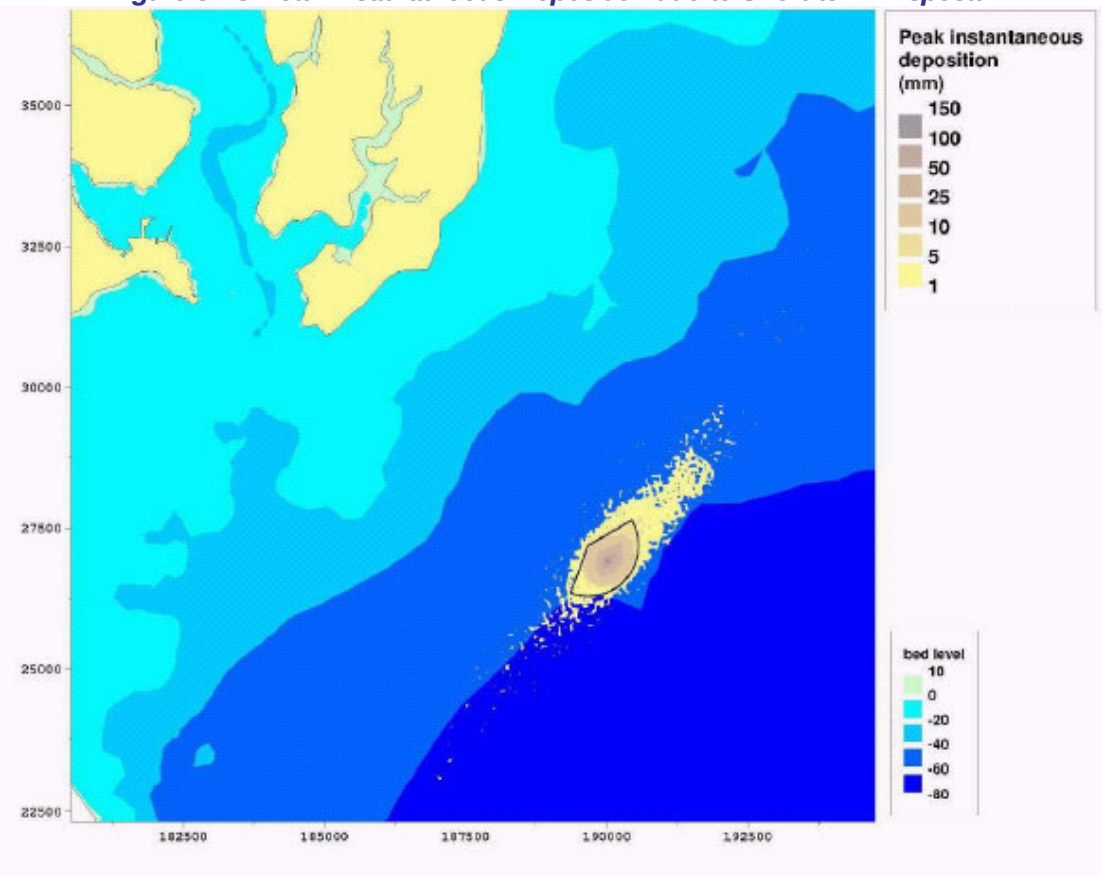
Overall, there is predicted to be a minor change to TSS concentrations (20mg/l) due to the disposal of dredged material at sea. This change will be temporary (i.e. it will only occur during disposal) and reversible (i.e. it will generally return to baseline conditions after disposal).

5.4.4 Change to Sediment Deposition due to Disposal of Clean Dredged Material at Sea

The disposal site has an area of approximately one million m^2 (i.e. 100ha). Allowing for a typical 30% bulk up of the material between dredging and disposal, the total volume placed at the site is expected to be of the order of 780,000m^3. If this volume were all to remain within the disposal site and be evenly distributed across it, the average depth of deposition would be 0.78m.

However, in reality there will be some loss of material from the disposal site and some spreading of the deposited amount, as shown by Figure 5-18. This simulation is used as a basis to provide a schematisation for deposition amounts for disposal of clean dredged material.

Figure 5-18 Peak Instantaneous Deposition due to Short-term Disposal



The net accretion results from the short-term simulation were replicated to cover the full extent of the disposal area and the total accretion plotted for the maximum total deposition volume of 600,000m^3 (see Figure 5-19). A general deposition depth of 0.1m to 0.5m is shown within the disposal area. Depths of 0.01m to 0.05m are shown within 800m of the disposal site's boundary. No areas of net accretion above 0.005m (i.e. 5mm) are shown beyond 1km of the disposal site's boundary. For comparison, Figures 5-20 and 5-21 show deposition plotted for total deposition volumes of 450,000m^3 and 300,000m^3 respectively should alternative uses of the dredged material be realised and reduce the volume requiring disposal in Falmouth Bay (e.g. use of maerl as a soil improver).

Figure 5-19 Total Deposition due to Disposal of 600,000m^3

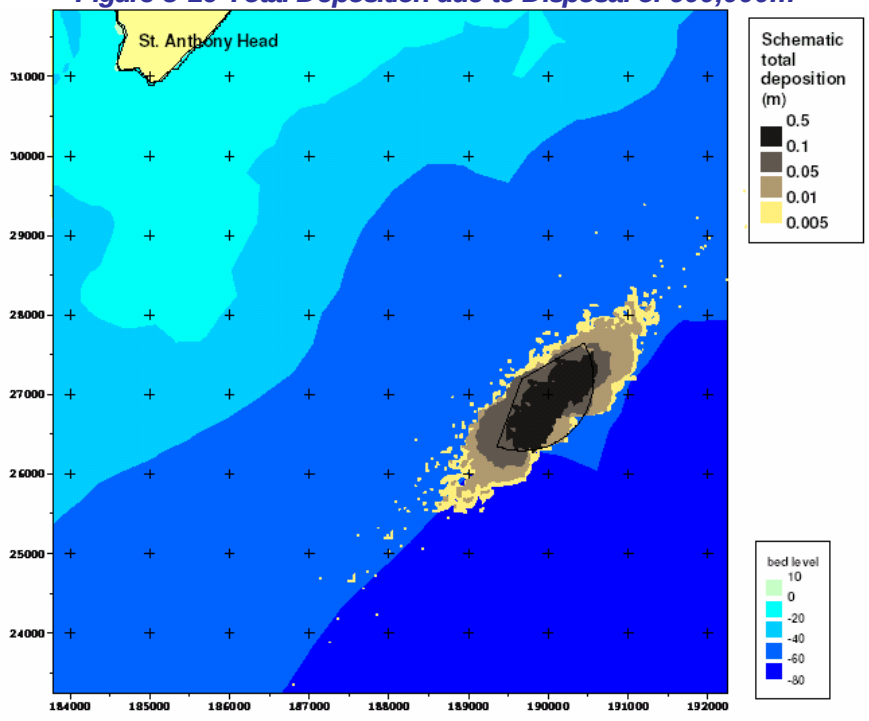


Figure 5-20 Total Deposition due to Disposal of 450,000m^3

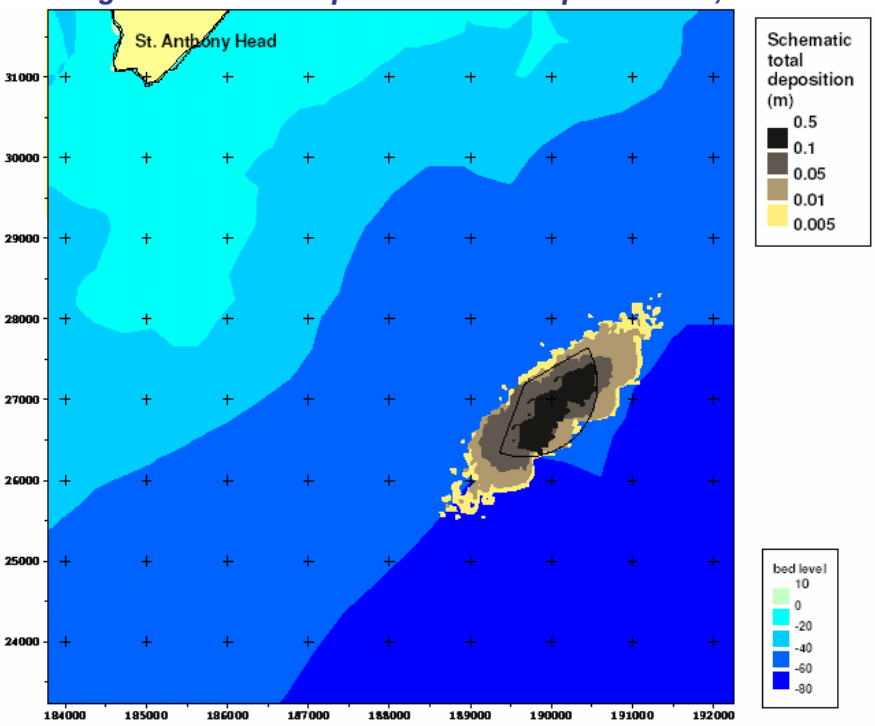
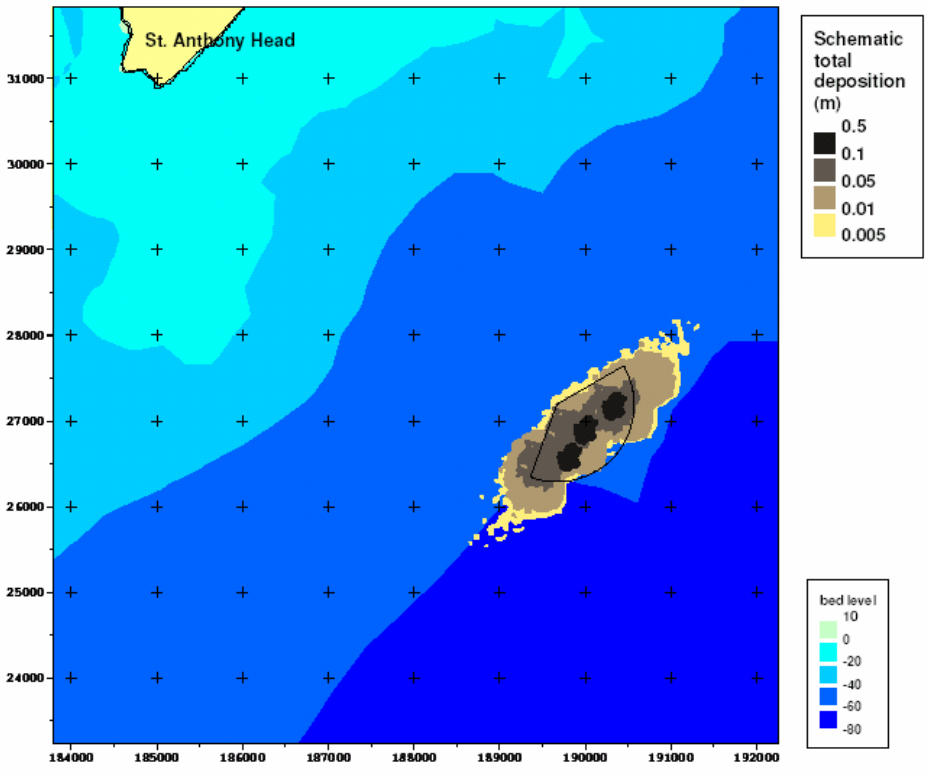


Figure 5-21 Total Deposition due to Disposal of 300,000m^3



Overall, there is predicted to be a moderate change to deposition within the disposal site's boundary (up to 0.5m), a minor change within 1km of the disposal site's boundary (0.05m), and a negligible change beyond 1km of the disposal site's boundary (<0.005m) change to sediment deposition due to capital dredging. This change will, to some extent, be temporary and reversible, depending on the time required for the deposited sediment to gradually disperse.

5.5 CHANGES DURING THE OPERATIONAL PHASE

A series of modelling studies were undertaken to address the effects of the proposed Falmouth Cruise Project in its operational phase. The aspects requiring study were described in the EIA Scoping Study (Royal Haskoning, 2006) and include changes to wave conditions, tidal conditions, sediment transport and coastal processes.

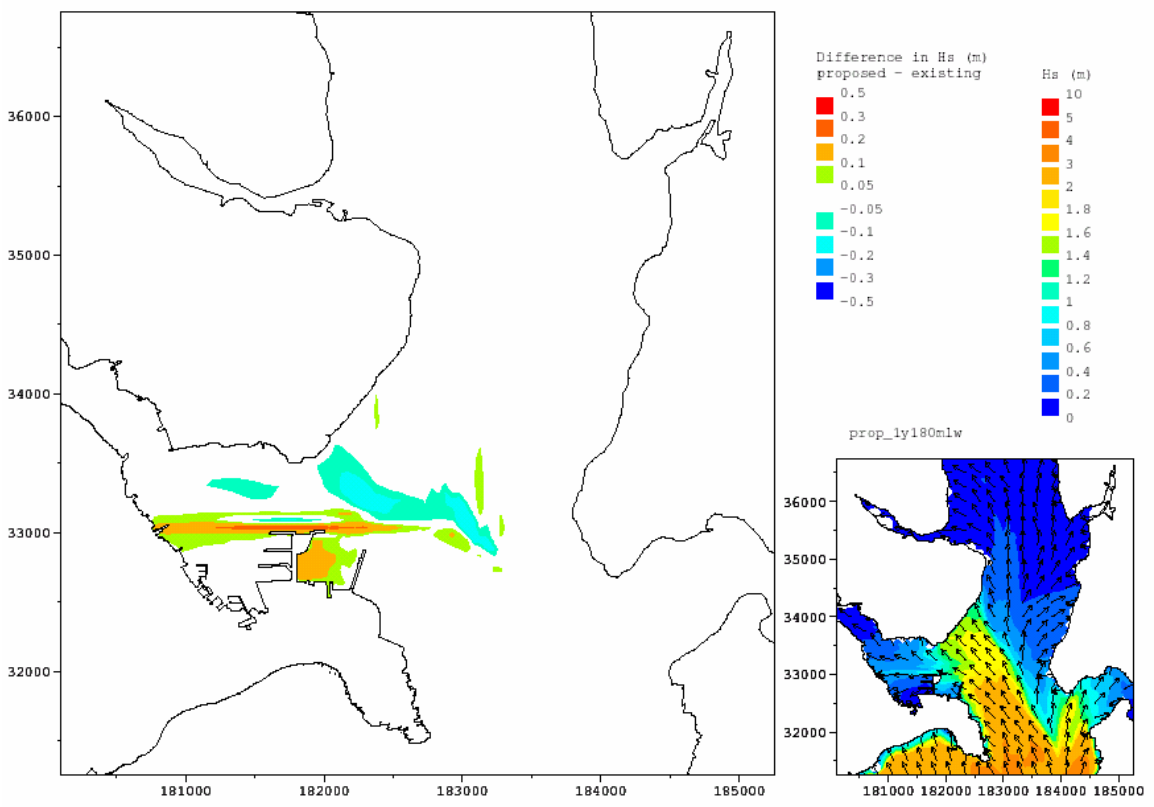
5.5.1 Change to Wave Conditions

Wave modelling was undertaken to determine the impact of the proposed project on waves within Falmouth Harbour. Hence representative offshore waves and locally generated wind wave conditions were chosen to represent those conditions that may be most affected by the proposed project. These waves are therefore to be viewed in a comparative basis and are not intended to be used as design wave conditions. Results have been calculated using the SWAN computational model.

Figure 5-22 shows an example of the type of predicted effect of the dredged channel on offshore waves. It shows the difference in significant wave heights between dredged

and existing cases under 1 in 1 year return period offshore wave conditions from 180°N at mean low water. Other examples are provided in Appendix A.

Figure 5-22 Difference in Significant Wave Heights (under 1 in 1 year return period offshore wave conditions from 180°N at MLW 1.45mCD)



There are no significant changes in wave conditions for the locally generated waves, from 310ºN and 10ºN. Waves from offshore are more affected by the dredging, with reflections from the dredged channel causing a decrease in wave height within the dredged channel, and increases in the basin to the east of Western Wharf, and toward Falmouth.

As for the overall pattern of waves within the estuary, the pattern of change is consistent for all offshore direction sectors tested and isolated to a few distinct areas. Increases in wave height in the conditions modelled can be summarised as follows:

- increases to the east of Western Wharf are of up to 0.15m;
- increases at Queen's Wharf are of up to 0.3m;
- increases adjacent Falmouth town frontage are of up to 0.2m locally, bringing the peak wave height there to 0.7m.

Overall, there is predicted to be a minor change to wave heights at a few sites mainly in and around the docks (<0.2m) under certain conditions, and a negligible change elsewhere and under other conditions to negligible (0.5mm) change to sediment deposition due to capital dredging. This change will be permanent (i.e. it will occur after the dredge) and irreversible (i.e. it will generally not return to baseline conditions after the dredge) for the few sites and under the limited conditions when a minor change is predicted to occur.

5.5.2 Change to Tidal Conditions

Computational modelling using the TELEMAC-2D model have been undertaken to predict the impact of the dredging on tidal flows.

The changes compared to the existing layout are shown in Figures 5-23 and 5-24 for spring tide conditions. The computational modelling predicts a decrease of velocity compared to the existing conditions of up to 0.07m/s during spring tide and less than 0.03m/s during neap tide. These predicted changes in tidal current velocity are very small related to the relatively low ambient currents and cover a small area.

Overall, there is predicted to be a negligible change to tidal flow conditions. This change will be permanent (i.e. it will occur after the dredge) and irreversible (i.e. it will generally not return to baseline conditions after the dredge).

Figure 5-23 Change in Peak Flood Currents - Spring Tide

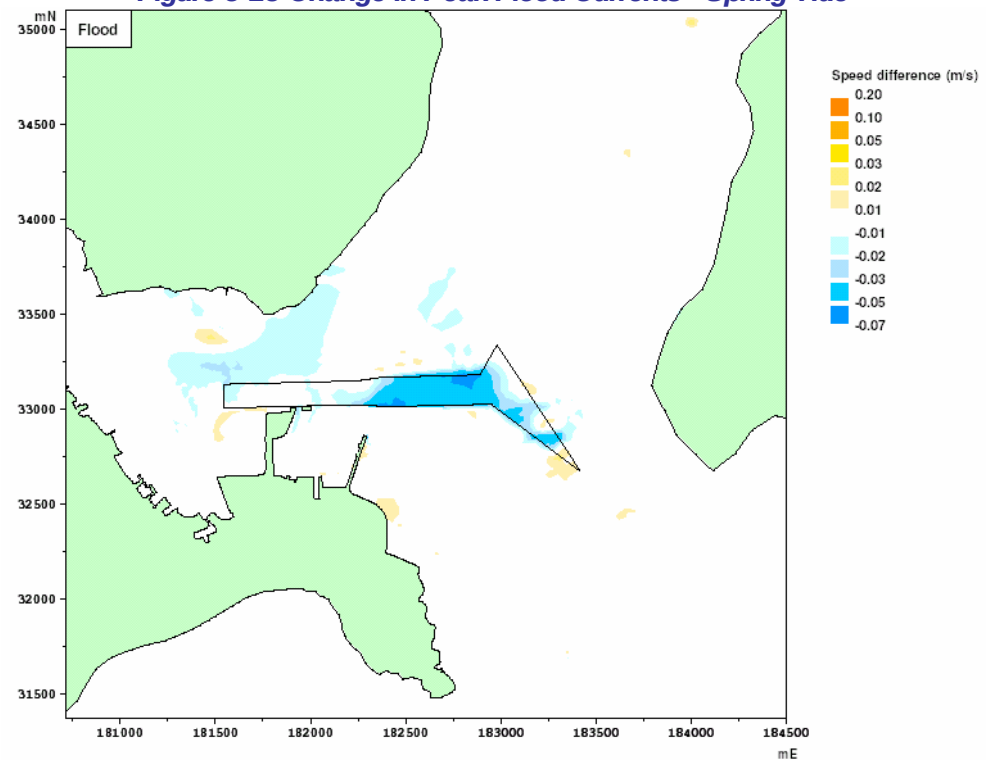
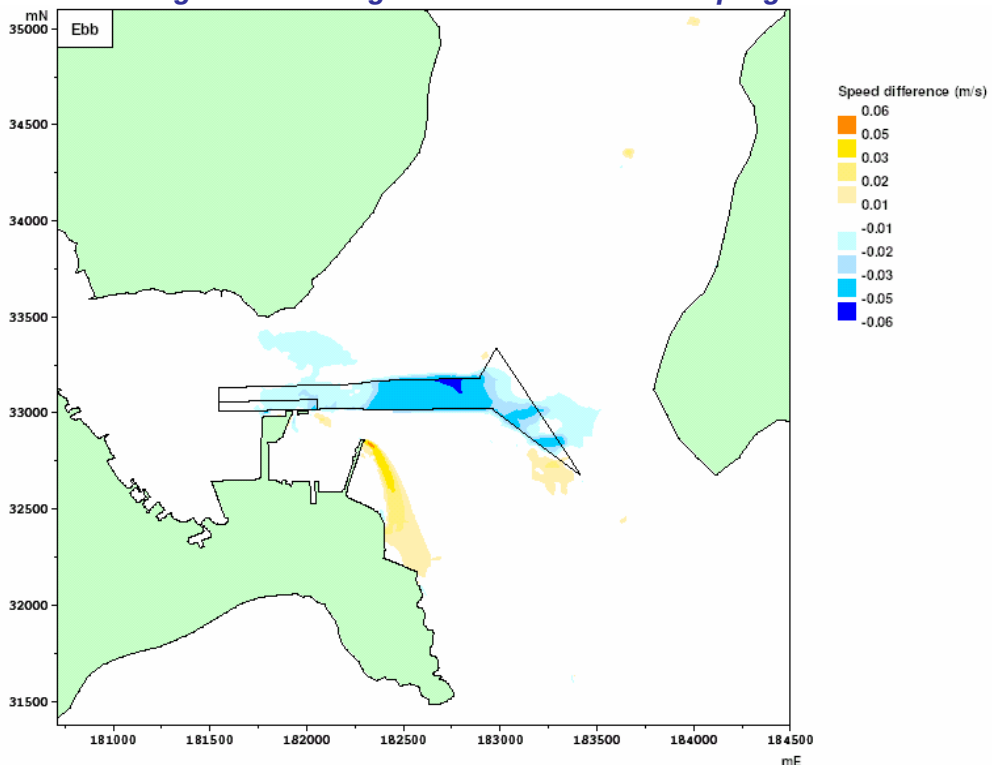


Figure 5-24 Change in Peak Ebb Currents - Spring Tide



5.5.3 Change to Mud Transport Conditions

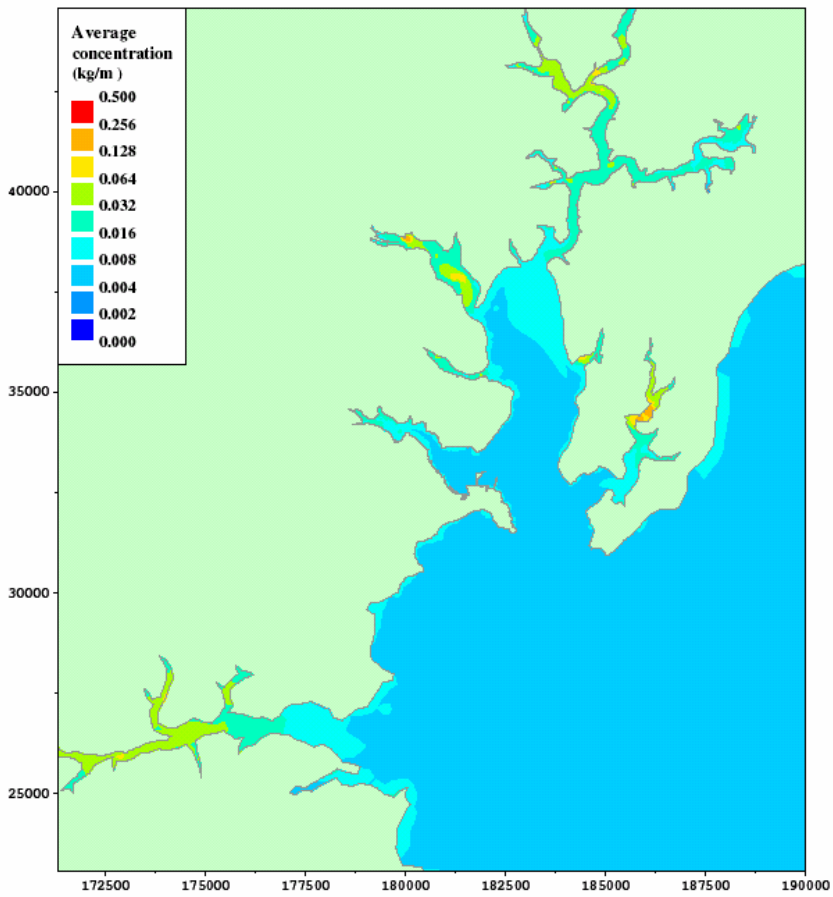
Whilst much of the bed sediments in and around the Fal Estuary are reported as silty, typical TSS concentrations as described in HR Wallingford (1985) are low, averaging less than 10mg/l. The possible sources of the bed material can be from fluvial sources, from the erosion of intertidal areas or coming inshore from the sea, possibly during storm events. Evidence from the Environment Agency's regular water sampling in the area has no elevated levels of suspended sediments in the lower half of the Fal Estuary, towards the sea, and highest values occurring in the upper areas of the estuary towards Truro, suggesting the sea is not a significant source of fine sediment to the system. This conclusion is consistent with the background literature (e.g. PMSP, 2003), which suggests the main source of sediment in suspension is that brought into suspension from erosion of the bed due to waves.

Mud transport modelling has been undertaken using the SUBIEF-2D computational model to examine the behaviour of the mud fraction with the expectation that the proposed new navigation channel may have consequences on the sediment dynamics near intertidal areas. The changed hydrodynamics could also result in accretion within the dredged channel requiring maintenance dredging.

The model was run for two repeating spring tides for the defined conditions with the deposition volumes calculated over the second tide. Neap tides were not used for the simulation as neap tides concentrations are even lower than the already low levels of suspended solids concentrations observed during spring tides. Therefore, neap tides were considered unlikely to significantly change mud transport or deposition patterns.

The model was run for tide alone conditions and the results for tide average suspended solids concentration are presented in Figure 5-25. The general behaviour of the area is shown with low concentrations covering Falmouth Bay and into Falmouth Harbour. Increased concentrations are shown the carious creeks and tributaries where mud deposits are present and the currents and small local wind waves are sufficient to keep the mud in suspension.

Figure 5-25 Average Suspended Solids Concentration for Tide Alone Conditions - Spring Tide



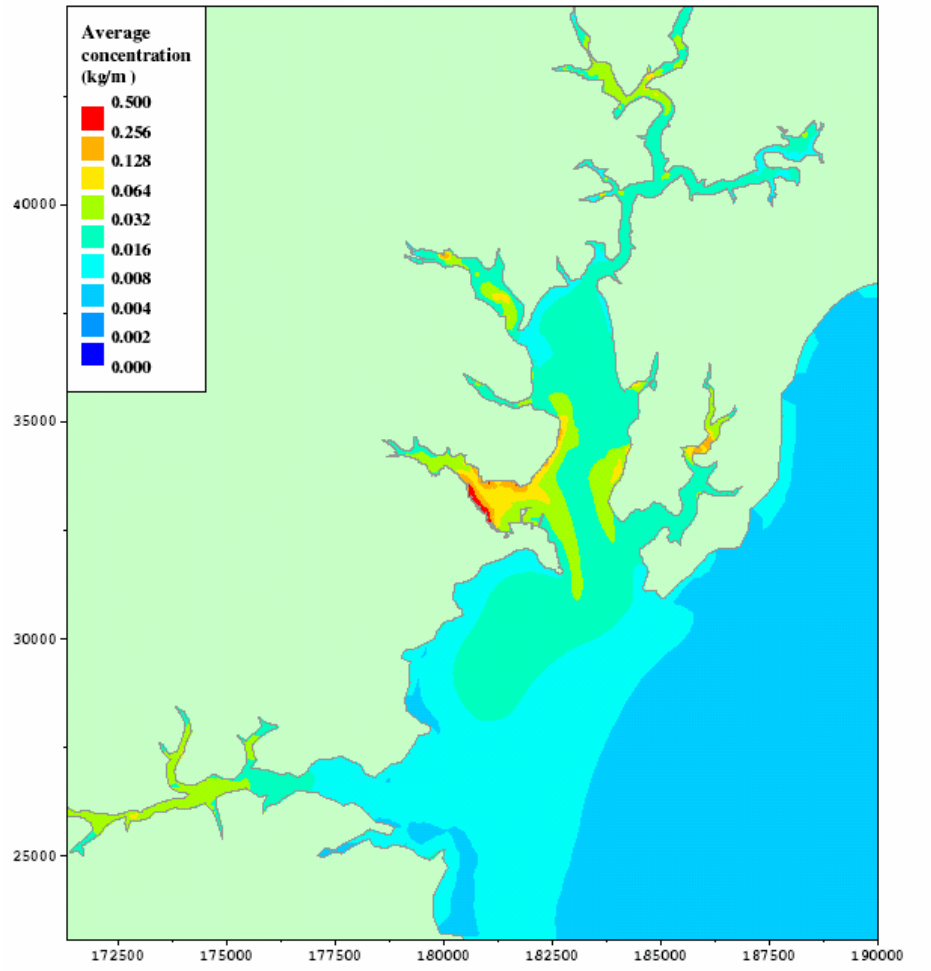
The model was run for various conditions with the addition of local wind wave forces in stirring the bed and for swell waves entering the system from offshore. Usually swell waves can provide larger amounts of energy to the sea bed because of their longer periods, however in the present case the swell wave tests generally had very little effect on suspended solids concentrations as most of the wave energies were lost before they entered the areas of known muddy bed sediments.

The conditions modelled were for the one year return period and are specified in the table below. The wave induced bed stress from the SWAN wave model runs were included in the model.

The sensitivity of the average suspended solids concentration to waves from offshore is shown in Figure 5-26, which shows the effect of waves with a one year return period entering Falmouth Bay from 180^{o}. As might be expected the effect of the waves stirring was to generally increase suspended solids concentrations. Values of more than 50mg/l

are shown in the area of the proposed dredge for this annual event. Similar results were shown for the various offshore wave tests.

Figure 5-26 Average Suspended Solids Concentration (for tide plus 1 in 1 year return period waves from180°) - Spring Tide



For the post construction case the same simulations were undertaken and the total volumes of deposition in the estuary calculated. It was assumed that the development will not alter the amount of fluvial input to the system. Figure 5-27 shows the annual deposition in the dredged area for the proposed scenario.

The annual deposition in the dredged area for the existing conditions has been calculated as 2360m^3/yr. The deposition in the same area for the proposed conditions has been calculated as 2970m^3/yr.

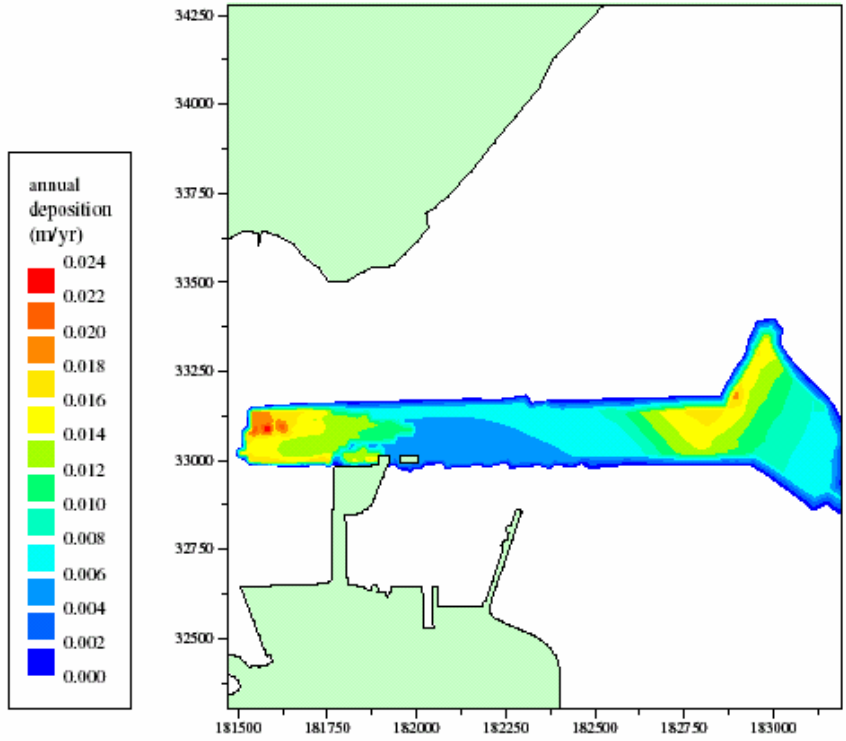
As the existing channel is not currently maintained it is a usual assumption that other processes not included in the model, for example ship passage keep the channel generally clear of sediment accretion reducing the simulated baseline rate of 2360m^3/yr to zero (or negligible). Assuming the same processes will continue with the dredged channel in place the accretion rate for fine sediment in the new dredged areas is represented by the proposed total minus the existing (i.e. 610m^3/yr). This total is very

low suggesting the accretion rate for fine sediment in the dredged area may not be sufficient to require regular maintenance dredging of the channel.

The small increase in fine sediment infill associated with the development suggests that the dredge will not significantly change the fine sediment regime in Falmouth Harbour.

Overall, there is predicted to be a negligible change to mud transport conditions. This change will be permanent (i.e. it will occur after the dredge) and irreversible (i.e. it will generally not return to baseline conditions after the dredge).

Figure 5-27 Prediction of Annual Mud Infill in the Proposed New Navigation Channel



5.5.4 Change to Sand Transport Conditions

Modelling Studies

The bed in the immediate area of the dredge is known to be sandy. A change to the bed level by dredging would be expected to change the processes of sand transport. These processes are transport by the tidal currents and stirring of the bed from waves. A changed sand transport patter could alter the distribution of bed sediments in the area around the dredge and potentially lead to sandy infill in the dredged area, requiring maintenance dredging. Sand transport modelling was required to demonstrate the effect of the dredge on sand transport patterns in the area and provide an indication of the potential maintenance dredging requirement in the new channel.

Sediment transport simulations were performed with the computational model SANDFLOW to predict the net residual potential sediment transport rate, and the corresponding patterns of erosion and deposition. SANDFLOW was used to simulate the sediment transport patterns throughout Falmouth Bay and the estuary due to tidal

conditions alone, and including the effects of wave stirring. The resulting sediment transport patterns include only the potential for sediment transport, since the information on the actual availability of sediment is not incorporated.

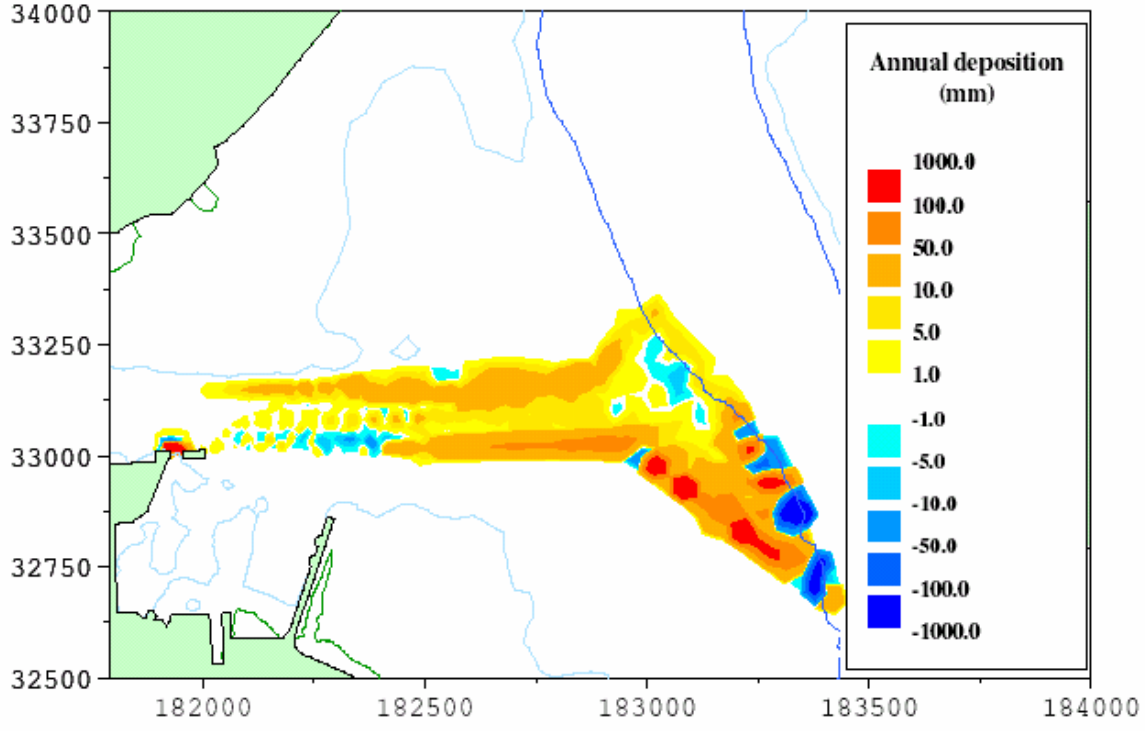
The same series of simulation were performed for the post dredging case and the results summed to calculate a total annual sand transport pattern. A comparison of the existing and post-dredge sediment transport patterns show no overall change in the sand transport patterns. This is as might be expected from the small changes in tidal and wave hydrodynamics predicted.

Figure 5-28 shows the annual deposition in the dredged area for the existing and proposed scenarios.

SANDFLOW assumes that sand is available for transport throughout the bed and so any calculation of annual accretion is regarded as a potential for deposition (i.e. accretion would occur if sand were available). In the immediate area of the proposed new navigation channel the bed sediment area generally sandy and so the assumption is acceptable. This assumption is also useful in that it gives a upper limit on the amount of sand that can deposit.

A calculation of the total volume of sand deposited annually (the difference between potential erosion and deposition) in the area of the proposed channel gives a total of less than 20m^3/yr. This simulation suggests whilst sand is mobile in the area of the proposed channel little can deposit overall. This insignificant amount is consistent with the present lack of need to undertake maintenance dredging in the approaches to Falmouth and the relatively stable nature of the sea bed in the longer term.

Figure 5-28 Prediction of Annual Sand Infill in the New navigation Channel



The calculation of the annual accretion with the proposed dredging in place give an accretion total of 5,500m^3/yr. This accretion rate is linked to the prediction of generally unchanged sand fluxes due to the channel but with deeper depths – resulting in less potential for transport directly over the deeper area and, therefore, deposition. The bulk of the deposition in predicted on the south-eastern corner end of the dredged area with maximum depth of deposition in the range 0.2-0.3m/yr. Values of less than 0.1m/yr are predicted on the southern side of the channel and less than 0.02m/s on the northern side.

Overall, there is predicted to be a negligible change to sand transport conditions. This change will be permanent (i.e. it will occur after the dredge) and irreversible (i.e. it will generally not return to baseline conditions after the dredge).

5.5.5 Changes to Coastal Processes

Sections 5.5.1 to 5.5.4 describe the predicted changes in the physical processes at work in the area (i.e. waves, tides and sediment transport). These changes have been integrated to assess their potential impact on coastal processes at a number of locations.

Summary of Integrated Physical Changes

There are no significant changes to those predicted waves which are generated locally within the Fal Estuary. Waves which propagate into the estuary from offshore are sufficiently energetic to be influenced by changes in the bathymetry brought about by the proposed dredging. Such changes include a decrease in wave height in the dredged channel, and increases in wave height within the basin to the east of Western Wharf. Wave heights are also expected to increase along the northern edge of Queen's Wharf, and towards Falmouth in the vicinity of the Prince of Wales Pier. Wave energy arriving at Trefusis Point is expected to reduce. These changes are not expected to cause any problems for coastal defences but, where increases in wave height are predicted, they may add to any existing problems of erosion or scour. Additionally, a predicted increase in wave energy reaching Prince of Wales Pier may add to any problems of overtopping already experienced there.

With regard to changes in tidal propagation, from the viewpoint of potential adverse effects on inter-tidal areas, beaches and coastal defences, the main concerns would be any increase in high tide levels and any increase in tidal currents close to the coast. The tidal flow modelling concluded that there would be no significant changes in high water levels anywhere within the Fal Estuary or at its mouth, so no concern exists, for example, regarding increased overtopping of coastal defences as a result of changes to water levels. Changes to tidal current speeds within, and adjacent to the dredged area, are expected to be very small and these changes diminish with distance away from the dredged area as to be virtually undetectable at the coast.

The shoreline around Falmouth is characteristically influenced by anthropogenic activity. There are numerous quay walls, marinas, and piers interspersed by narrow inter-tidal foreshores of rock and mud, with some sandy and coarse deposits. The majority of these inter-tidal areas are unlikely to be altered significantly even by large changes in forcing conditions. There are, however, several beaches in the area (in Falmouth Bay) which are important in terms of public and tourist amenity, although it is not considered

that these beaches will experience any significant morphological changes as a result of the proposed dredging. There may be an initial increase of suspended sediments in the water column within the inner harbour as a result of the dredging activity, and a portion of these may settle on the inter-tidal foreshore. In such an eventuality, it is unlikely that the character of the foreshore would alter.

Falmouth Bay (Gyllyngvase and Castle Beaches)

The main tourist beaches of Falmouth are in Falmouth bay, to the west of Castle Headland. These include Gyllyngvase and Castle beaches. There are no changes to the predicted hydrodynamics and morphology as a result of the proposed dredging.

Castle Headland

The promontory of Pendennis Castle marks the western extremity of the Fal Estuary. The headland is characteristically rocky. There are no changes to the predicted hydrodynamics and morphology as a result of the proposed dredging.

Falmouth Docks

Between Castle Headland and Falmouth lies Falmouth Docks. Model predictions indicate that there will be an increase of up to 0.2m to the significant wave height within the western half of the docks during the most severe storm event examined, although the nature of the dock basin dictates that coastal morphology will not be affected here. The proposed dredging will not significantly affect the tidal currents within the docks, although as the tide ebbs it is predicted that a small increase in the current speed of less than 0.06m/s will be induced to the east of the Eastern breakwater. It is not considered that this will affect the shoreline morphology form the docks southwards towards Pendennis.

Port Pendennis Marina

Port Pendennis Marina can be found immediately to the west of Falmouth Docks. This marina is accessed via a tidal lock. There are no changes to the predicted hydrodynamics and morphology as a result of the proposed dredging.

National Maritime Museum

The shoreline at the Maritime Museum is defined in the main by sheet steel piles. Some concrete armouring is also present with a small deposit of fine sediments and some pebbles present. There are no changes to the predicted hydrodynamics and morphology as a result of the proposed dredging.

Discovery Quay

The boatyard at Discovery Quay is fringed by a short stretch of inter-tidal foreshore. This narrow inter-tidal foreshore is rocky and muddy. There are no changes to the predicted hydrodynamics and morphology as a result of the proposed dredging.

Custom House Quay

The harbour at Custom House Quay contains a narrow deposit of muddy sediment which is visible around low water. There are no changes to the predicted hydrodynamics and morphology as a result of the proposed dredging.

Visitors Yacht Haven

The inter-tidal foreshore landwards of Visitors Yacht Haven is the longest stretch of foreshore along Falmouth waterside. The foreshore is muddy with rocky outcrops. There are no changes to the predicted hydrodynamics and morphology as a result of the proposed dredging.

Fish Strand Quay

Some sandy and muddy deposits can be found adjacent to Fish Strand Quay, with the foreshore generally contained here by the quay wall and rocky outcrops. Wave modelling predictions indicate that there is likely to be a small increase in wave heights (up to 0.1m or 15-20% for those conditions examined) reaching the foreshore here as a result of the proposed dredging. There are no changes to the predicted tidal regime as a result of the proposed dredging.

Prince of Wales Pier

From the Prince of Wales Pier to Admirals Quay, the coastline consists of pocket inter-tidal foreshores and seawalls. It is predicted that wave heights here may increase by up to 0.2m (or 30%) for the selection of wave conditions examined. Whilst it is unlikely that the morphology of the inter-tidal foreshore will alter noticeably as a result, it is possible that any existing problems of inundation of the Pier itself during times of very high water and storms may be worsened. There are no changes to the predicted tidal regime as a result of the proposed dredging.

Admirals Quay

A narrow sandy inter-tidal foreshore is present in this area, backed by seawalls and strewn with boulders fronts Admirals Quay (The Packet Quays). There are no changes to the predicted hydrodynamics and morphology as a result of the proposed dredging.

Greenbank Quay

Greenbank Quay is the northern-most limit (along Falmouth waterside) of the range of influence expected as a result of the proposed dredging. There is a predicted reduction in wave height of less than 0.1m for the most severe wave condition examined by the modelling. It is not thought that this change will alter the morphology of the contained beaches between Admirals Quay and Greenbank Quay. There are no changes to the predicted tidal regime as a result of the proposed dredging.

Flushing

The coastline at Flushing, on the eastern shore of the Penryn River, is characterised by seawalls, quays and a rocky inter-tidal foreshore. There are no changes to the predicted hydrodynamics and morphology as a result of the proposed dredging.

Kiln Quay

Between Flushing and Trefusis Point lies Kiln Quay. The sandy beaches here are contained by rocky outcrops, and are backed by seawalls and eroding soft-cliffs. There are no changes to the predicted waves and morphology as a result of the proposed dredging. Minor changes (less than 0.02m/s) to the tidal current speeds may be expected at some stages of the tide in the vicinity of Kiln Quay. These changes will be unnoticeable.

Trefusis

The Trefusis Estate extends eastwards from Kiln Quay past Trefusis Point. This is the limit of the field of influence of the proposed dredging at the coast. Model predictions indicate that wave heights here may be reduced by up to 0.1m during the severest conditions tested. It is not thought that shoreline morphology here will be significantly affected by this reduction, as depth-limited waves impacting on this coastline during storm events will still be capable of eroding the soft cliffs. The rocky foreshore will remain unaffected. Minor changes (less than 0.02m/s) to the tidal current speeds may be expected at some stages of the tide along a small portion of the Trefusis shoreline. These changes will be unnoticeable.

Overall, there is predicted to be negligible change at Falmouth Docks, Kiln Quay and Trefusis and no change at Gyllyngvase and Castle Beaches, Castle Headland, Port Pendennis Marina, the National Maritime Museum, Discovery Quay, Custom House Quay, Visitors Yacht Haven, Fish Strand Quay, Prince of Wales Pier, Admirals Quay, Greenbank Quay and Flushing. These changes will be permanent (i.e. it will occur after the dredge) and irreversible (i.e. it will generally not return to baseline conditions after the dredge).

6 SEDIMENT QUALITY

6.1 INTRODUCTION

This chapter of the ES concerns the quality of the marine sediment and how it could be affected by the proposed Falmouth Cruise Project. Sediment quality is assessed in terms of changes to:

- physical characteristics in terms of sediment substrate type and grain-size;
- chemical characteristics in terms of the following contaminants: metals (arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), lead (Pb), mercury (Hg), nickel (Ni) and zinc (Zn)), organo-tin compounds (tributyl-tin (TBT) and dibutyl-tin (DBT)), hydrocarbons (i.e. total petroleum hydrocarbons (TPH) and polyaromatic hydrocarbons (PAHs)), polychlorinated biphenyls (PCBs) and organo-chlorine pesticides (OCPs).
- biological characteristics in terms of the following contaminants: enteric bacteria (faecal coliforms and faecal streptococci) and algal biotoxins (***Alexandrium*** sp.); and
- sediment toxicity in terms of the following bioassays: whole sediment bioassays (***Corophium*** sp. and ***Arenicola*** sp.) and elutriate bioassays (***Arenicola*** sp.).

Issues identified in the Environmental Scoping Study (Royal Haskoning, 2006; and by consultees during the preparation of the ES relate to the potential for dredging and marine works to release sediment and associated contaminants into the water column so that they become transported and deposited in other parts of the seabed (i.e. impact receptor areas) within the Fal Estuary and Falmouth Bay. Capital dredging (during construction) is the principal activity that can generate this impact.

This chapter draws upon data collected through numerical modelling of sediment deposition, baseline surveys of sediment quality, and the information and views expressed by consultees including the MFA, Cefas and the Environment Agency Natural England, Cornwall Wildlife Trust, Cornwall County Council, Friends of the Earth and the public. For more detailed information on these data the reader should refer to Appendices A and B respectively.

6.2 ASSESSMENT METHODOLOGY

6.2.1 Study Area

The study area for sediment quality includes the outer part of the Fal Estuary and Falmouth Bay because this area includes:

- the footprint of the proposed capital dredging (see Figure 2-2);
- the demarcated dredged material disposal site in Falmouth Bay (see Figure 2-5); and
- the potential extent of sediment deposition on the seabed (in terms of depth of sediment measured in mm) caused by capital dredging in Falmouth Harbour and dredged material disposal in Falmouth Bay (see Figures 5-1 and 5-2).

6.2.2 Baseline Data Collection

Baseline data has been collected from various sources, notably:

- Site specific surveys for sediments in and around Falmouth Docks and the approach channel including the ***Falmouth Docks Dredging Study*** by Posford Duvivier (1998) and the surveys described in Section 6.2.3;
- Environment Agency monitoring data from the Fal Estuary;
- Cycleau Project including Management of TBT Contaminated Sediment in the Fal Estuary by Wardell Armstrong (2006); and
- Published research and studies as cited and identified in the references at the end of this ES including ***Site Characterisation of the South West European Marine Sites - Fal and Helford cSAC*** by PMSP (2003) and various publications by Cefas including Aquatic Environment Monitoring Reports and Technical Reports.

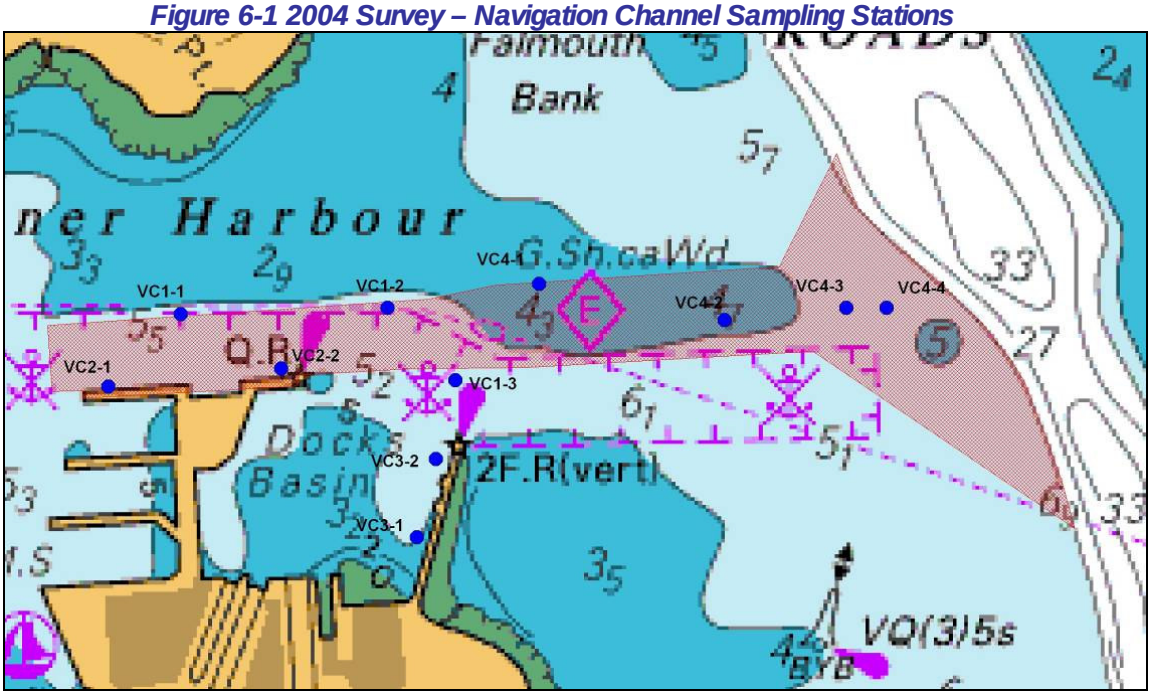
Referenced data sources are listed at the end of this chapter.

6.2.3 Surveys

Sediment Quality Survey 2004

A sediment quality survey was undertaken in 2004 to inform a FEPA licence application for the disposal of dredged material at sea. The application was made by FHC and FDEC and concerned an earlier proposal for capital dredging.

Figure 6-1 2004 Survey – Navigation Channel Sampling Stations



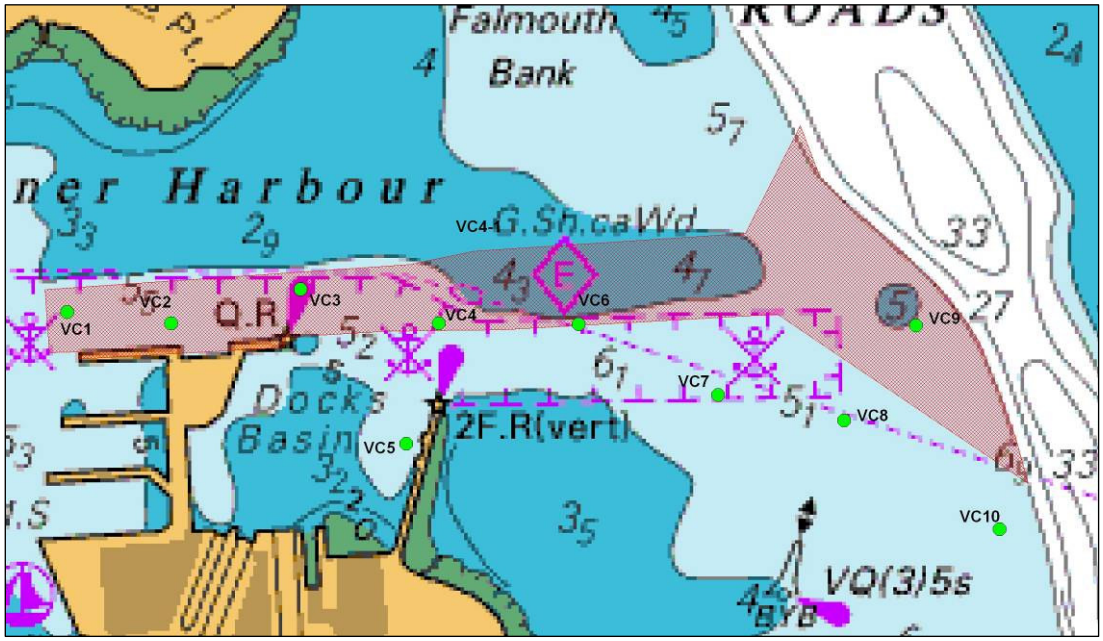
The scope of the survey's sampling and analytical requirements was made in consultation with Defra (i.e. the MFA) and Cefas. Sediment cores to depths up to 2.5m were collected from 11 sampling stations covering the western navigation channel (VC1-1, VC1-2 and VC1-3), the Northern and Queens Wharves (VC2-1 and VC2-2), the eastern navigation channel (VC4-1, VC4-2, VC4-3 and VC4-4) and the FOS Jetty (VC3-

1 and VC3-2), as shown on Figure 6-1. [Note: the FOS Jetty is outside the proposed capital dredge area.] Sediment cores were collected using a vibro-corer. Surface samples and up to two other samples were taken from each core (depending on core recovery depth) to provide 27 samples in total. All samples were analysed by Cefas for metals, TBT, DBT, PCBs and PAHs. Analytical data are presented in Appendix B.

Sediment Quality Survey 2007

A survey was undertaken in 2007 to inform the EIA process for the proposed Falmouth Cruise Project.

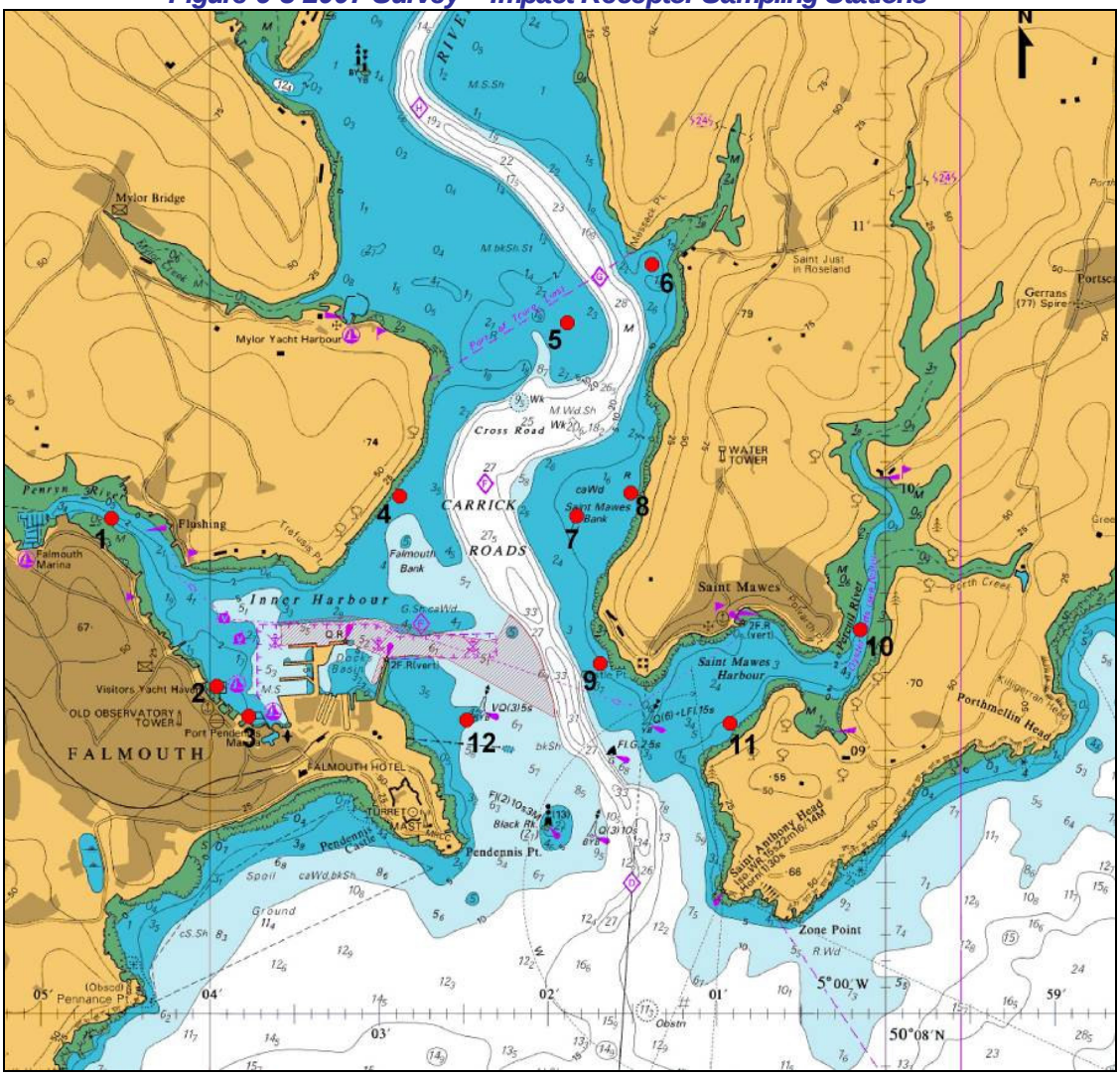
Figure 6-2 2007 Survey – Navigation Channel Sampling Stations



The scope of the survey was made in consultation with Defra (i.e. the MFA), Cefas and the Environment Agency, and considered numerical model predictions of potential maxima for sediment dispersion in the water column and sediment deposition on the seabed (see Figure 6-2). Sediment cores to depths up to 2.5m were collected from 10 sampling stations covering the western navigation channel (VC1, VC3 and VC4), the Northern and Queens Wharves (VC2), the eastern navigation channel (VC6, VC9), the FOS Jetty (VC5) and the area to the south of the eastern navigation channel (VC7, VC8 and VC10) (see Figure 6.2). [Note: the FOS Jetty and the areas to the south of the eastern navigation channel are outside the proposed capital dredge area.] Sediment cores were collected using a vibro-corer. Surface samples and up to three other samples were taken from each core (depending on core recovery depth) to provide 34 samples in total. All samples were analysed by MaCaulay Analytical Services for PSA, organic matter, metals, TBT, DBT, PCBs, PAHs, TPH and OCPs. All surface samples were analysed by Cefas for bacteriological parameters. Analytical data are presented in Appendix B. In addition, two surface samples were collected using a grab sampler at sampling stations VC2 and VC5 (see Figure 6-2) to represent worst-case contamination conditions) and were analysed by Cefas for whole sediment bioassays. Analytical data are presented in Appendix B.

To cover the potential impact receptor areas, twelve surface samples were collected using a grab sampler at sampling stations 1 to 12 (see Figure 6-3). All samples were analysed by MaCaulay Analytical Services for PSA, organic matter, metals, TBT, DBT, PCBs, PAHs, TPH and OCPs, and by Cefas for bacteriological parameters. Analytical data are presented in Appendix B.

Figure 6-3 2007 Survey – Impact Receptor Sampling Stations



The sampling stations represent the following potential impact receptor areas:

1. Shellfish habitat, Penryn River;
2. Marina, Falmouth Harbour;
3. Marina, Falmouth Harbour;
4. Eelgrass habitat, west of Carrick Roads;
5. Shellfish habitat, west of Carrick Roads;
6. Shellfish habitat, east of Carrick Roads;
7. Maerl habitat, east of Carrick Roads;
8. Eelgrass habitat, east of Carrick Roads;
9. Maerl habitat, east of Carrick Roads;
10. Shellfish habitat Percuil River;
11. Eelgrass habitat, Pecuil River; and
12. Possible maerl habitat enhancement site, east of Pendennis.

6.2.4 Assessment Criteria

Physical Parameters

In the UK, there are no quantified standards for in situ marine sediment quality for physical characteristics such as particle size distribution and organic matter content. Therefore, the physical characteristics of the sediment at the potential impact receptor areas are used as assessment criteria.

Chemical Parameters

In the UK, there are no quantified standards for in situ marine sediment quality for chemical parameters. The only UK guidance establishes “standstill (no deterioration)” conditions and is given for most of the substances identified under List 1 of the Dangerous Substances Directive (76/464/EEC).

In the absence of quantified standards for in situ marine sediment quality, the following guidelines have been used as assessment criteria to inform the EIA process:

- Cefas action levels for assessing the disposal of dredged material at sea (see Table 6-1, derived from OSPAR Commission, 2004); and
- Canadian sediment quality guidelines for the protection of aquatic life (see Table 6-2, derived from CCME, 2002).

Cefas’s action levels are used as part of a weight of evidence approach to assess dredged material and its suitability for disposal to sea. The action levels are used along with other assessment methods (e.g. bioassays) and historical data and knowledge regarding the site, to make management decisions regarding the fate of dredged material. Since the action levels are derived, in part, from toxicological data the weight of evidence approach balances multiple lines of evidence concerning ecological assessment as an aid to decision making (OSPAR Commission, 2004). Accordingly, the action levels do not constitute simple pass or fail criteria.

The two action levels form the following three management decision making responses:

- below action level 1 contaminants in the dredged material are generally of no concern and are unlikely to influence the licensing decision about sea disposal. For example, action level 1 acts as a nominal background concentration for metals and a primary anthropogenic impact detection concentration for TBT;
- between action levels 1 and 2 contaminants in the dredged material require further consideration and testing before a decision can be made about sea disposal; and
- above action level 2 contaminants in the dredged material are generally considered unsuitable for sea disposal. This situation most often applies only to a part of a proposed dredging area and this may result in part of the proposed dredging area being excluded from disposal at sea and requiring disposal of dredged material by other routes (e.g. landfill).

Cefas's action levels have been used to inform impacts on the marine environment, including impacts on SACs for appropriate assessment, in terms of potential toxicological effects (e.g. Cefas, 2000).

A revised set of action levels has been proposed by Cefas but is not yet in use. Therefore, the existing action levels are applied to the EIA process (see Table 6.1). The existing action levels include for metals and totals for TBT (and TBT's breakdown products, DBT and MBT), PCBs and hydrocarbons, but do not include for any PAHs (although the proposed revised action levels do include some PAHs).

Table 6-1 Cefas Action Levels (source: OSPAR Commission, 2004)

Contaminant	Action level 1 (mg/kg)	Action level 2 (mg/kg)
Arsenic	20	50-100
Cadmium	0.4	2
Chromium	40	400
Copper	40	400
Lead	50	500
Mercury	0.3	3
Nickel	20	200
Zinc	130	800
TBT, DBT, MBT	0.1	1
PCBs	0.02	0.2
Total hydrocarbons	100	

The Canadian sediment quality guidelines for the protection of aquatic life constitute threshold effect levels (TELs) and probable effect levels (PELs) that indicate in situ marine sediment quality with respect to biological effects (see Table 6.2 overleaf). The two levels form three biological effects ranges for chemical contaminants as follows:

- minimal effect range below the TEL where adverse biological effects occur rarely;
- possible effect range between the TEL and PEL where adverse biological effects occur occasionally; and
- probable effect range above the PEL where adverse biological effects occur frequently.

The TEL also acts as an interim sediment quality guideline (ISQG) level (CCME, 1999). WRc (1999) recommend that “in the absence of any UK standards, these guidelines can be used as a first approximation in assessing whether organisms are at risk from sediment concentrations of toxic substances.”

The Canadian sediment quality guidelines are derived from biological effects data and are intended to establish benchmarks for protecting benthic organisms and for assessing potential impacts of contaminants in sediment on biota (CCME, 1999).

The Canadian effect levels include for most metals, total PCBs and a range of PAHs, but do not include for nickel, TBT (and TBT’s breakdown products, DBT and MBT) and hydrocarbons.

Table 6-2 Selected Canadian Sediment Quality Guidelines (source: CCME, 2002)

Contaminant	Threshold effect level (mg/kg)	Probable effect level (mg/kg)
Arsenic	7.24	41.6
Cadmium	0.7	4.2
Chromium	52.3	160
Copper	18.7	108
Lead	30.2	112
Mercury	0.13	0.7
Zinc	124	271
PCBs total	0.0215	0.189
PAHs acenaphthene	0.00671	0.0889
PAHs acenaphthylene	0.00587	0.128
PAHs anthracene	0.0469	0.245
PAHs benz(a)anthracene	0.0748	0.693
PAHs benzo(a)pyrene	0.0888	0.763
PAHs chrysene	0.108	0.846
PAHs dibenz(a,h)anthracene	0.00622	0.135
PAHs fluoranthracene	0.113	1.494
PAHs fluorene	0.0212	0.144
PAHs 2-methylnaphthalene	0.0202	0.201
PAHs naphthalene	0.0346	0.391
PAHs phenanthrene	0.0867	0.544
PAHs pyrene	0.153	1.398
OCP: gamma HCH	0.00094	0.0038
OCP: DDT	0.00199	0.00477
OCP: DDE	0.00142	0.00675
OCP: DDD	0.00354	0.00851
OCP: Dieldrin	0.00285	0.00667
OCP: Endrin	0.00267	0.0624

Biological Parameters

In the UK there are no quantified standards for in situ marine sediment quality for biological parameters such as faecal coliforms and faecal streptococci, or for algal biotoxins such as ***Alexandrium*** sp. Therefore, the baseline bacteriological conditions at the potential impact receptor areas are used as assessment criteria.

Sediment Toxicity

For whole sediment bioassay methods using ***Corophium*** and ***Arenicola***, sediment quality can be assessed by comparing the bioassay endpoints to a control sample comprising uncontaminated reference sediment. In addition, sediment quality can be assessed by comparing the bioassay endpoints to the values identified in Jones and Franklin (1998) (see Table 6-3). Endpoints are mortality (M) and reduction in casting (RC), which represents reduced feeding activity.

Table 6-3 Sediment Toxicity Assessment Criteria

Sediment Quality	*Corophium* M (%)	*Arenicola* M (%)	*Arenicola* RC (%)
Good	<39	<20	<30
Slightly impaired	40-99	21-50	31-50
Substantial deterioration		51-99	51-89
Very poor	100	100	90-99

In the ***Final Report of the Sediment Bioassay Task Team***, the UK's Marine Pollution Monitoring Management Group (MPMMG) (the Group Co-ordinating Sea Disposal Monitoring) suggested that an initial pass/fail criterion of 40-50% mortality be adopted for dredged material assessment. This level allows "for a 2-fold 'dilution' of the material when incorporated with the receiving sediments without risk of interference at the detection limit" (where the detection limit is set at 20% mortality) (Roddie, 1997).

6.2.5 Assessment Techniques

Baseline Environmental Conditions

To determine the baseline environmental conditions for physical, chemical and biological parameters, the EIA survey results for the capital dredge area and the impact receptor areas are compared to the assessment criteria identified in Section 6.2.4.

To determine the baseline environmental conditions for whole sediment toxicity, the EIA survey results for the capital dredge area are compared to the assessment criteria identified in Section 6.2.4.

Impact Assessment

To assess potential environmental impacts for physical, chemical and biological parameters, the EIA survey results for the capital dredge area are compared to the EIA survey results for the impact receptor areas with respect to the assessment criteria identified in Section 6.2.4. The affected impact receptor areas are identified using numerical modelling of sediment deposition.

To assess potential environmental impacts for whole sediment toxicity, the EIA survey results for the capital dredge area are compared to the assessment criteria identified in Section 6.2.4. The affected impact receptor areas are identified using numerical modelling of sediment deposition.

6.2.6 Assessment of Impact Significance

Impact significance has been assessed using the methodology set out in Section 1.4.3.

6.3 BASELINE ENVIRONMENTAL CONDITIONS

The following paragraphs describe the baseline environmental conditions concerning the sediment's physical, chemical, biological and toxicological characteristics. The descriptions use the sediment quality data recorded by the 2004 and 2007 surveys (see Section 6.2.3) related to the assessment criteria (see Section 6.2.4) and compared to other available data (see Section 6.2.2).

Where relevant to the impact assessments described in Sections 6.4 and 6.5, the sediment's characteristics are described for the following geographical areas:

- Falmouth Docks and the proposed new navigation channel;
- Fal Estuary and the potential impact receptor areas; and
- Falmouth Bay and the offshore disposal site for dredged material.

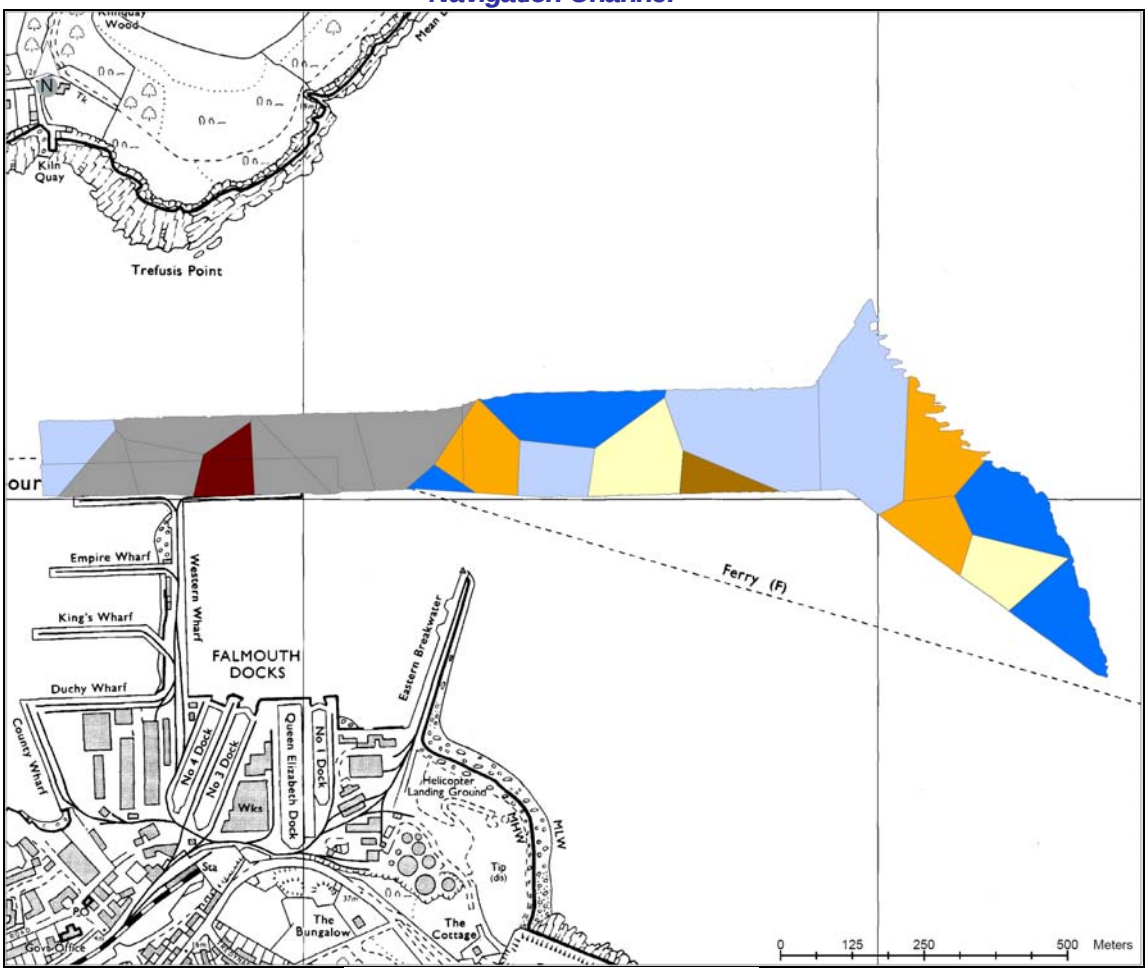
6.3.1 Physical Characteristics

Falmouth Docks and the Proposed New Navigation Channel

PSA data from the 2004 and 2007 surveys described in Section 6.2.3 are used to characterise the seabed substrate types of the proposed capital dredging area and new navigation channel. As shown in Figure 6-4:

- fine-grained material, notably clay, forms the majority of sediment exposed across the western part of the navigation channel including the berth off the Queens and Northern Wharves; and
- medium- and coarse-grained material, notably maerl and sand, forms the majority of sediment exposed across the eastern part of the navigation channel.

Figure 6-4 Existing Substrate Types forming the Seabed of the Proposed New Navigation Channel



Clay

Clay with frequent Maerl

Maerl

Mud with frequent Maerl

Sand

Sand with frequent Maerl

Sand / Gravel with Maerl

Fal Estuary and Impact Receptor Areas

Section 5.3.4 and Figure 5-5 provide a description of the seabed sediment characteristics around the Fal Estuary.

Falmouth Bay and the Offshore Dredged Material Disposal Site

According to Admiralty Chart No. 1267, the seabed at the disposal site consists of shelly sand and is believed to be characteristic of the surrounding area. Marine monitoring information from 2004 (provided by Cefas) identifies that the seabed within and around the offshore disposal site comprises mud and sand and, in some areas, shells.

6.3.2 Chemical Characteristics: Organo-tins

Falmouth Docks and the Proposed New Navigation Channel

It is well documented that the sediment in and around Falmouth Docks contains significantly elevated concentrations of TBT and its breakdown products, largely due to the consequences of historical dry dock activities involving the stripping and application of anti-fouling paint. High concentrations, particularly concentrations exceeding 1mg/kg, indicate the presence of particles and/or flakes of anti-fouling paint within the sediment, and it is documented that sediment in and around Falmouth Docks contains TBT in these forms (e.g. Posford Duvivier, 1998; Wardell Armstrong, 2006).

The 2005 and 2007 surveys of the capital dredge area show that the highest concentrations of TBT and DBT are present at concentrations above 1mg/kg in the surface sediment within the western part of the new navigation channel and the cruise berth along the Queens and Northern Wharves. The highest concentrations were recorded from surface sediment taken from sampling stations located off the Northern Wharf:

- 3.466mg/kg for TBT and 1mg/kg for DBT in 2005; and
- 1.468mg/kg for TBT and 0.626mg/kg for DBT in 2007.

The lowest concentrations of TBT and DBT are present at concentrations near or below the analytical detection limit (<0.002mg/kg in 2005 and <0.001mg/kg in 2007) in much of the sub-surface sediment within the western part of the new navigation channel and the cruise berth and the surface and sub-surface sediment within the eastern part of the new navigation channel.

The distribution of TBT and DBT is reflected in the comparison of the TBT and DBT data against Cefas's action levels for both the 2004 survey (see Table 6-4) and the 2007 survey (see Table 6-5). The surface sediment within the western part of the navigation channel and the cruise berth contains TBT and DBT at concentrations either exceeding Action Level 1 (0.01mg/kg) or Action Level 2 (1mg/kg). All other samples record TBT and DBT at concentrations below Cefas Action Level 1, except for one sub-surface sample (2m depth) at the eastern end of the navigation channel, which just exceeds Cefas Action Level 1. [Note: there are no Canadian sediment quality guidelines for TBT and DBT.]

Table 6-4 2005 Survey – Organo-tins Comparison to Cefas Action Levels

Location	Depth	TBT	DBT
VC 1-1	Surface	1.664	0
VC 1-1	1m	<0.002	<0.001
VC 1-1	1.8	<0.002	<0.001
VC 1-2	Surface	0.754	0.129
VC 1-2	1m	<0.001	<0.001
VC 1-3	Surface	1.651	0.327
VC 2-1	Surface	0.097	0.018
VC 2-1	1.5m	<0.002	<0.001
VC 2-1	3.0m	<0.002	<0.001
VC 2-2	Surface	3.466	1
VC 2-2	1.5m	<0.001	<0.001
VC 4-1	Surface	<0.002	<0.001
VC 4-1	1m	<0.002	<0.001
VC 4-1	2.5m	<0.002	<0.001
VC 4-2	Surface	<0.002	<0.001
VC 4-2	1m	<0.002	<0.001
VC 4-2	2.5m	<0.002	<0.002
VC 4-3	Surface	0.014	<0.002
VC 4-3	1m	<0.002	<0.001
VC 4-3	2.5m	<0.002	<0.002
VC 4-4	Surface	<0.002	<0.002
VC 4-4	1m	<0.002	<0.002
VC 4-4	2.5m	0.014	<0.002

Table 6-5 2007 Survey – Organo-tins Comparison to Cefas Action Levels

Location and Depth	TBT	DBT
VC1 - 0m	0.381	0.209
VC1 - 1m	0.012	0.002
VC1 - 2m	<0.001	0.004
VC1 - 3m	0.019	<0.001
VC2 - 0m	1.468	0.626
VC3 - 0m	0.318	0.214
VC3 - 1m	0.015	0.005
VC4 - 0m	0.635	0.342
VC4 - 1m	0.023	0.008
VC4 - 2m	0.025	0.004
VC4 - 3m	0.026	0.006
VC6 - 0m	0.039	0.02
VC6 - 1m	<0.001	0.003
VC6 - 2m	<0.001	0.001
VC7 - 0m	0.011	0.01
VC7 - 1m	0.002	0.001
VC7 - 2m	0.002	0.001
VC7 - 3m	<0.001	0.002
VC8 - 0m	0.005	0.004
VC8 - 1m	<0.001	<0.001
VC8 - 2m	<0.001	<0.001
VC8 - 3m	0.004	0.001
VC9 - 0m	0.001	0.003
VC9 - 1m	0.002	0.001
VC9 - 2m	0.115	0.052
VC9 - 3m	0.014	0.003
VC10 - 0m	0.001	0.004
VC10 - 1m	0.004	0.002
VC10 - 2m	0.003	0.003
VC10 - 3m	<0.001	0.001

Fal Estuary and Impact Receptor Areas

The 2007 survey shows that the highest concentrations of TBT and DBT are present at concentrations above 0.1mg/kg in the surface sediment within the western part of Falmouth Harbour (near two marinas) and in the Penryn River. This distribution probably reflects the historical use of anti-fouling paint on smaller vessels, although a ban on the use of TBT-based anti-fouling paints on vessels <25m has been in place since 1987.

Lower concentrations of TBT and DBT are present at concentrations near or below the analytical detection limit (<0.001mg/kg) in the surface sediment within the other potential impact receptor areas around the lower Fal estuary. Interestingly, DBT concentrations are generally higher than TBT concentrations, indicating that TBT concentrations are reducing as TBT slowly breaks down to DBT, MBT and eventually elemental tin (Sn).

The distribution of TBT and DBT is reflected in the comparison of the TBT and DBT data against the Cefas action levels (see Table 6-6 and Figure 6-5). The surface sediment within the western part of Falmouth Harbour contains TBT and DBT at concentrations exceeding Action Level 1 (0.01mg/kg). All other samples record TBT and DBT at concentrations below Cefas Action Level 1. [Note: there are no Canadian sediment quality guidelines for TBT and DBT.]

Table 6-6 2007 Survey – Organo-tins Comparison to Cefas Action Levels

Receptor Area	TBT	DBT
1	0.294	0.149
2	0.282	0.181
3	0.474	0.231
4	0.001	0.007
5	0.002	0.01
6	0.01	0.009
7	0.003	0.009
8	0.01	0.013
9	0.001	0.009
10	<0.001	0.008
11	<0.001	0.004
12	<0.001	0.008

The datasets available and used by PMSP (2003) indicate that TBT is present in large parts of the Fal Estuary, particularly near the estuary's mouth. The datasets available and used by Wardell Armstrong (2006) identify 'hotspots' of TBT in sediments in and around Falmouth Docks, Penryn, Mylor and St. Mawes harbours, associated with anti-fouling paint used in dry dock, shipping and leisure sailing activities.

Figure 6-5 TBT concentrations around Falmouth, Penryn and Mylor (source: Wardell Armstrong, 2006)

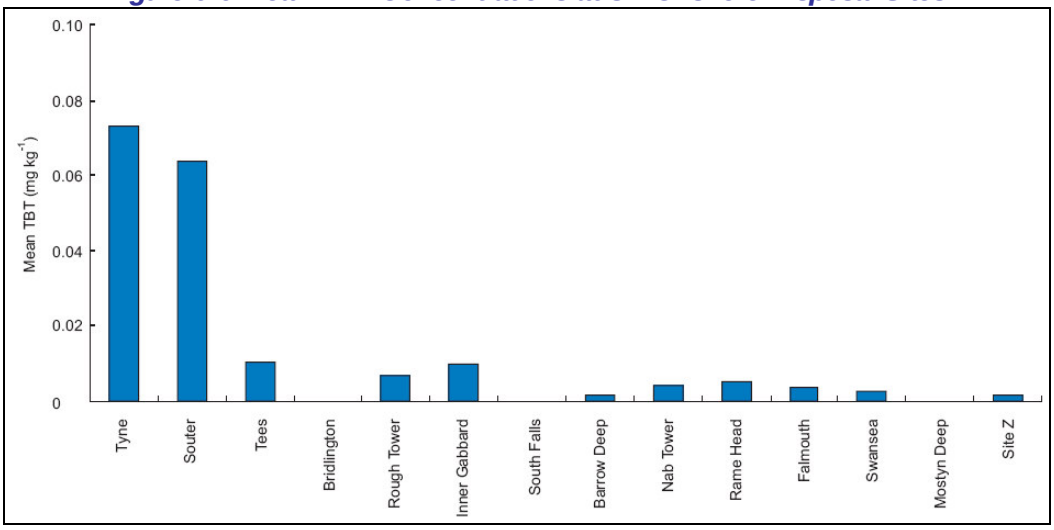


Falmouth Bay and the Offshore Dredged Material Disposal Site

Marine monitoring information from 2004 and 2006 was provided by Cefas and identifies that the seabed within and around the offshore disposal site contains TBT and DBT at concentrations below 0.001µg/kg (i.e. the analytical limit of detection). This data is consistent with data published by Cefas (2007).

Cefas (2005) results for TBT and DBT from a number of offshore disposal sites include results for Falmouth Bay offshore disposal site. Figure 6-6 identifies the mean concentrations of TBT at the disposal sites, including the Falmouth Bay disposal site.

Figure 6-6 Mean TBT Concentrations at UK Offshore Disposal Sites



A summary of the data is provided in Cefas (2005) and shows that of 17 samples:

- the mean and maximum TBT concentrations were 0.004mg/kg and 0.029mg/kg respectively; and
- the mean and maximum DBT concentrations were 0.003mg/kg and 0.008mg/kg respectively

Of the 17 samples, the maximum value for TBT (0.029mg/kg was the one relatively high concentration recorded at the Falmouth Bay disposal site. All data are below Cefas Action Level 1 (0.1mg/kg).

6.3.3 Chemical Characteristics: Metals

Falmouth Docks and the Proposed New Navigation Channel

It is well documented that the Fal estuary is subject to significant contamination by various metals (e.g. As, Cu, Pb, Sn and Zn) as a result of centuries of inputs of metal-rich waters that drain from inland mining areas to the estuary via Restronguet Creek. Consequently, metal concentrations in surface sediments tend to reduce with distance from Restronguet Creek (e.g. PMSP, 2003).

The 2005 survey of the capital dredge area shows that the highest concentrations of metals are present in the surface and, for some sampling stations, in sub-surface

sediment within the western part of the new navigation channel and the cruise berth along the Queens and Northern Wharves. The 2007 survey shows a similar distribution, but also shows some elevated concentrations of Cu, Hg, Pb and Zn in sediment further east along the proposed new navigation channel, as represented by VC4, but this is expected to be a hot-spot of contamination given its inconsistency with the 2004 survey.

The lowest concentrations of metals are present in much of the surface and sub-surface sediment within the eastern part of the new navigation channel.

The distribution of metals is reflected in the comparison of the metals data against the Cefas action levels and Canadian sediment quality guidelines for both the 2004 survey (see Tables 6-7 and 6-8) and the 2007 survey (see Tables 6-9 and 6-10). The surface sediment within the western part of the navigation channel and the cruise berth contains:

- As, Cu, Hg, Pb and Zn at concentrations either exceeding Cefas Action Level 1 / Canadian TEL or Cefas Action Level 2 / Canadian PEL;
- Ni at concentrations exceeding largely exceeding Cefas Action Level l; and
- Cd and Cr at concentrations largely below Cefas Action Level 1 / Canadian TEL.

The surface sediment within the eastern part of the navigation channel contains:

- As, Cd, Cr, Cu, Hg, Pb and Zn at concentrations largely below Cefas Action Level 1 / Canadian TEL; and
- Ni at concentrations either exceeding or below Cefas Action Level l.

Table 6-7 2004 Survey – Metals Comparison to Cefas Action Levels

Location	Depth	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
VC 1-1	Surface	38	0.14	24	183	1.50	21	87	295
VC 1-1	1m	3	0.26	22	11	0.14	21	12	56
VC 1-1	1.8m	4	0.14	21	7	<0.01	16	9	42
VC 1-2	Surface	17	0.08	11	77	1.1	13	41	175
VC 1-2	1m	11	<0.01	18	13	0.02	18	15	43
VC 2-1	Surface	88	0.5	45	404	7.2	39	373	622
VC 2-1	1.5m	15	0.28	39	28	0.24	37	27	128
VC 2-1	3.0m	13	0.20	35	17	0.06	35	18	81
VC 2-2	Surface	42	0.22	35	329	2.10	38	244	882
VC 4-1	1m	<0.22	0.02	1.3	0.3	<0.01	0.76	0.64	4.2
VC 4-2	Surface	1.8	<0.09	6.5	6.6	0.04	4.8	4.9	154
VC 4-2	1m	0.27	<0.08	2.9	0.79	<0.01	2.4	1.1	9.3
VC 4-2	2.5m	0.85	<0.08	6.7	2.3	<0.01	6	2.3	19
VC 4-3	1m	0.25	<0.07	3.6	1.1	<0.01	2.6	1.4	9.9
VC 4-3	2.5m	2.5	<0.09	8.3	3.9	0.01	9	4.1	27
VC 4-4	Surface	5.2	<0.13	15	15	0.03	15	9.3	47
VC 4-4	2.5m	10	0.29	43	19	0.05	44	21	94

Table 6-8 2004 Survey – Metals Comparison to Canadian Sediment Quality Guidelines

Location	Depth	As	Cd	Cr	Cu	Hg	Pb	Zn
VC 1-1	Surface	38	0.14	24	183	1.50	87	295
VC 1-1	1m	3	0.26	22	11	0.14	12	56
VC 1-1	1.8m	4	0.14	21	7	<0.01	9	42
VC 1-2	Surface	17	0.08	11	77	1.1	41	175
VC 1-2	1m	11	<0.01	18	13	0.02	15	43
VC 2-1	Surface	88	0.5	45	404	7.2	373	622
VC 2-1	1.5m	15	0.28	39	28	0.24	27	128
VC 2-1	3.0m	13	0.20	35	17	0.06	18	81
VC 2-2	Surface	42	0.22	35	329	2.10	244	882
VC 4-1	1m	<0.22	0.02	1.3	0.3	<0.01	0.64	4.2
VC 4-2	Surface	1.8	<0.09	6.5	6.6	0.04	4.9	154
VC 4-2	1m	0.27	<0.08	2.9	0.79	<0.01	1.1	9.3
VC 4-2	2.5m	0.85	<0.08	6.7	2.3	<0.01	2.3	19
VC 4-3	1m	0.25	<0.07	3.6	1.1	<0.01	1.4	9.9
VC 4-3	2.5m	2.5	<0.09	8.3	3.9	0.01	4.1	27
VC 4-4	Surface	5.2	<0.13	15	15	0.03	9.3	47
VC 4-4	2.5m	10	0.29	43	19	0.05	21	94

Table 6-9 2007 Survey – Metals Comparison to Cefas Action Levels

Location and Depth	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
VC1 - 0m	41.11	0.2465	21.64	150.0	1.680	21.88	118.0	306.3
VC1 - 1m	12.83	0.1957	21.04	10.34	0.045	23.06	16.95	63.37
VC1 - 2m	13.00	0.1672	18.35	10.06	0.124	20.12	16.10	62.46
VC1 - 3m	10.60	0.2032	18.71	8.589	0.022	19.31	14.06	60.16
VC2 - 0m	52.30	0.4069	24.26	216.5	2.789	25.90	274.1	562.0
VC3 - 0m	24.42	0.1699	18.76	90.05	4.220	21.36	84.65	215.7
VC3 - 1m	6.142	0.0480	23.44	21.93	0.051	26.38	21.00	54.51
VC4 - 0m	46.41	0.3511	22.55	251.5	17.02	26.71	216.4	447.2
VC4 - 1m	6.142	0.1382	16.47	6.755	0.309	19.32	9.415	40.81
VC4 - 2m	14.35	0.2702	25.96	13.73	0.079	28.69	16.34	69.16
VC4 - 3m	27.05	0.0257	21.43	11.35	0.062	17.69	13.50	44.83
VC6 - 0m	22.66	0.1949	23.80	89.86	3.294	25.13	80.20	180.1
VC6 - 1m	19.30	0.1414	11.41	72.00	8.884	15.75	88.61	114.8
VC6 - 2m	4.291	0.1849	18.56	8.919	0.071	22.53	15.00	61.59
VC7 - 0m	15.09	0.0620	16.66	48.61	0.235	18.85	32.80	90.21
VC7 - 1m	8.981	0.1220	18.70	10.71	0.030	23.20	12.92	53.64
VC7 - 2m	8.859	0.1712	26.59	12.92	0.041	28.48	16.67	62.00
VC7 - 3m	5.760	0.1588	24.51	12.93	0.043	29.05	14.91	63.03
VC8 - 0m	15.64	0.0532	21.43	30.59	0.813	21.90	33.77	89.42
VC8 - 1m	7.058	0.1197	18.02	8.769	0.009	20.11	11.11	44.95
VC8 - 2m	8.379	0.1858	22.50	10.99	0.011	24.18	13.41	57.86
VC8 - 3m	14.33	0.0758	26.27	12.49	0.042	19.67	16.48	45.47
VC9 - 0m	7.595	0.0828	16.18	17.81	0.097	17.67	16.62	50.61
VC9 - 1m	4.432	0.1113	24.79	11.10	<0.006	25.54	14.88	59.25
VC9 - 2m	5.887	0.1710	19.97	11.89	0.128	24.71	15.57	62.21
VC9 - 3m	6.529	0.1186	23.19	9.300	0.018	28.33	14.40	59.39
Location and Depth	**As**	**Cd**	**Cr**	**Cu**	**Hg**	**Ni**	**Pb**	**Zn**

VC10 - 0m	12.97	0.0617	20.52	33.71	0.110	17.71	30.04	78.14
VC10 - 1m	4.247	0.1358	23.14	8.855	<0.006	25.25	13.61	48.77
VC10 - 2m	6.579	0.1285	20.62	11.26	0.040	24.52	14.85	42.88
VC10 - 3m	3.240	0.1471	22.54	7.967	0.030	26.30	12.86	40.37

Table 6-10 2007 Survey – Metals Comparison to Canadian Sediment Quality Standards

Location and Depth	As	Cd	Cr	Cu	Hg	Pb	Zn
VC1 - 0m	41.11	0.2465	21.64	150.0	1.680	118.0	306.3
VC1 - 1m	12.83	0.1957	21.04	10.34	0.045	16.95	63.37
VC1 - 2m	13.00	0.1672	18.35	10.06	0.124	16.10	62.46
VC1 - 3m	10.60	0.2032	18.71	8.589	0.022	14.06	60.16
VC2 - 0m	52.30	0.4069	24.26	216.5	2.789	274.1	562.0
VC3 - 0m	24.42	0.1699	18.76	90.05	4.220	84.65	215.7
VC3 - 1m	6.142	0.0480	23.44	21.93	0.051	21.00	54.51
VC4 - 0m	46.41	0.3511	22.55	251.5	17.02	216.4	447.2
VC4 - 1m	6.142	0.1382	16.47	6.755	0.309	9.415	40.81
VC4 - 2m	14.35	0.2702	25.96	13.73	0.079	16.34	69.16
VC4 - 3m	27.05	0.0257	21.43	11.35	0.062	13.50	44.83
VC6 - 0m	22.66	0.1949	23.80	89.86	3.294	80.20	180.1
VC6 - 1m	19.30	0.1414	11.41	72.00	8.884	88.61	114.8
VC6 - 2m	4.291	0.1849	18.56	8.919	0.071	15.00	61.59
VC7 - 0m	15.09	0.0620	16.66	48.61	0.235	32.80	90.21
VC7 - 1m	8.981	0.1220	18.70	10.71	0.030	12.92	53.64
VC7 - 2m	8.859	0.1712	26.59	12.92	0.041	16.67	62.00
VC7 - 3m	5.760	0.1588	24.51	12.93	0.043	14.91	63.03
VC8 - 0m	15.64	0.0532	21.43	30.59	0.813	33.77	89.42
VC8 - 1m	7.058	0.1197	18.02	8.769	0.009	11.11	44.95
VC8 - 2m	8.379	0.1858	22.50	10.99	0.011	13.41	57.86
VC8 - 3m	14.33	0.0758	26.27	12.49	0.042	16.48	45.47
VC9 - 0m	7.595	0.0828	16.18	17.81	0.097	16.62	50.61
VC9 - 1m	4.432	0.1113	24.79	11.10	<0.006	14.88	59.25
VC9 - 2m	5.887	0.1710	19.97	11.89	0.128	15.57	62.21
VC9 - 3m	6.529	0.1186	23.19	9.300	0.018	14.40	59.39
VC10 - 0m	12.97	0.0617	20.52	33.71	0.110	30.04	78.14
VC10 - 1m	4.247	0.1358	23.14	8.855	<0.006	13.61	48.77
VC10 - 2m	6.579	0.1285	20.62	11.26	0.040	14.85	42.88
VC10 - 3m	3.240	0.1471	22.54	7.967	0.030	12.86	40.37

Fal Estuary and Impact Receptor Areas

The datasets available and used by PMSP (2003) indicate that there are elevated concentrations of metals in all rivers and tributaries of the Fal Estuary. Arsenic concentrations are particularly high in and around Restronguet Creek and Mylor Creek (up to 5,515mg/kg), reflecting former mining activity. Copper, lead and zinc concentrations are highest in and around Restronguet Creek. Mercury concentrations are highest in Mylor Creek (0.9mg/kg) and at the mouth of Restronguet Creek (1mg/kg). Cadmium concentrations are highest in Restronguet Creek (12.6mg/kg). Pirrie ***et al***. (2003) note a clear spatial distribution for the metals

arsenic, copper, lead and zinc. Maximum concentrations occur to the west (Restronguet Creek) and north (Calenick Creek and the Tresillian River) of the upper estuary, and lowest concentrations to the east. The metals are derived from mining waste entering the estuary from Restronguet Creek and are distributed by the dominant tidal flow directions to both north and south.

The 2007 survey of the potential impact receptor areas shows elevated concentrations of As, Cu, Hg, Pb, Ni and Zn at all sampling stations. Cd and Cr concentrations are generally lower at all sampling stations. Concentrations of all metals are slightly lower at sampling stations 11 (lower Percuil River) and 12 (off Pendennis).

The distribution of metals is reflected in the comparison of the metals data against the Cefas action levels and Canadian sediment quality guidelines for the 2007 survey (see Tables 6-11 and 6-12). The surface sediment at the potential impact receptor areas around the lower Fal estuary contains:

- As at concentrations largely exceeding Cefas Action Level 2 / Canadian PEL;
- Cu, Hg, Ni, Pb and Zn at concentrations either exceeding Cefas Action Level 1 / TEL and the Canadian PEL (but not Cefas Action Level 2); and
- Cd and Cr at concentrations below Cefas Action Level 1 / Canadian TEL.

Table 6-11 2007 Survey – Metals Comparison to Cefas Action Levels

Receptor Area	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
1	60.08	0.2388	31.66	329.4	2.086	28.48	159.6	356.8
2	61.50	0.2559	29.53	274.0	2.106	27.61	147.0	362.6
3	56.83	0.2722	31.43	343.5	2.314	28.55	180.6	397.7
4	30.92	0.1099	17.21	66.70	0.273	16.23	41.90	98.48
5	76.81	0.1456	23.22	218.3	0.535	24.60	64.42	275.9
6	72.07	0.1536	21.44	209.8	0.414	23.89	59.56	242.3
7	57.73	0.1224	24.36	169.6	0.434	25.82	71.69	219.8
8	55.77	0.1676	23.23	153.6	0.791	23.23	72.14	217.0
9	34.41	0.1016	20.34	88.56	0.290	23.21	57.68	138.5
10	28.58	0.1390	20.23	102.6	0.564	23.74	58.39	149.2
11	15.74	0.0885	13.71	38.14	0.243	24.98	26.59	90.35
12	19.01	0.0475	8.151	28.92	0.090	13.78	41.70	75.16

Table 6-12 2007 Survey – Metals Comparison to Canadian Sediment Quality Guidelines

Receptor Area	As	Cd	Cr	Cu	Hg	Pb	Zn
1	60.08	0.2388	31.66	329.4	2.086	159.6	356.8
2	61.50	0.2559	29.53	274.0	2.106	147.0	362.6
3	56.83	0.2722	31.43	343.5	2.314	180.6	397.7
4	30.92	0.1099	17.21	66.70	0.273	41.90	98.48
5	76.81	0.1456	23.22	218.3	0.535	64.42	275.9
6	72.07	0.1536	21.44	209.8	0.414	59.56	242.3
7	57.73	0.1224	24.36	169.6	0.434	71.69	219.8
8	55.77	0.1676	23.23	153.6	0.791	72.14	217.0
9	34.41	0.1016	20.34	88.56	0.290	57.68	138.5
10	28.58	0.1390	20.23	102.6	0.564	58.39	149.2
11	15.74	0.0885	13.71	38.14	0.243	26.59	90.35
12	19.01	0.0475	8.151	28.92	0.090	41.70	75.16

Falmouth Bay and the Offshore Dredged Material Disposal Site

Marine monitoring information from 2004 and 2006 was provided by Cefas but it did not include any data for metals.

6.3.4 Chemical Characteristics: PAHS

Falmouth Docks and the Proposed New Navigation Channel

The 2005 survey of the capital dredge area shows that the highest concentrations of metals are present in the surface sediment within the western part of the new navigation channel and the cruise berth along the Queens and Northern Wharves. The 2007 survey shows a similar distribution, but also shows some elevated concentrations of PAHs in sediment further east along the proposed navigation channel, as represented by VC6, but this is expected to be a hot-spot of contamination given its inconsistency with the 2004 survey. The lowest concentrations of PAHs are present in much of the surface and sub-surface sediment within the eastern part of the new navigation channel, where many concentrations are recorded near or at the analytical detection limit (i.e. <0.001mg/kg).

The distribution of PAHs is reflected in the comparison of the data against the Canadian sediment quality guidelines for both the 2005 survey (see Table 6-13) and the 2007 survey (see Table 6-14). The surface sediment within the western part of the navigation channel and the cruise berth contains PAHs at concentrations exceeding the Canadian TEL and, in some samples, the Canadian PEL. The sub-surface sediment within the western part of the navigation channel and the cruise berth surface and the sub-surface sediment within the eastern part of the navigation channel contains:

- PAHs except naphthalene at concentrations below the Canadian TEL; and
- Naphthalene at concentrations exceeding the Canadian TEL and, in one sample, the Canadian PEL.

Table 6-13 2004 Survey – PAHs Comparison to Canadian Sediment Quality Standards

Location and Depth	Acenaph-thene	Acenaph-thylene	Anthra-cene	Benz(a)-anthra-cene	Benzo(a)-pyrene	Chrysene
VCs1 - 0m	0.015	0.078	0.319	0.784	1.009	0.768
VCs2 - 0m	0.038	0.431	0.487	1.665	2.381	1.824
VCs2 - 1.5m	0.0016	0.024	0.0036	0.0085	0.0029	0.029
VCs4 - 0m	0.0006	0.0013	0.0038	0.0056	0.0039	0.018
Location and Depth	**Dibenz (a,h)-anthra-cene**	**Fluor-anthra-cene**	**Fluorene**	**Naph-thalene**	**Phen-anthrene**	**Pyrene**
VCs1 - 0m	0.255	1.224	0.1	0.207	1.043	1.031
VCs2 - 0m	0.442	3.56	0.258	0.558	2.507	3.792
VCs2 - 1.5m	0.0018	0.0066	0.013	0.094	0.012	0.006
VCs4 - 0m	0.0006	0.0044	0.0015	0.011	0.021	0.006

Table 6-14 2007 Survey – PAHs Comparison to Canadian Sediment Quality Standards

Location and Depth	Acenaph-thene	Acenaph-thylene	Anthra-cene	Benz(a)-anthra-cene	Benzo(a)-pyrene	Chrysene
VC1 - 0m	0.039	0.002	0.77	0.408	0.963	0.355
VC1 - 1m	0.003	<0.001	<0.001	<0.001	<0.001	<0.001
VC1 - 2m	0.002	<0.001	<0.001	<0.001	<0.001	<0.001
VC1 - 3m	0.003	<0.001	<0.001	<0.001	<0.001	<0.001
VC2 - 0m	0.096	0.006	0.197	0.991	2.698	0.852
VC3 - 0m	0.02	<0.001	0.05	0.185	0.422	0.19
VC3 - 1m	0.048	0.027	0.005	0.001	<0.001	0.004
VC4 - 0m	0.297	0.023	0.77	3.27	7.023	2.198
VC4 - 1m	0.057	<0.001	<0.001	0.022	<0.001	0.005
VC4 - 2m	0.003	<0.001	<0.001	0.004	<0.001	0.003
VC4 - 3m	0.003	<0.001	<0.001	0.007	<0.001	0.004
VC6 - 0m	0.045	0.006	0.08	0.398	0.872	0.414
VC6 - 1m	0.161	0.167	1.97	4.628	8.850	3.162
VC6 - 2m	0.003	<0.001	<0.001	<0.001	<0.001	<0.001
VC7 - 0m	<0.001	<0.001	<0.001	0.008	0.01	0.012
VC7 - 1m	0.002	<0.001	<0.001	0.002	<0.001	0.001
VC7 - 2m	0.002	<0.001	<0.001	<0.001	<0.001	<0.001
VC7 - 3m	0.002	<0.001	0.001	0.002	<0.001	0.001
VC8 - 0m	<0.001	<0.001	0.003	0.028	0.024	0.045
VC8 - 1m	0.002	<0.001	0.001	0.002	<0.001	0.004
VC8 - 2m	0.003	<0.001	<0.001	0.003	<0.001	0.002
VC8 - 3m	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
VC9 - 0m	0.002	<0.001	0.002	0.029	0.03	0.042
VC9 - 1m	0.003	<0.001	<0.001	0.004	<0.001	0.003
VC9 - 2m	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
VC9 - 3m	0.004	0.004	<0.001	<0.001	<0.001	<0.001
VC10 - 0m	0.004	0.004	0.003	0.012	0.009	0.018

Location and Depth	Acenaph-thene	Acenaph-thylene	Anthra-cene	Benz(a)-anthra-cene	Benzo(a)-pyrene	Chrysene
VC10 - 1m	0.005	0.005	<0.001	0.01	<0.001	0.008
VC10 - 2m	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
VC10 - 3m	0.003	<0.001	<0.001	<0.001	<0.001	<0.001
Location and Depth	**Dibenz (a,h)-anthra-cene**	**Fluor-anthra-cene**	**Fluorene**	**Naph-thalene**	**Phen-anthrene**	**Pyrene**
VC1 - 0m	0.035	0.675	0.034	0.172	0.295	0.471
VC1 - 1m	<0.001	0.002	0.003	0.157	0.006	0.002
VC1 - 2m	<0.001	0.003	0.003	0.15	0.006	0.003
VC1 - 3m	<0.001	0.003	0.003	0.17	0.005	0.005
VC2 - 0m	0.069	1.735	0.094	0.188	0.761	1.312
VC3 - 0m	0.018	0.383	0.021	0.201	0.218	0.282
VC3 - 1m	<0.001	0.008	0.038	0.23	0.053	0.004
VC4 - 0m	0.182	5.593	0.314	0.317	3.084	3.63
VC4 - 1m	<0.001	0.037	<0.001	0.526	0.023	0.01
VC4 - 2m	<0.001	0.006	0.004	0.183	0.007	0.004
VC4 - 3m	<0.001	0.005	0.004	0.203	0.008	0.009
VC6 - 0m	0.041	0.836	0.051	0.306	0.391	0.562
VC6 - 1m	0.19	9.002	0.524	0.359	5.435	5.886
VC6 - 2m	<0.001	0.003	0.004	0.166	0.008	0.005
VC7 - 0m	<0.001	0.01	0.003	0.113	0.008	0.012
VC7 - 1m	<0.001	0.002	0.003	0.071	0.007	0.003
VC7 - 2m	<0.001	0.002	0.002	0.081	0.005	0.002
VC7 - 3m	<0.001	0.002	0.003	0.096	0.007	0.003
VC8 - 0m	<0.001	0.035	<0.001	0.127	0.012	0.034
VC8 - 1m	<0.001	0.005	0.003	0.093	0.009	0.006
VC8 - 2m	<0.001	0.003	0.002	0.125	0.005	0.004
VC8 - 3m	<0.001	<0.001	<0.001	0.135	0.002	<0.001
VC9 - 0m	0.001	0.06	0.002	0.078	0.03	0.05
VC9 - 1m	<0.001	0.004	0.005	0.12	0.011	0.005
VC9 - 2m	<0.001	0.003	0.006	0.111	0.015	0.005
VC9 - 3m	<0.001	0.002	0.007	0.175	0.014	0.003
VC10 - 0m	<0.001	0.028	0.006	0.107	0.03	0.024
VC10 - 1m	<0.001	0.007	0.01	0.153	0.022	0.01
VC10 - 2m	<0.001	0.002	0.003	0.124	0.009	0.003
VC10 - 3m	<0.001	0.002	0.003	0.113	0.008	0.004

Fal Estuary and Impact Receptor Areas

The 2007 survey shows that the highest concentrations of PAHs are present at elevated concentrations at receptor areas 1, 2 and 3, located in the western part of Falmouth Harbour (near two marinas) and in the Penryn River. This distribution probably reflects inputs from road run-off and small-scale but regular spills of fuels from vessels.

Lower concentrations of all PAHs except naphthalene are present receptor areas 7, 8, 9, 10 and 11 located to the east of Carrick Road, and receptor area 12 located off Pendennis.

The distribution of PAHs is reflected in the comparison of the data against the Canadian sediment quality guidelines (see Table 6-15). The surface sediment within the western part of Falmouth Harbour (i.e. receptor areas 1, 2 and 3) contains PAHs at concentrations generally exceeding the Canadian TEL and PEL. All other receptor areas contain PAHs at concentrations below the Canadian TEL, with the exception of naphthalene.

PMSP (2003) report that there is does not appear to be any data for PAHs for the Fal estuary.

Table 6-15 2007 Survey – PAHs Comparison to Canadian Sediment Quality Standards

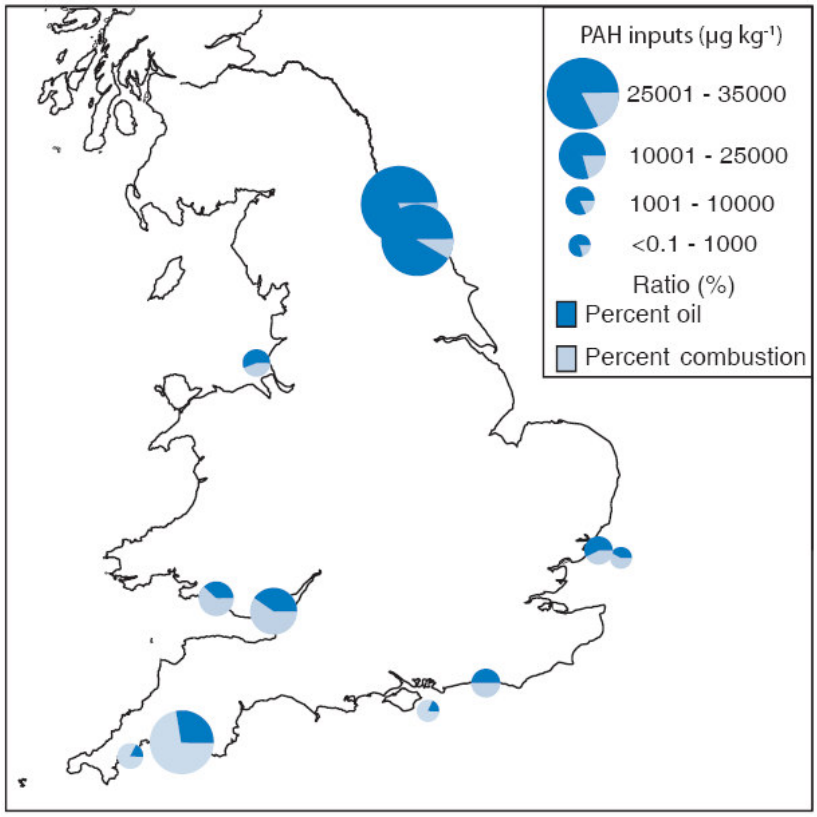
Receptor Area	Acenaph-thene	Acenaph-thylene	Anthra-cene	Benz(a)-anthra-cene	Benzo(a)-pyrene	Chrysene
1	0.042	0.008	0.022	0.848	1.925	1.044
2	0.079	0.004	0.4	2.448	5.661	2.122
3	0.083	0.023	0.344	1.867	4.17	1.732
4	0.007	<0.001	0.003	0.014	0.013	0.029
5	0.022	0.001	0.055	0.144	0.244	0.166
6	0.031	0.005	0.096	0.15	0.27	0.221
7	0.009	0.002	0.009	0.03	0.042	0.063
8	0.008	<0.001	0.015	0.043	0.061	0.081
9	<0.001	<0.001	0.005	0.014	0.018	0.026
10	0.072	0.001	0.01	0.033	0.03	0.058
11	0.004	0.002	0.004	0.006	<0.001	0.012
12	0.004	0.001	<0.001	0.003	<0.001	0.007
Receptor Area	**Dibenz (a,h)-anthra-cene**	**Fluor-anthra-cene**	**Fluorene**	**Naph-thalene**	**Phen-anthrene**	**Pyrene**
1	0.073	2.067	0.056	0.153	0.643	1.52
2	0.129	3.598	0.105	0.258	1.076	3.132
3	0.099	3.499	0.105	0.201	1.189	2.609
4	<0.001	0.023	0.008	0.124	0.034	0.023
5	0.01	0.327	0.024	0.148	0.23	0.0327
6	0.01	0.487	0.082	0.156	0.412	0.487
7	0.004	0.069	0.012	0.151	0.055	0.061
8	0.005	0.113	0.011	0.188	0.065	0.093
9	<0.001	0.037	0.004	0.168	0.025	0.035
10	<0.001	0.079	0.092	0.438	0.186	0.077
11	<0.001	0.015	0.007	0.138	0.022	0.014
12	<0.001	0.007	0.006	0.157	0.017	0.008

Falmouth Bay and the Offshore Dredged Material Disposal Site

Marine monitoring information from 2004 and 2006 was provided by Cefas but it did not include any data for PAHs.

Cefas (2005) identifies approximate PAHs concentrations at the Falmouth Bay offshore disposal site in the range <1 to 1000µg/kg, and identifies that the majority are combustion-derived rather than oil-derived (see Figure 6-7).

Figure 6-7 Locations of Offshore Disposal Sites and PAHs Concentrations (source: Cefas, 2005)



6.3.5 *Chemical Characteristics: PCBs*

Falmouth Docks and the Proposed New Navigation Channel

The 2004 and 2007 surveys show that the highest concentrations of total PCBs (i.e. the sum of 25 congeners) are elevated at various sampling station locations across the proposed new navigation channel, with the highest concentrations are recorded from surface and sub-surface sediment taken from sampling stations located in the western part of the new navigation channel and off the Northern Wharf. The lowest concentrations of total PCBs are generally present in the surface and sub-surface sediment within the eastern part of the new navigation channel.

The distribution of total PCBs is reflected in the comparison of the data against the Cefas Action Levels and Canadian sediment quality guidelines for both the 2004 survey (see Table 6-16) and the 2007 survey (see Table 6-17). Sediment within the

western part of the new navigation channel and the cruise berth contains total PCBs at concentrations largely exceeding Cefas Action Level 1 / Canadian TEL, although some concentrations are exceeding Cefas Action Level 1 / Canadian TEL.

Table 6-17 2004 Survey – PCBs (25 congeners) Comparison to Cefas Action Levels (left) and Canadian Sediment Quality Standards (right)

Location and Depth	Total PCBs
VCs1 - 0m	0.06561
VCs2 - 0m	0.2665
VCs2 - 1.5m	0.00022
VCs4 - 0m	0.279

Location and Depth	Total PCBs
VCs1 - 0m	0.06561
VCs2 - 0m	0.2665
VCs2 - 1.5m	0.00022
VCs4 - 0m	0.279

Table 6-17 2007 Survey – PCBs (25 congeners) Comparison to Cefas Action Levels (left) and Canadian Sediment Quality Standards (right)

Location and Depth	Total PCBs
VC1 - 0m	0.275
VC1 - 1m	0.007
VC1 - 2m	0.004
VC1 - 3m	0.023
VC2 - 0m	0.473
VC3 - 0m	0.47
VC3 - 1m	0.766
VC4 - 0m	0.004
VC4 - 1m	0.006
VC4 - 2m	0.006
VC4 - 3m	0.008
VC6 - 0m	0.061
VC6 - 1m	0.033
VC6 - 2m	0.053
VC7 - 0m	0.012
VC7 - 1m	0.015
VC7 - 2m	0.009
VC7 - 3m	0.014
VC8 - 0m	0.011
VC8 - 1m	0.008
VC8 - 2m	0.022
VC8 - 3m	0.036
VC9 - 0m	0.024
VC9 - 1m	0.019
VC9 - 2m	0.021
VC9 - 3m	0.029
VC10 - 0m	0.003
VC10 - 1m	0.001
VC10 - 2m	0.004
VC10 - 3m	0.004

Location and Depth	Total PCBs
VC1 - 0m	0.275
VC1 - 1m	0.007
VC1 - 2m	0.004
VC1 - 3m	0.023
VC2 - 0m	0.473
VC3 - 0m	0.47
VC3 - 1m	0.766
VC4 - 0m	0.004
VC4 - 1m	0.006
VC4 - 2m	0.006
VC4 - 3m	0.008
VC6 - 0m	0.061
VC6 - 1m	0.033
VC6 - 2m	0.053
VC7 - 0m	0.012
VC7 - 1m	0.015
VC7 - 2m	0.009
VC7 - 3m	0.014
VC8 - 0m	0.011
VC8 - 1m	0.008
VC8 - 2m	0.022
VC8 - 3m	0.036
VC9 - 0m	0.024
VC9 - 1m	0.019
VC9 - 2m	0.021
VC9 - 3m	0.029
VC10 - 0m	0.003
VC10 - 1m	0.001
VC10 - 2m	0.004
VC10 - 3m	0.004

Fal Estuary and Potential Impact Receptor Areas

The 2007 survey shows that the highest concentrations of total PCBs are present at elevated concentrations at receptor areas 1, 2 and 3, located in the western part of Falmouth Harbour (near two marinas) and in the Penryn River, and at receptor area 8 to the east of Carrick Roads. Lower concentrations of total PCBs are at the other receptor areas in the Fal estuary.

The distribution of total PCBs is reflected in the comparison of the data against the Canadian sediment quality guidelines (see Table 6-18). The surface sediment at receptor areas 1, 2, 3 and 8 contains total PCBs at concentrations exceeding the Canadian TEL. All other receptor areas contain total PCBs at concentrations below the Canadian TEL.

PMSP (2003) report that there is does not appear to be any data for PCBs for the Fal estuary.

Table 6-18 2007 Survey – PCBs (25 congeners) Comparison to Cefas Action Levels (left) and Canadian Sediment Quality Standards (right)

Receptor Area	Total PCBs
1	0.051
2	0.153
3	0.118
4	0.019
5	0.01
6	0.01
7	0.018
8	0.026
9	0.015
10	0.012
11	0.11
12	0.002

Receptor Area	Total PCBs
1	0.051
2	0.153
3	0.118
4	0.019
5	0.01
6	0.01
7	0.018
8	0.026
9	0.015
10	0.012
11	0.11
12	0.002

Falmouth Bay and the Offshore Dredged Material Disposal Site

Marine monitoring information from 2004 and 2006 was provided by Cefas but it did not include any data for PCBs.

6.3.6 Chemical Characteristics: OCPs

Falmouth Docks and the Proposed New Navigation Channel

In accordance with advice provided during consultation with the Environment Agency, analyses for OCPs were conducted on the sediment samples taken from the ten sampling stations within the proposed new navigation channel during the 2007 survey. The analytical results for OCPs (see Appendix B) identified that all sediment samples taken from the proposed new navigation channel contain:

- HCH compounds (alpha, beta, gamma and delta) at concentrations below the analytical detection limit of 2µg/kg (i.e. 0.002mg/kg);

- all the ‘drin compounds (aldrin, dieldrin, endrin and isodrin) at concentrations below the analytical detection limit of 2µg/kg; and
- all DDT and derivative compounds (DDE, DDD (TDE) and DDT) at concentrations below the analytical detection limit of 2µg/kg.

Comparison to available Canadian sediment quality guidelines indicates that concentrations less than 2µg/kg are below the TELs for DDD, dieldrin and endrin, and between the TEL and PEL for gamma HCH, DDT and DDE. However, since all survey data for OCPs are recorded below the analytical detection limit, which is not a defined concentration, it is assumed that these compounds are generally not present in the sediment.

Fal Estuary and Impact Receptor Areas

The analytical results for OCPs (see Appendix B) identified that all sediment samples taken from the potential impact receptor areas around the lower Fal estuary contain:

- HCH compounds (alpha, beta, gamma and delta) at concentrations below the analytical detection limit of 2µg/kg;
- ‘drin compounds (aldrin, dieldrin, endrin and isodrin) at concentrations below the analytical detection limit of 2µg/kg; and
- DDT and derivative compounds (DDE, DDD (TDE) and DDT) at concentrations below the analytical detection limit of 2µg/kg.

As described above, comparison to available Canadian sediment quality guidelines indicates that concentrations less than 2µg/kg are below the TELs for DDD, dieldrin and endrin, and between the TEL and PEL for gamma HCH, DDT and DDE. However, since all survey data for OCPs are recorded below the analytical detection limit, which is not a defined concentration, it is assumed that these compounds are generally not present in the sediment.

PMSP (2003) report that there is little data for organic contaminants, including OCPs, for the Fal estuary apart from data recorded at off Falmouth at Middle Point in 1990-1994. These data include for gamma HCH, ‘drin compounds, and DDT and derivative compounds and are largely recorded at concentrations below detection limits. This is consistent with the results of the 2007 survey for the potential impact receptor areas.

Falmouth Bay and the Offshore Dredged Material Disposal Site

Marine monitoring information from 2004 and 2006 was provided by Cefas but it did not include any data for OCPs.

6.3.7 Biological Characteristics: Bacteria

Falmouth Docks and the Proposed New Navigation Channel

In accordance with advice provided during consultation with the Environment Agency, analyses for faecal coliforms and faecal streptococci were conducted on surface sediment samples taken from the ten sampling stations within the proposed new navigation channel during the 2007 survey. The analyses were performed on

surface sediment samples only because research indicates that bacteria “are more abundant in the top one or two centimetres of sediment, and that they are seldom isolated from depths greater than 4cm” (WS Atkins, 2000).

The analytical results for bacteria identified that:

- all of the surface sediment samples taken from the proposed new navigation channel contain faecal coliforms at concentrations below the analytical detection limit of 100 colony forming units per 100 grams of sediment (cfu/100g); and
- all but one of the surface sediment samples taken from the proposed new navigation channel contain faecal streptococci at concentrations below the analytical detection limit of 100 cfu/100g: sampling station VC7 contains faecal coliforms at 100 cfu/100g (i.e. immediately above the detection limit).

Since all survey data are recorded below the analytical detection limit, which is not a defined concentration, it is assumed that faecal coliforms and faecal streptococci are generally not present in the sediment.

Fal Estuary and Impact Receptor Areas

In accordance with advice provided during consultation with the Environment Agency, analyses for faecal coliforms and streptococci were conducted on surface sediment samples taken from the twelve sampling stations during the 2007 survey representing potential impact receptor areas.

The analytical results for bacteria identified that:

- all but one of the surface sediment samples taken from the potential impact receptor areas contain faecal coliforms at concentrations below the analytical detection limit of 100 cfu/100g: sampling station 1 contains faecal coliforms at 200 cfu/100g; and
- all but two of the surface sediment samples taken from the potential impact receptor areas contain faecal streptococci at concentrations below the analytical detection limit of 100 cfu/100g: sampling stations 7 and 9 contain faecal streptococci at 101 cfu/100g and 360 cfu/100g respectively.

Since all survey data are recorded below the analytical detection limit, which is not a defined concentration, it is assumed that faecal coliforms and faecal streptococci are generally not present in the sediment.

Falmouth Bay and the Offshore Dredged Material Disposal Site

Marine monitoring information from 2004 and 2006 was provided by Cefas but it did not include any data for bacteria.

6.3.8 Biological Characteristics: Algal Biotoxins

Falmouth Docks and the Proposed New Navigation Channel

In accordance with advice provided during consultation with the Environment Agency, analyses for dinoflagellate algal cysts capable of inducing paralytic shellfish poisoning (PSP) (i.e. ***Alexandrium*** sp.) were conducted on surface sediment

samples taken from the ten sampling stations within the proposed new navigation channel during the 2007 survey.

The analytical results for algal cysts identified that:

- eight of the surface sediment samples taken from the new navigation channel contain Alexandrium sp. (as A. minutum) at concentrations below the analytical detection limit of 1 Alexandrium sp. cyst per millilitre of sediment (cyst/ml): sampling stations VC2-VC6 and VC8-VC10 contain no Alexandrium sp.; and
- two of the surface sediment samples taken from the new navigation channel contain Alexandrium sp. (as A. minutum) at concentrations at the analytical detection limit of 1 cyst/ml: sampling stations VC1 and VC7 contain Alexandrium sp. at 1 cyst/ml.

Fal Estuary and Impact Receptor Areas

The concentrations of algal biotoxins in the Fal Estuary and impact receptor areas are believed to be similar to those recorded in Falmouth Docks and the new navigation channel. Comparison to work on the Fal Estuary by Blanco (2005) found that "Although the areas sampled and method of analysis are not directly comparable, the number of cysts found in the [Falmouth Cruise Project] samples is within the ranges found for A. minutum in the Blanco study" (Higman, 2007; see Appendix B).

Falmouth Bay and the Offshore Dredged Material Disposal Site

Marine monitoring information from 2004 and 2006 was provided by Cefas but it did not include any data for algal biotoxins.

6.3.9 Sediment Toxicity: Whole Sediment Bioassay

Falmouth Docks and the Proposed New Navigation Channel

Analyses for acute toxicity (i.e. mortality endpoint) and sub-lethal effects (i.e. reduction in casting endpoint) were conducted on whole sediment samples taken from one sampling station within the proposed new navigation channel (i.e. VC2) during the 2007 survey. Sampling station VC2 was chosen since it represents the most contaminated part of the capital dredge area and therefore provides an indication of the worst-case conditions of sediment toxicity for the proposed Falmouth Cruise Project.

The analytical results for whole sediment acute toxicity using the marine amphipod ***C. volutator*** identified that:

- a control sample (based on a muddy sand reference sediment from Shoebury Sands) causes mortality at 4% (i.e. a mean survival rate of 96%);
- a whole sediment sample taken from the capital dredge area at sampling station VC2 causes mortality at 40% (i.e. a mean survival rate of 60%).

The analytical results for whole sediment acute toxicity using the lugworm A. marina identified that:

- a control sample (based on a muddy sand reference sediment from Shoebury Sands) causes mortality at 8% (i.e. a mean survival rate of 92%); and
- whole sediment samples taken from the capital dredge area at sampling stations VC2 causes mortality of at 4% (i.e. a mean survival rate of 96%).

In terms of acute toxicity, comparison of mean survival rates found that:

- mean survival of ***C. volutator*** in the VC2 sediment was 36% lower than the control sample, which was statistically significant ($p < 0.05$), indicating an acute toxic effect; and
- mean survival of ***A. marina*** in VC2 sediment was not significantly different from the control sample ($p>0.05$), indicating no acute toxic effect (Allen and Tolhurst, 2007; see Appendix B).

Comparison of VC2 results to mortality endpoints identified in Jones and Franklin (1998) indicates:

- acute toxicity using the marine amphipod ***C. volutator*** records mortality at 40% (i.e. a mean survival rate of 60%), which correlates to 'slightly impaired' sediment quality;
- acute toxicity using the lugworm ***A. marina*** records mortality at 4% (i.e. a mean survival rate of 96%), which correlates to 'good' sediment quality; and

Comparison of VC2 results to an initial pass/fail criterion for dredged material assessment for sea disposal identified in Roddie (1997) indicates:

- acute toxicity using the marine amphipod ***C. volutator*** records mortality at 40% (i.e. a mean survival rate of 60%), which correlates to a borderline pass/fail for sea disposal; and
- acute toxicity using the lugworm ***A. marina*** records mortality at 4% (i.e. a mean survival rate of 96%), which correlates to a pass for sea disposal.

The analytical results for whole sediment sub-lethal effect using the lugworm ***A. marina*** identified that:

- a control sample (based on a muddy sand reference sediment from Shoebury Sands) has a mean daily casting rate of 3.72 casts per day; and
- a whole sediment sample taken from the capital dredge area at sampling station VC2 causes a mean daily casting rate of 2.84 casts per day.

In terms of sub-lethal effects, comparison of casting rates found that the casting rate was reduced in the whole sediment sample taken from the proposed new navigation channel at sampling station VC2 to 76% of the control sample rate, indicating a sub-lethal effect (Allen and Tolhurst, 2007; see Appendix B).

Comparison of VC2 results to reduced casting endpoints identified in Jones and Franklin (1998) indicates:

- sub-lethal toxicity using the lugworm ***A. marina*** records a reduced casting rate at 4% (i.e. a mean survival rate of 96%), which correlates to 'good' sediment quality***.***

Fal Estuary and Impact Receptor Areas

The toxicity of whole sediment in the Fal Estuary and impact receptor areas is believed to reflect the chemical characteristics of the sediment. Accordingly,

sediments in the western part of Falmouth Harbour (i.e. impact receptor areas 1, 2 and 3) are believed to exhibit similar toxicity characteristics to the western part of the proposed new navigation channel, as characterised by the whole sediment toxicity recorded from the sample at VC2.

Falmouth Bay and the Offshore Dredged Material Disposal Site

Marine monitoring information from 2004 and 2006 was provided by Cefas but it did not include any data for whole sediment bioassays.

6.3.10 Sediment Toxicity: Sediment Elutriate Bioassay

Falmouth Docks and the Proposed New Navigation Channel

In addition, analyses for acute toxicity were conducted on one sediment elutriate sample taken from within the proposed new navigation channel (i.e. VC2) during the 2007 survey. The results are used to calculate the median 24 hours effect concentration (EC_{50}), the No Observed Effect Concentration (NOEC) and the Lowest Observed Effect Concentration (LOEC) in terms of the percentage of sediment (by weight) to water (by volume) (%w/v), which corresponds to a sediment to water ratio.

The analytical results for whole sediment acute toxicity using the oyster embryo ***C. gigas*** identified that the sediment elutriate sample derived from the capital dredge area at sampling station VC2 has:

- an EC_{50} of 32.7%w/v (1:3.06);
- a NOEC of 25%w/v (1:4); and
- a LOEC of 33.3%w/v (1:3).

These results indicate that sediment elutriate sample from the capital dredge area at sampling station VC2 exhibits acute toxic effects to oyster embryos (Allen and Tolhurst, 2007; see Appendix B).

Fal Estuary and Impact Receptor Areas

The toxicity of sediment elutriate in the Fal Estuary and impact receptor areas is believed to reflect the chemical characteristics of the sediment. Accordingly, sediments in the western part of Falmouth Harbour (i.e. impact receptor areas 1, 2 and 3) are believed to exhibit similar toxicity characteristics to the western part of the proposed new navigation channel, as characterised by the sediment elutriate toxicity recorded from the sample at VC2.

Falmouth Bay and the Offshore Dredged Material Disposal Site

Marine monitoring information from 2004 and 2006 was provided by Cefas but it did not include any data for sediment elutriate bioassays.

6.4 POTENTIAL IMPACTS DURING THE CONSTRUCTION PHASE

6.4.1 *Impact on Sediment Quality in the New Navigation Channel due to Capital Dredging*

Capital dredging for the proposed new navigation channel will remove the sediment comprising the seabed surface and will uncover a new seabed with new physical, chemical, biological and sediment toxicity characteristics.

Physical Changes

The physical characteristics of the present seabed are described in Section 6.3.1. In summary, the present seabed exposes (i.e. at its surface) fine-grained material, notably clay, across the western part of the navigation channel including the berth off the Queens and Northern Wharves, and medium- and coarse-grained material, notably maerl and sand, across the eastern part of the navigation channel, as shown on Figure 6-4.

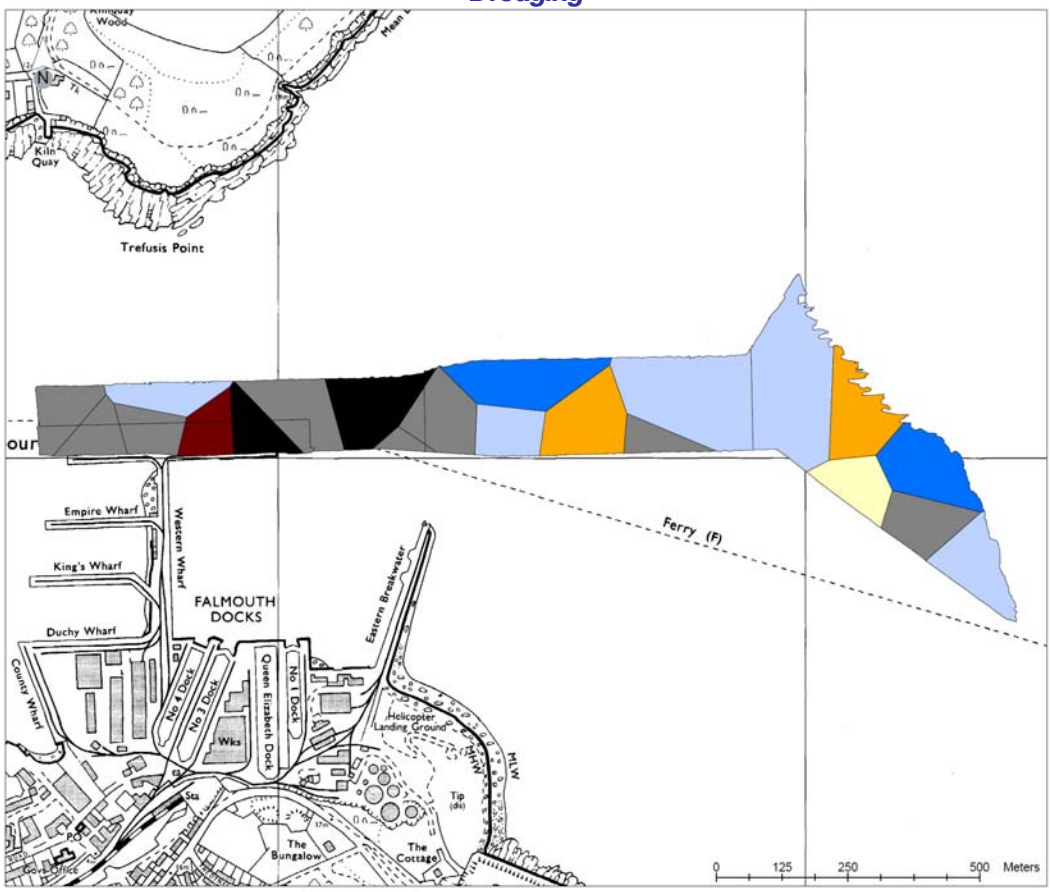
After capital dredging, the new seabed will expose fine-grained material, notably clay, and some (weathered) rock across the western part of the navigation channel including the berth off the Queens and Northern Wharves, and fine-, medium- and coarse-grained material, notably sand and some maerl and clay, across the eastern part of the navigation channel, as shown on Figure 6-8. The magnitudes of the changes are identified in Table 6-19.

Table 6-19 Change in Areas of Different Seabed Sediments

Substrate	Pre-dredge Area (ha)	Post-dredge Area (ha)	Change in Area (ha)
Clay	7.49	10.92	+3.43
Clay with Frequent Maerl	10.28	11.80	+1.52
Maerl	5.93	4.08	-1.85
Mud with Frequent Maerl	0.95	0.00	-0.95
Sand	3.32	1.21	-2.11
Sand with Frequent Maerl	4.51	1.96	-2.55
Sand / Gravel with Maerl	0.66	0.00	-0.66
Rock	0.00	2.85	+2.85
Mud	0.00	0.33	+0.33

While the sediment quality is sensitive to physical characteristics in relation to nature conservation and ecology (i.e. the seabed provides habitat), there are no sediment quality guidelines for these parameters to indicate sensitivity to change. Therefore, the change to physical characteristics in the new navigation channel is predicted to cause an adverse impact of minor significance.

Figure 6-8 Physical Characteristics of the New Navigation Channel after Capital Dredging





Chemical Changes

In summary, the surface sediment of the western part of the new navigation channel including the cruise berth contains concentrations of organo-tins (TBT and DBT), some metals (As, Cu, Hg, Pb and Zn), PAHs and total PCBs that are generally elevated above the Cefas Action Levels 1 or 2 and the Canadian TEL or PEL. The sub-surface sediment of the western part of the navigation channel including the cruise berth and the surface and sub-surface sediment of the eastern navigation

channel contain concentrations of organo-tins, metals, PAHs, total PCBs and OCPs that are generally much lower, below the Cefas Action Level 1 and the Canadian TEL.

After capital dredging, the new seabed will comprise the sub-surface sediment represented by the sub-surface samples taken at lowest depths during the 2004 and 2007 surveys. The results of the 2004 and 2007 surveys show that the sub-surface sediment of the western part of the navigation channel including the cruise berth contains much lower concentrations of organo-tins (TBT and DBT), some metals (As, Cu, Hg, Pb and Zn), PAHs and total PCBs than the sediment overlying it. Accordingly, in the western part of the navigation channel there will be a large magnitude of change of these contaminants, which in some cases will represent a reduction in concentrations by three orders of magnitude. The results of the 2004 and 2007 surveys show that the sub-surface sediment of the eastern part of the navigation channel contains similar concentrations of contaminants to the sediment overlying it. Accordingly, in the eastern part of the navigation channel there will be a negligible magnitude of change to concentrations.

In terms of sensitivity, the Cefas Action Levels and Canadian Sediment Quality Guidelines indicate that there will be an improvement in sediment quality, particularly for organo-tins (TBT and DBT), some metals (As, Cu, Hg, Pb and Zn), PAHs and total PCBs. Therefore, the change to chemical characteristics is predicted to cause a beneficial impact of moderate to major significance.

Biological Changes

In summary, the present seabed contains very low to non-detectable concentrations of bacteria and very low to non-detectable concentrations of algal biotoxins (as viable cysts).

Bacteria and algal biotoxins are known to not survive in sediment at depths of several centimetres. The capital dredge will remove sediment in the orders of several metres to reveal the new seabed. Accordingly, it is reasonable to assume that no bacteria or algal biotoxins are present in the sediment that will be revealed by the capital dredge.

Given that the present seabed contains very low to non-detectable concentrations of bacteria and algal biotoxins, the magnitude of change will be correspondingly very low to non-detectable. While the sediment quality is sensitive to bacteria and algal biotoxins in relation to shellfish hygiene and human health, there are no sediment quality guidelines for these parameters to indicate sensitivity to change. Therefore, the change to biological characteristics is predicted to cause an impact of no or negligible significance.

Sediment Toxicity Changes

In summary, the present seabed (based on the most contaminated sediment) can cause a range of lethal and sub-lethal effects, reflected by mortality and reduced casting endpoints respectively. However, the endpoints are not statistically significant for all bioassay tests and comparison to other assessment criteria indicates a sediment quality ranges from good to impaired.

After capital dredging, the new seabed will expose new sediment. There are no sediment toxicity data for the sediment to be exposed. However, given that sediment toxicity is related to chemical contaminant concentrations, it is reasonable to assume that sediment toxicity (like chemical contamination) will be much lower for the sediment to be exposed by capital dredging. Accordingly, in the western part of the navigation channel there will be a large magnitude of change for sediment toxicity and in the eastern part of the navigation channel there will be a negligible magnitude of change to sediment toxicity.

In terms of sensitivity, the assessment criteria identified by Jones and Franklin (1998) and by Roddie (1997) indicate that there will be an improvement in sediment toxicity. Therefore, the change to sediment toxicity characteristics is predicted to cause a beneficial impact of moderate to major significance.

Impact Significance

Capital dredging will remove large quantities of chemical contaminants from the seabed and the lower Fal Estuary's environment. The predicted magnitude of reduced chemical contaminant concentrations (and associated sediment toxicity) in relation to the receptor sensitivities (as defined by the assessment criteria) is predicted to cause an overall moderate to major beneficial impact on sediment quality in the capital dredge area.

Mitigation and Residual Impact

No mitigation measures are recommended and there will be an overall moderate to major residual beneficial impact on sediment quality.

6.4.2 Impact on Sediment Quality beyond the New Navigation Channel due to Capital Dredging

Throughout the EIA process, it has been recognised that capital dredging for the proposed new navigation channel will release sediment into the water column so that it becomes transported and deposited on other parts of the seabed around the Fal Estuary, and potentially Falmouth Bay. The sediment has the potential to change the physical, chemical, biological and sediment toxicity characteristics of the seabed where it is deposited.

In terms of the predicted deposition:

- the peak deposition associated with capital dredging at the western end of the new navigation channel, near the Queens and Northern Wharves, is shown in Figure 5-10; and
- the peak deposition associated with capital dredging at the eastern end of the new navigation channel, near Carrick Roads, is shown in Figures 5-12 and 5-14.

Physical Changes

Beyond the new navigation channel, the physical characteristics of the seabed sediment will be affected by deposition of dredging induced sediment plumes, as

illustrated by Figures 5-10, 5-12 and 5-14. As described in Section 5.4.2 and Table 5-2, the magnitudes of deposition across the Fal Estuary and into Falmouth Bay are very small (0.5 to 1.7mm) and are unlikely to change the nature of the seabed in the areas affected, although the presence of finer factions of sediment may be detectable in particular areas and deposition will be liable to vary due to the details of the seabed (e.g. small scale bed features or quiescent hydrodynamic areas).

Chemical Changes

In summary, it is only the surface sediment of the western part of the new navigation channel (including the cruise berth) that contain concentrations of contaminants (i.e. organo-tins (TBT and DBT), some metals (As, Cu, Hg, Pb and Zn), PAHs and total PCBs that are generally elevated above the Cefas Action Levels 1 or 2 and the Canadian TEL or PEL).

Figure 5-10 shows the predicted extent of sediment deposition associated with capital dredging of the western part of the new navigation channel, where sediment is most contaminated. Sediment deposition is predicted to occur beyond the new navigation channel to be limited to the seabed area around the western docks and beyond the Eastern Breakwater, and the depth of deposition to be at a very low magnitude: up to 0.05mm. Chemical changes can be summarised as follows:

- assuming the sediment quality of the seabed area around the western docks to be represented by impact receptor areas 1, 2 and 3, then there will be no impact to sediment quality because data from the 2007 survey shows that the sediment quality of the affected seabed area is similar to the western part of the new navigation channel; and
- assuming the sediment quality of the seabed area beyond the Eastern Breakwater to be represented by impact receptor area 12, then there will be a negligible impact to sediment quality because although the data from the 2007 survey shows that the sediment quality of the affected area of seabed is less contaminated than the western part of the new navigation channel, the magnitude of deposition will be very small.

Biological Changes

In summary, the present seabed in the area of the new navigation channel contains very low to non-detectable concentrations of bacteria and very low to non-detectable concentrations of algal biotoxins (as viable cysts). Biological changes can be summarised as follows:

- assuming the sediment quality of the seabed area around the western docks to be represented by impact receptor areas 1, 2 and 3, then there will be no impact to sediment quality because data from the 2007 survey shows that the sediment quality of the affected seabed area is similar to the western part of the navigation channel; and
- assuming the sediment quality of the seabed area beyond the Eastern Breakwater to be represented by impact receptor areas 1, 2 and 3, then there will be no impact to sediment quality because the data from the 2007 survey shows that the sediment quality of the affected area of seabed is similar to the western part of the navigation channel.

Sediment Toxicity Changes

Given that sediment toxicity is related to chemical contaminant concentrations, it is reasonable to assume that sediment toxicity changes will be similar to chemical changes. Accordingly, sediment toxicity changes can be summarised as follows:

- assuming the sediment quality of the seabed area around the western docks to be represented by impact receptor areas 1, 2 and 3, then there will be no impact to sediment quality because data from the 2007 survey shows that the sediment quality of the affected seabed area is similar to the western part of the navigation channel; and
- assuming the sediment quality of the seabed area beyond the Eastern Breakwater to be represented by impact receptor area 12, then there will be a negligible impact to sediment quality because although the data from the 2007 survey shows that the sediment quality of the affected area of seabed is less contaminated than the western part of the navigation channel, the magnitude of deposition will be very small.

Impact Significance

Capital dredging of the upper sediments within the western part of the new navigation channel will deposit small quantities of sediment and associated chemical contaminants to a limited extent beyond the new navigation channel. The resulting changes to sediment quality in the affected areas are predicted to have a negligible impact on sediment quality.

Mitigation and Residual Impact

No mitigation measures are recommended and there will be an overall negligible residual impact on sediment quality**.**

6.4.3 Impact on Sediment Quality due to Disposal of Dredged Material

Like capital dredging, the disposal of dredged material at sea will release sediment into the water column so that it becomes transported and deposited on the seabed within and beyond the boundaries of the designated offshore disposal site in Falmouth Bay. The sediment has the potential to change the physical, chemical, biological and sediment toxicity characteristics of the seabed where it is deposited.

Physical Changes

As described in Section 2.3.1 and Table 2-2, the dredged material to be disposed of comprises a range of substrates including clay, sand, gravel and maerl. The seabed in Falmouth Bay comprises a range of mud and sand, and some shelly sediment. At the disposal site itself, some of this sediment will have been sourced from previous deposits of dredged material from the Fal Estuary. Accordingly, there will be some consistency between the existing seabed material and that which will be deposited over it, particularly the clay, mud and sand. Maerl substrate is expected to not be present at the disposal site and therefore this will be a new material introduced to the seabed.

Chemical Changes

As described in Section 2.3.1, Cefas have advised that:

- the surface sediments to 1m below bed level in the western part of the proposed navigation channel to 2m in the deep water cruise berth are too contaminated to be suitable for disposal at sea; and
- the deeper sediment in western navigation channel and the deep water berth, and all sediment in the eastern navigation channel is not too contaminated and therefore suitable for disposal at sea.

In summary, the deeper sediment in western navigation channel and the deep water berth, and all sediment in the eastern navigation channel contains concentrations of organo-tins, metals, PAHs, total PCBs and OCPs that are below the Cefas Action Level 1 and the Canadian TEL. At these concentrations, the change to chemical characteristics caused by disposal will be negligible because available existing data indicate that contaminant concentrations at the disposal site are also below Action Level 1.

Biological Changes

The biological characteristics of the dredged material contains very low to non-detectable concentrations of bacteria and very low to non-detectable concentrations of algal biotoxins (as viable cysts). Assuming the sediment quality of the seabed area in Falmouth Bay to also contain very low to non-detectable concentrations of these parameters, then the change to biological characteristics caused by disposal will be negligible.

Sediment Toxicity Changes

Given that sediment toxicity is related to chemical contaminant concentrations, it is reasonable to assume that sediment toxicity changes will be similar to chemical changes. Assuming that the change to chemical characteristics caused by disposal will be negligible, a similar conclusion can be drawn concerning sediment toxicity. Accordingly, the change to biological characteristics caused by disposal will be negligible.

Impact Significance

The disposal of clean dredged material will impact on the sediment quality of the affected area by virtue of changes to physical characteristics and not chemical, biological or sediment toxicity characteristics, and therefore there will be a minor adverse impact on sediment quality.

Mitigation and Residual Impact

No mitigation measures are recommended are there will remain a minor adverse residual impact.

6.5 POTENTIAL IMPACTS DURING THE OPERATIONAL PHASE

6.5.1 Impact on Sediment Quality in the New Navigation Channel after Capital Dredging

Physical Changes

Sections 5.5.3 and 5.5.4 describe the predicted sediment deposition in the new navigation channel after dredging. Numerical modelling by HR Wallingford predicts the annual deposition of fine-grained material (i.e. silt) in the new navigation channel to be 2,970m^3/yr (see Section 5.5.3 and Figure 5-27). The magnitude of increase over existing conditions is very low at 610m^3/yr. Numerical modelling by HR Wallingford predicts the annual deposition of medium-grained material (i.e. sand) in the new navigation channel to be 5,5000m^3/yr (see Section 5.5.4 and Figure 5-28). The magnitude of increase over existing conditions is negligible at <20m^3/yr. Changes in sediment depth due to erosion and deposition tend to occur mainly in the south-eastern corner end of the new navigation channel with maximum changes in the range of 0.2m/yr to 0.3m/yr.

Given the very low magnitude of the predicted increase in sediment deposition rates and the localised sediment fluxes, the change to physical characteristics will be negligible in most of the new navigation channel and minor in the south-eastern corner end.

Other Changes

The possible sources of fine-grained sediment (i.e. silt) that may deposit in the new navigation channel include rivers, the re-suspension of bed material within the Fal estuary, and the sea, but PMSP (2003) suggest the main source of sediment is bed material re-suspended by waves. The possible sources of medium-grained sediment (i.e. sand) that may deposit in the new navigation channel relate to the existing causes of sand fluxes within this area of the estuary and include re-suspension of bed material and transport by tidal currents.

Given these sediment sources and very low magnitude of the predicted increase in sediment deposition rates, the change to chemical, biological and sediment toxicity characteristics will be negligible.

Impact Significance

The hydrodynamic and sediment regime in the estuary with the new navigation channel in place will be such that there will be a minor, localised change to the physical characteristics at the eastern end of the new navigation channel. All other changes will be negligible. The overall impact on sediment quality will be negligible.

Mitigation and Residual Impact

No mitigation measures are recommended and there will be an overall negligible residual impact to sediment quality.

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7 WATER QUALITY

7.1 INTRODUCTION

This chapter of the ES concerns the water quality of the marine environment and how it could be affected by the proposed Falmouth Cruise Project. Water quality is assessed in the context of statutory water quality requirement in terms of changes to:

- physical contaminants: total suspended solids concentrations (TSS);
- chemical contaminants: metals (As, Cd, Cr, Cu, Pb, Hg, Ni and Zn), TBT, PAHs, PCBs and OCPs; and
- biological contaminants: enteric bacteria (faecal coliforms and faecal streptococci) and algal biotoxins (***Alexandrium*** sp.).

Issues identified in the Environmental Scoping Study (Royal Haskoning, 2006) and by consultees during the preparation of the ES relate to the potential for dredging and marine works to release sediment and associated contaminants into the water column so that they disperse within the Fal Estuary and Falmouth Bay. Capital dredging (during construction) is the principal activity that can generate this impact.

This chapter draws upon data collected from the Environment Agency's water quality monitoring programmes, numerical modelling of sediment and contaminant dispersion, and the information and views expressed by consultees including the MFA, Cefas, the Environment Agency, Natural England, Cornwall Wildlife Trust, Cornwall County Council, Friends of the Earth and the public. For more detailed information on sediment and contaminant dispersion, the reader should refer to Appendix A.

7.2 ASSESSMENT METHODOLOGY

7.2.1 Study Area

The study area for water quality includes the Fal Estuary and Falmouth Bay because this area includes:

- the footprint of the proposed capital dredging (see Figure 2-2);
- the demarcated dredged material disposal site in Falmouth Bay (see Figure 2-5); and
- the potential extent of sediment plume dispersion in the water column (in terms of TSS measured in mg/l and contaminants measured in µg/l) caused by capital dredging in Falmouth Harbour and dredged material disposal in Falmouth Bay (see Figures 5-1 and 5-2).

7.2.2 Baseline Data Collection

Water quality data has been obtained from the Environment Agency's database of monitoring records. The data used to inform the EIA process is derived from monitoring records covering the years from 1999 to 2007.

Additional baseline data has been collected from various other published sources, notably Site Characterisation of the South West European Marine Sites - Fal and Helford cSAC by PMSP (2003).

7.2.3 Surveys

Given the spatial and temporal extent of the Environment Agency's water quality monitoring data, no surveys have been undertaken to inform the EIA process.

7.2.4 Assessment Criteria

Water Framework Directive

Council Directive 2000/60/EC establishing a framework for Community action in the field of water quality (also known as the Water Framework Directive and hereafter referred to as the WFD) aims for all inland and coastal waters to reach "good status" by 2015 by establishing a river basin district structure within which environmental objectives will be set, including ecological targets for surface waters. The WFD is transposed into UK legislation by statutory instruments such as the Water Environment (Water Framework Directive) (England and Wales) Regulations 2003.

The WFD provides an overarching framework for other directives concerning water quality, including the following directives relevant to the proposed Falmouth Cruise Project:

- Dangerous Substances Directives (DSD);
- Shellfish Water Directive (SWD); and
- Bathing Water Directive (BWD).

These directives' integration under the WFD is described in the following paragraphs.

Dangerous Substances Directive

Council Directive 76/464/EEC on pollution caused by certain dangerous substances discharged into the aquatic environment and its daughter directives (also known as the Dangerous Substances Directive and hereafter referred to as the DSD) aims to control pollution caused by certain dangerous substances discharged to controlled waters. This directive has been repealed, replaced and aligned to the WFD by amending Council Directive 2006/11/EC.

The DSD identifies two lists (List I and List II) of families and groups of substances. List I contains certain substances that are selected mainly on the basis of their toxicity, persistence and bioaccumulation, with the exception of those which are biologically harmless or which are rapidly converted into substances which are biologically harmless. This list includes organo-tin compounds (e.g. TBT), the metals mercury and cadmium, and persistent mineral oils and hydrocarbons of petroleum origin (e.g. PAHs). Pollution through the discharge of the various dangerous substances within List I must be eliminated. Environmental quality standards (EQSs) for List I substances are established by the quality objectives identified in the daughter directives to the original DSD (i.e. Council Directive 76/464/EEC), as referred to in Annex IX to the WFD.

List II contains substances are regarded as less dangerous but which have a deleterious effect on the aquatic environment. This list includes metals such as

arsenic, chromium, copper, lead, nickel and zinc, and biocides not identified under List I (e.g. OCPs). Pollution by these substances must be reduced. Environmental quality standards for List II substances are to be established by Member States. EQSs for List II substances are established by the Surface Waters (Dangerous Substances) (Classification) Regulations 1989 and its 1992, 1997 and 1998 amendments in accordance with the original DSD (i.e. Council Directive 76/464/EEC). These regulations are implemented under the current DSD via UK legislation implementing the WFD (i.e. the Water Environment (Water Framework Directive) (England and Wales) Regulations 2003).

The water quality objectives implemented through the coastal and estuarine EQSs (rather than fresh water EQSs) for List I and List II substances form the assessment criteria for water quality concerning the DSD in relation to the proposed Falmouth Cruise Project (see Table 7-1).

Table 7-1 EQSs for Selected List I and List II Dangerous Substances

Substance	List	EQS Type	Coastal and estuarine EQS (µg/l)
Cadmium (dissolved)	I		2.5
Mercury (dissolved)	I		0.3
Arsenic (dissolved)	II	Annual average	25
Copper (dissolved)	II	Annual average	5
Lead (dissolved)	II	Annual average	25
Naphthalene	II	Annual average	5
TBT	II	Maximum concentration	0.002
Zinc (total)	II	Annual average	40

As part of the WFD, a European 'priority list' of 33 substances posing a threat to or via the aquatic environment has been established. These substances are referred to as ‘priority substances', and those which are thought to pose the greatest threat are further identified as 'priority hazardous substances'. A proposal for a daughter directive on the priority substances was published by the European Commission in July 2006. It includes quality standards for the concentrations of the priority substances in surface water bodies. The proposal, amongst other things, also includes obligations aimed at:

- the progressive reduction of discharges, emissions and losses of priority substances; and
- the cessation or phasing-out of discharges, emissions and losses of priority hazardous substances.

The aim in the proposal is to achieve these goals by 2025. An additional objective is to achieve 'good chemical status' for surface water bodies by 2015. A body would obtain ‘good chemical status’ if it met all of the quality standards for priority substances and certain other pollutants. The proposal will need to be agreed by member states and the European Parliament before it comes into force.

Shellfish Waters Directive

Council Directive 79/923/EEC on the quality required of shellfish waters (also known as the Shellfish Waters Directive and hereafter referred to as the SWD) aims to protect or improve shellfish waters in order to support shellfish life and growth,

therefore contributing to the high quality of edible shellfish products. The SWD is transposed into the legislation of England and Wales by the Surface Waters (Shellfish) (Classification) Regulations 1997. The SWD is designed to protect the aquatic habitat of bivalve and gastropod molluscs, including oysters, mussels, cockles, scallops and clams. It does not cover shellfish crustaceans such as crabs, crayfish and lobsters.

The SWD sets physical, chemical and microbiological water quality requirements for designated shellfish waters (see Table 7-2). For each parameter, the SWD specifies the minimum number of samples to be taken, the standards to be met and the percentage of samples that must meet these standards. The standards are set as either a numeric limit or a descriptive standard. The standards are met if the following percentage of the samples analysed do not exceed the limit values:

- 100% for metals and organo-halogen compounds;
- 95% for salinity and dissolved oxygen;
- 75% for other substances.

Selected standards from the Surface Waters (Shellfish) (Classification) Regulations 1997 form the assessment criteria for water quality concerning the SWD in relation to the proposed Falmouth Cruise Project. The selected standards include TSS and the metals Cu, Hg, Pb and Zn. Given the low concentrations of OCPs recorded in the sediment to be dredged (all <0.0002mg/kg; see Section 6.3.6), no OCPs are used as assessment criteria.

The SWD will be repealed in 2013 by the 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 provided by the SWD.

Bathing Waters Directive

Council Directive 76/160/EEC concerning the quality of bathing water (also known as the Bathing Water Directive and hereafter referred to as the BWD) aims to protect public health and the environment from faecal pollution at bathing waters. The BWD requires Member States to identify popular bathing areas and to monitor water quality at these bathing waters throughout the bathing season, which runs from mid May to September in England. The BWD is transposed into the legislation of England by the Bathing Waters (Classification) Regulations 1991, as modified by the Bathing Waters (Classification) (England) Regulations 2003.

The BWD sets a number of microbiological and physico-chemical standards that bathing waters must either comply with ('mandatory' standards) or endeavour to meet ('guideline' standards)[1]. The main standards used to assess the quality of bathing water use microbiological parameters, namely total coliforms and faecal coliforms, which are bacteria found in the guts of humans and other warm-blooded animals, and are indicators of faecal pollution. In order for bathing water to comply with the Directive, mandatory standards stipulate that 95% of the samples (19 out of 20) must not contain more than 10,000 total coliforms per 100ml and 2,000 faecal coliforms per 100ml, and must meet the other criteria. Mandatory physico-chemical

[1] A full table of mandatory and guideline standards is presented in the Council Directive 79/923/EEC on the Quality Required of Shellfish Water

standards for bathing water quality include pH between 6 and 9, no abnormal change in colour, transparency, no visible film and odour due to mineral oils, etc. The mandatory bathing water quality criteria form the statutory assessment guidelines for water quality concerning bathing waters.

Table 7-2 Criteria for Classification of Waters as Shellfish Waters under the Surface Waters (Shellfish) (Classification) Regulations 1997

Parameter	Units	Requirements
pH	pH units	>=7 and <=9
Colouration (after filtration)	mgPt/l	A discharge affecting shellfish waters must not cause the colour of the waters after filtration to deviate by more than 10 mg Pt/l from the colour of waters not so affected
Suspended solids	mg/l	A discharge affecting shellfish waters must not cause the suspended solid content of the waters to exceed by more than 30% the content of waters not so affected
Salinity	ppt	<=40 per thousand A discharge affecting shellfish waters must not cause their salinity to exceed by more than 10% the salinity of waters not so affected
Dissolved oxygen	% saturation	>=70% (average value) If an individual measurement indicates a value lower than 70%, measurements shall be repeated An individual measurement may not indicate a value lower than 60% unless there are no harmful consequences for the development of shellfish colonies
Petroleum hydrocarbons		Hydrocarbons must not be present in the shellfish waters in such quantities as to: - produce a visible film on the surface of the waters and/or a deposit on the shellfish, - have harmful effects on the shellfish
Organo-halogenated substances		The concentration of each substance in the shellfish waters or in shellfish flesh must not reach or exceed a level which has harmful effects on the shellfish and their larvae
Metals Silver Arsenic Cadmium Chromium Copper Mercury Nickel Lead Zinc	mg/l Ag As Cd Cr Cu Hg Ni Pb Zn	The concentration of each substance in the shellfish waters or in the shellfish flesh must not reach or exceed a level which has harmful effects on the shellfish and their larvae The synergic effects of these metals must be taken into consideration
Substances affecting the taste of the shellfish		Concentration should be lower than that which is liable to impair the taste of the shellfish

There are more stringent guideline criteria which stipulate that 80% of samples must not contain more than 500 total coliforms or 100 faecal coliforms or 100 faecal streptococci per 100ml and 90% of samples must not contain more than 100 faecal streptococci per 100ml. The mandatory standard for faecal coliforms (i.e. 2,000 faecal coliforms per 100ml) forms the assessment criteria for water quality concerning the BWD in relation to the proposed Falmouth Cruise Project.

The BWD has been updated and simplified to take into account lessons learnt from its implementation, developments in science and knowledge about the risks of bathing, and the changes in environmental protection offered by more recent European water legislation. A revised BWD 2006/7/EC came into force in March 2006 and must be transposed into UK law within two years, although it will take longer for the new features to come into effect. Key changes include a tightening of water quality standards and a requirement to provide information about bathing waters to the public.

The revised BWD has updated the way in which water quality is monitored, including fewer microbiological indicators (i.e. two indicators - intestinal enterococci and Escherichia coli), and establishes tighter microbiological standards, which are to be met by 2015. It also revises water quality classification, basing it on 3 or 4 years monitoring data, using 95 or 90 percentiles, to generate the following four new classification categories:

- 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.

The timetable of the revised BWD is in line with the WFD as bathing waters are protected areas under the WFD. This means that the tighter microbiological standards under the revised BWD have to be met by 2015, which is in line with when the WFD's main environmental objectives have to be met.

7.2.5 Assessment Techniques

Water Quality Indicator Parameters

Six chemical contaminants have been chosen as water quality indicator parameters and used to assess impacts. The indicator parameters were identified and agreed in consultation with the Environment Agency and include:

- TBT;
- four metals (Cu, Hg, Pb and Zn); and
- one PAH (naphthalene).

One physical contaminant has been chosen as a water quality indicator parameter and used to assess impacts:

- TSS.

One biological contaminant has been chosen as a water quality indicator parameter and used to assess impacts:

- faecal coliforms.

For the purposes of the EIA process, indicative partition coefficients have been derived for the chemical contaminant indicator parameters and used in numerical modelling to predict impacts on water quality associated with dredging. Partition coefficients are measured in terms of the ratio of an indicator parameter's concentration in the sediment's solid phase (i.e. the sorbed concentration of the parameter expressed as milligrams of parameter per kilogram of sediment (mg/kg)) relative to its concentration in the sediment's liquid phase (i.e. the dissolved concentration of the parameter expressed as milligrams of parameter per litre of water (mg/l)). Hence, Table 7-3 identifies that the ratio of TBT in the solid phase compared to the liquid phase to be $40x10^3$ to 1.

Table 7-3 identifies the water quality indicator parameters, their relevance to the water quality assessment criteria, and (where relevant) their partition coefficients.

Table 7-3 Water Quality Assessment Parameters – Application and Partition Coefficients

Parameter	DSD	SWD	BWD	WFD	Partition Coefficient (L kg^{-1})
TBT	✓	×	×	✓	$40x10^3$
Cu	✓	✓	×	✓	$10x10^3$
Pb	✓	✓	×	✓	$1x10^3$
Hg	✓	✓	×	✓	$200x10^3$
Zn	✓	✓	×	✓	$15x10^3$
Naphthalene	✓	×	×	✓	$100x10^3$
TSS	×	✓	×	✓	n/a
Faecal coliforms	×	×	✓	✓*	n/a

* assumes faecal coliforms to represent Escherichia coli

Source – Pathway – Receptor Model

Where impacts relate to dredging and sediment plume effects, the potential impacts on water quality are assessed in the context of a source-pathway-receptor model. For these impact assessments:

- the impact's source is the sediment to be released and dispersed by dredging, and its physical, chemical and biological contaminant characteristics, as defined by the sediment quality baseline conditions (see Section 7.3);
- the impact's pathway is the dredging induced release and dispersion of a sediment plume and associated contaminants, as defined by numerical modelling results predicted by HR Wallingford (see Section 5.4.1); and
- the impact's receptor is the water and its quality affected by the sediment plume and its contaminants, as defined by the water quality baseline conditions (see Section 7.3).

Impact Magnitude

Impact magnitude is considered against the water quality assessment criteria, including those established by the current versions of the DSD, SWD and BWD, and

the WFD where applicable to impacts predicted to occur within the timeframes relating to it.

Where possible, impact magnitude has been assessed quantitatively, allowing a comparison between a predicted environmental change in water quality and the water quality assessment criteria. In some cases, changes to water quality have been predicted by numerically modelling. In these cases, all results present worst case scenarios because they are based on:

- the highest concentrations of the indicator parameters in the source sediment;
- a conservative release rate from the dredger; and
- the maximum contaminant concentrations and maximum dispersion areas created by both neap and spring tidal conditions.

If a quantitative assessment cannot be made, then impacts have been predicted qualitatively.

Impacts associated with the proposal's operational phase (see Section 7.5) are assessed against the water quality standards required by the future versions of the DSD, SWD and BWD, as incorporated into the WFD.

Impact Sensitivity

Impact sensitivity is considered against the water quality requirements applicable to the receiving waters in the Fal Estuary and Falmouth Bay, including those established by the current versions of the DSD, SWD and BWD, and the WFD where applicable to impacts predicted to occur within the timeframes relating to it.

7.2.6 Assessment of Impact Significance

The principal approach to assessing water quality effects has been to predict impacts against the assessment criteria established as current and future water quality standards under the DSD, SWD and BWD. The assessment of impact significance is made in relation to a number of water quality indicator parameters.

7.3 BASELINE ENVIRONMENT

7.3.1 Dangerous Substances

The DSD applies to all controlled waters and therefore it covers the Fal Estuary's tidal waters and its tributaries, and Falmouth Bay.

TBT

Of the dangerous substances listed under the DSD, TBT is a key concern for water quality in the tidal waters of Fal estuary since it is present at concentrations greater than the EQS (0.002µg/l). Given TBT's elevated concentrations, the Environment Agency monitor for it at various locations around the Fal estuary, including many around Falmouth Docks (see Figure 7-1).

Figure 7-1 Environment Agency Monitoring Stations



PMSP (2003) reported on the Environment Agency's data for TBT in the Fal estuary's tidal waters from 1996 to 2001, noting:

- a mean concentration of 0.023µg/l;
- a median concentration of 0.014µg/l; and
- maximum concentrations of 0.247µg/l and 0.2µg/l recorded in the Penryn River (Islington Quay) and Fal (mid-channel).

The Environment Agency's data for TBT in the Fal Estuary's tidal waters is summarised in Table 7-4.

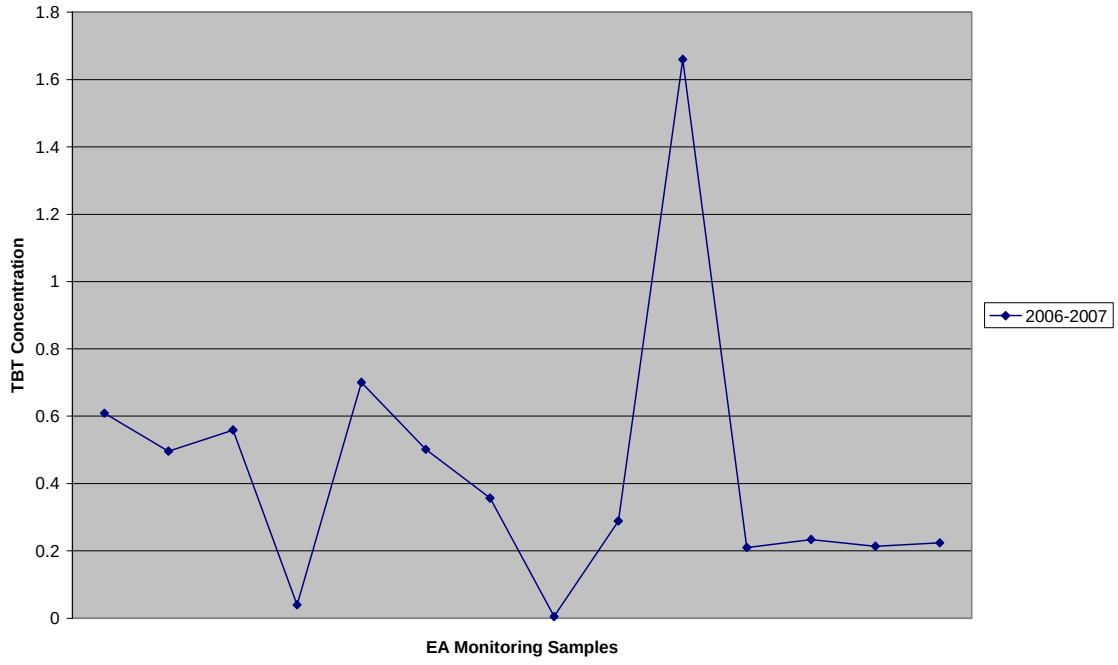
Table 7-4 Summary of Water Quality for TBT in the Fal Estuary at Various Monitoring Stations: Minimum, Maximum, Mean and Median Values for TBT (µg/l)

Monitoring Station	Ref No.	Years	Min	Max	Mean	Median
River Fal at Vilt Buoy (estuarine water)	81910139	1999-2007	0.002	0.101	0.006	0.0023
Penryn River – Flushing / Falmouth Marina (estuarine water)	81910635	1999-2007	0.002	0.517	0.020	0.017
Falmouth Docks Northern Wharf (estuarine water)	H1910125	1998-2007	0.002	0.315	0.033	0.015
River Fal at Black Rock Buoy (sea water)	81910116	1997-2007	0.002	0.024	0.0048	0.0027

The minimum concentration at all monitoring sites is 0.002µg/l, which is same value as the EQS for TBT (and is probably the detection limit of the analytical equipment used to measure TBT concentrations). These data imply that TBT concentrations at all monitoring stations comply with the EQS – which is set as a maximum allowable concentration – at all sites on occasions over the monitoring duration. The maximum, mean and median concentrations at all monitoring sites exceed the EQS for TBT. These data imply that, overall; the tidal waters of the Fal estuary do not comply with the TBT EQS set under the DSD.

With regard to previous activities at Falmouth Docks, Figure 7-2 identifies that the effluent mixing zone for the outfall shows the highest maximum, mean and median concentrations for TBT. As noted by PMSP (2003) "the outfall at Falmouth Docks stands out as the principal source of TBT in the area". The present situation is that dry docks activities involving TBT-based anti-fouling paints were subject to active-carbon treatment but have ceased as of 2008. Nevertheless, the Environment Agency's monitoring of the effluent discharge from the combined outfall still record inputs of TBT up to the end of the most recent dataset (January 2006 to August 2007).

Figure 7-2 TBT Concentrations in Effluent Discharges from Falmouth Docks Combined Outfall



Metals

The Environment Agency's data for metals (Cu, Hg, Pb and Zn) at three monitoring locations in the Fal estuary's tidal waters is summarised in Table 7-5. The minimum concentrations for all metals at all sites are below the respective EQSs. One maximum concentration at one site (5.9µg/l for Cu in the Penryn River) exceeds the EQS (5µg/l).

The EQSs for metals are assessed in terms of an annual average. On the basis of the mean values in Table 7-5, the data imply that, overall; the tidal waters of the Fal Estuary comply with the EQSs set under the DSD.

PMSP (2003) reported that metals concentrations are generally less in the lower part of the Fal estuary compared to the upper estuary. This is largely due to the distance from the main source of metal inputs to the Fal Estuary: Restroguet Creek.

Table 7-5 Summary of Water Quality for Metals at the Fal Estuary's Shellfish Water Monitoring Stations: Minimum and Maximum Values for Metals (µg/l)

Monitoring Station	Metal	Years	Min	Max	Mean	Median	EQS
Carrick Roads	Cu	1999-2007	<0.5	3.6	1.48	1.48	5
Carrick Roads	Hg	1999-2007	<0.01	0.13	0.062	0.02	0.3
Carrick Roads	Pb	1999-2007	0.048	0.086	0.07	0.076	25
Carrick Roads	Zn	1999-2007	<4.0	20.1	8.05	6.9	40
Penryn River	Cu	1999-2007	0.6	5.9	1.98	1.9	5
Penryn River	Hg	1999-2007	<0.01	0.04	0.02	0.01	0.3
Penryn River	Pb	1999-2007	0.18	0.744	0.36	0.18	25
Penryn River	Zn	1999-2007	<4.0	18.4	8.43	7.23	40
Percuil River	Cu	1999-2007	0.6	4.13	1.139	1.0	5
Percuil River	Hg	1999-2007	<0.01	0.02	0.014	0.01	0.3
Percuil River	Pb	1999-2007	0.048	0.083	0.061	0.054	25
Percuil River	Zn	1999-2007	<4.0	18.4	5.05	4.9	40

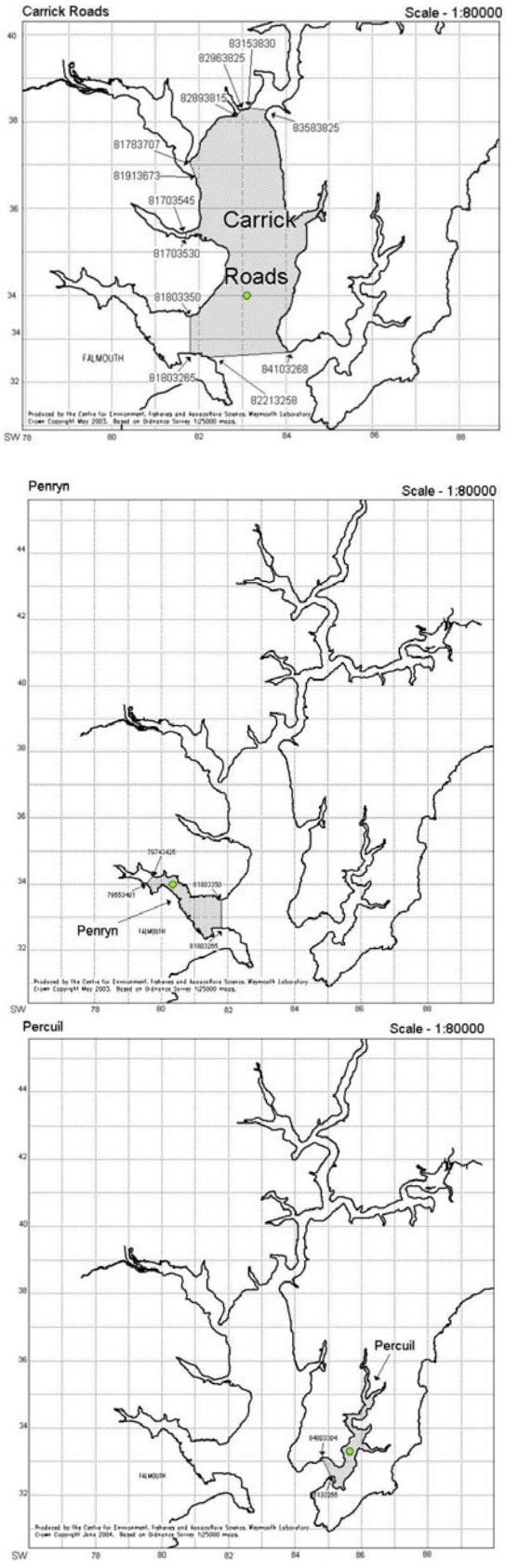
Naphthalene

There are no Environment Agency baseline data for naphthalene in the lower part of the Fal Estuary. The only monitoring site in the Fal Estuary is for the River Carnon at Devoran Bridge, where 35 naphthalene concentrations were recorded at <0.5µg/l and four others were recorded between 0.71µg/l and 0.82µg/l. All data are therefore below the EQS of 5µg/l.

7.3.2 Shellfish Waters

The Fal Estuary accommodates five shellfish waters. The Carrick Roads shellfish water covers the estuary's main body of water (see Figure 7-3). The Penryn River and Percuil River shellfish waters occupy the lower two tributaries to the Fal Estuary (see Figure 7-3). The Fal Estuary and Tresillian shellfish waters occupy the upstream tributaries to the River Fal. A sixth shellfish water occupies the Helford Estuary.

Figure 7-3 Geographical Extents of Shellfish Waters in the Southern Fal Estuary: Carrick Roads (top), Penryn (middle) and Percuil (bottom)



The Environment Agency has water quality monitoring data for shellfish waters from 1999 to 2007, which is summarised in Table 7-6. TSS concentrations fall within a small range and reflect the generally low hydrodynamic conditions in the lower Fal Estuary. They are generally consistent with the findings of HR Wallingford (see Section 5.3.4), which identified average TSS concentrations in the order of <10mg/kg. Copper, mercury, lead and zinc concentrations are below the EQSs included under the DSD.

Table 7-6 Summary of Water Quality in Shellfish Waters 1999-2007: Minimum and Maximum Values for EIA Indicator Parameters for Water Quality

Parameter	Units	Carrick Roads	Penryn	Percuil
TSS	mg/l	<3.0 to 17.2	<3.0 to 12.7	<3.0 to 15.0
Cu	µg/l	<0.5 to 3.6	0.6 to 5.9	0.6 to 4.13
Hg	µg/l	<0.01 to 0.13	<0.01 to 0.04	<0.01 to 0.02
Pb	µg/l	0.048 to 0.086	0.18 to 0.744	0.048 to 0.083
Zn	µg/l	<4.0 to 20.1	<4 to 18.4	2.47 to 6.8

7.3.3 Bathing Waters

There are several bathing waters within the study area (see Figure 7-4). Two bathing waters are situated to the west of the mouth of the Fal Estuary, namely Gyllangvase Beach (Grid reference: X: 180911.12, Y: 31589.88) and Swanpool Beach (Grid reference: X: 180297.3, Y: 31293.54). Another bathing water is situated further west at Maenporth (Grid reference: X: 178995.55, Y: 29518.72). The nearest bathing water to the east of the mouth of the Fal Estuary is outside the study area, situated at Portcurnick Beach, just east of Portscatho. There are no designated bathing waters within the Fal Estuary.

Figure 7-4 Bathing Water Locations (source: www.environment-agency.gov.uk)



Table 7-7 shows that the bathing waters are classified as having excellent water quality, which means they meet the mandatory standards required under the BWD. That is, 95% of the samples taken over the bathing water season (May to September) must not contain more than 10,000 total coliforms per 100ml and 2,000 faecal coliforms per 100ml.

Table 7-7 Bathing Water Quality Classification 1988-2007

Year	Gyllngvase Beach	Swanpool Beach	Maen Porth
2007	Excellent	Excellent	Excellent
2006	Excellent	Excellent	Excellent
2005	Excellent	Excellent	Excellent
2004	Excellent	Excellent	Excellent
2003	Excellent	Good	Excellent
2002	Excellent	Excellent	Excellent
2001	Excellent	Excellent	Excellent
2000	Excellent	Excellent	Excellent
1999	Excellent	Good	Good
1998	Excellent	Excellent	Good
1997	Excellent	Good	Poor
1996	Excellent	Excellent	Good
1995	Excellent	Excellent	Good
1994	Excellent	Excellent	Good
1993	Excellent	Good	Good
1992	Excellent	Poor	Poor
1991	Good	Good	Good
1990	Good	Good	Good
1989	Good	Good	Good
1988	Good	Good	Good

Bathing water quality under the revised BWD has been predicted by the Environment Agency using 2003 to 2006 water quality monitoring data and assuming no further action is taken to improve water quality (Defra, 2007). The predictions for the bathing waters within the study area are:

- Gyllangvase Beach – excellent;
- Swanpool Beach – excellent; and
- Maen Porth – good.

7.4 POTENTIAL IMPACTS DURING THE CONSTRUCTION PHASE

7.4.1 Impact on Dangerous Substances Water Quality due to Capital Dredging

Capital dredging for the proposed new navigation channel will release sediment and associated contaminants into the overlying water column where they will disperse within the Fal Estuary. Some of the contaminants in the sediment to be dredged are included under the DSD as List I or II dangerous substances. Accordingly, capital dredging may increase the concentrations of contaminants in the Fal Estuary relative to the water quality requirements of the DSD that are established by the EQSs (see Table 7-1). For this impact assessment, TBT and metals (Cu, Hg, Pb and Zn) are used as indicator parameters concerning the DSD.

The sediment to be dredged is the source of the contaminants that could change water quality conditions relating to the DSD. Baseline sediment quality conditions are described in Sections 6.3.1 to 6.3.10. In summary, the surface sediment of the western part of the navigation channel including the cruise berth contains elevated concentrations of TBT and metals (Cu, Hg, Pb and Zn) and, therefore, is the key source providing high potential for capital dredging to disperse significant concentrations of TBT and metals to the into the controlled waters in the Fal Estuary and Falmouth Bay.

The controlled waters of the Fal Estuary and Falmouth Bay are the receptors of the contaminants that could change water quality conditions relating to the DSD. Baseline water quality conditions for the indicator parameters are described in Section 7.3.1. In summary, TBT already exceeds the EQS and is an existing water quality concern in the Fal Estuary, while the other DSD indicator parameters (Cu, Hg, Pb and Zn) are generally below their respective EQSs.

Dredging releases sediment into the overlying water in the form of a sediment plume and thereby provides a pathway for TBT and metals to affect water quality. The extent of sediment plume dispersion is predicted by numerical modelling results (see Section 5.4.1 and Appendix A). With regard to the indicator parameters TBT and Cu, Figures 7-5 and 7-6 respectively show the predicted maximum increase in concentrations over a full neap tide and a full spring tide (i.e. including flood and ebb parts of the tide) for the anticipated worst case scenario associated with the proposed capital dredge. The figures clearly show that capital dredging provides a pathway for releasing contaminants into the Fal estuary and, on ebb spring tides, Falmouth Bay. [Note: Total concentrations are shown for TBT and dissolved concentrations are shown for Cu because their respective EQSs are established for these measurements.]

Numerical modelling predicts that on neap tides the plumes largely remain in the vicinity of Falmouth Docks and the harbour area. They extend north towards Trefusis, west as far as the Falmouth waterfront between the town and the docks, east as far the harbour entrance, and south as far as Pendennis Point. They do not extend into Carrick Roads or into Falmouth Bay. On spring tides, the plumes extend north as far as Trefusis, west to the Falmouth waterfront and slightly up the Penryn River, east as far as the harbour entrance, and south past Pendennis Point and into Falmouth Bay.

Compared with the baseline conditions for TBT identified in Table 7-4, dredging will cause a substantial increase over mean TBT concentrations, although may not cause an increase over maximum TBT conditions. Increases will be highest immediately around the dredger (0.15µg/l) and around Falmouth Docks (>0.05µg/l). The majority of the sediment plume contains TBT at lower concentrations (0.01-0.05µg/l). Overall though and irrespective of baseline conditions, capital dredging will cause TBT concentrations to increase further over the EQS required under the DSD. Accordingly, the magnitude of concentration increases for TBT is high, particularly around Falmouth Docks and Falmouth Harbour.

Figure ***7-5 Increases in Maximum TBT Total Concentrations due to Capital Dredging on Neap Tides (top) and Spring Tides (bottom)***

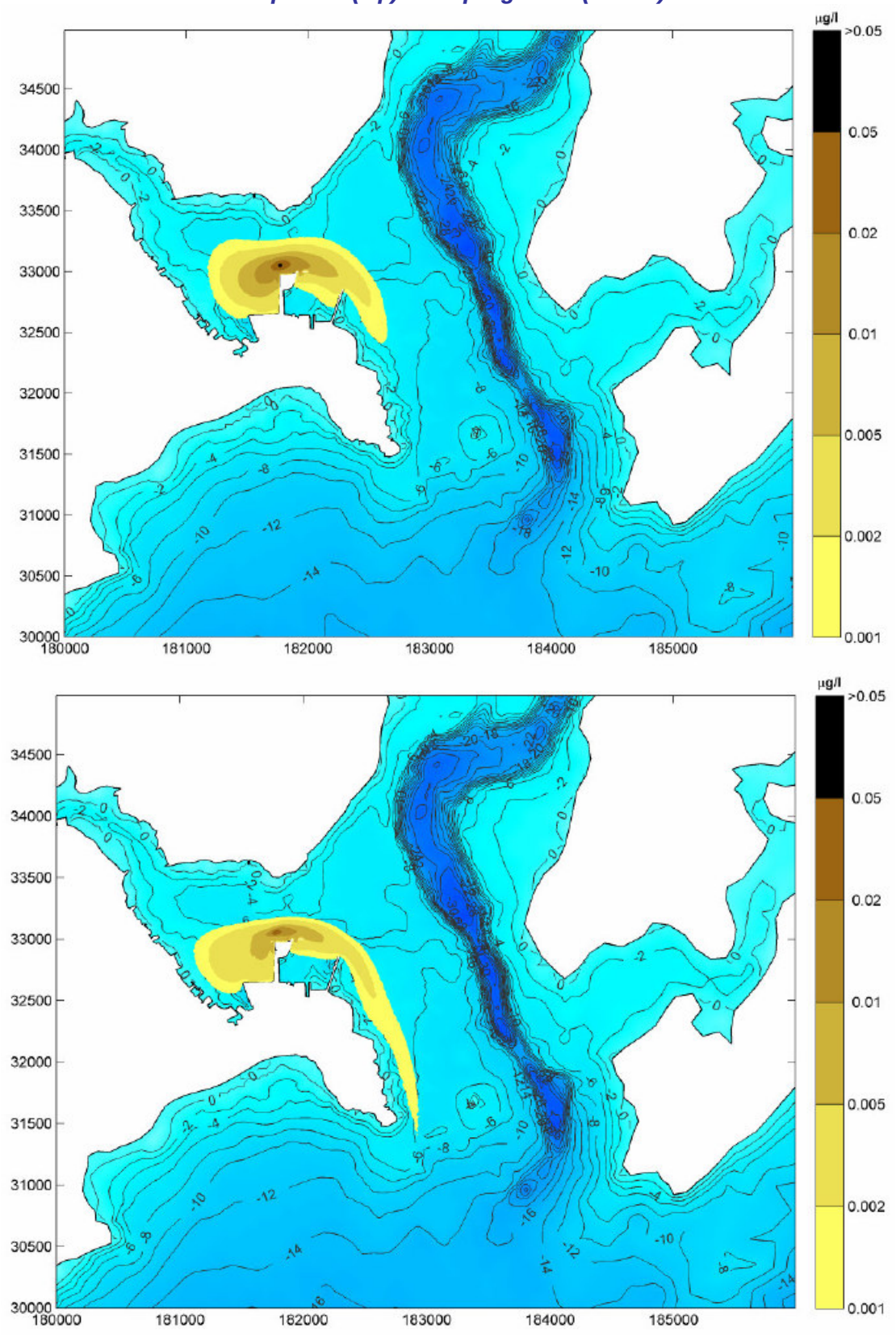
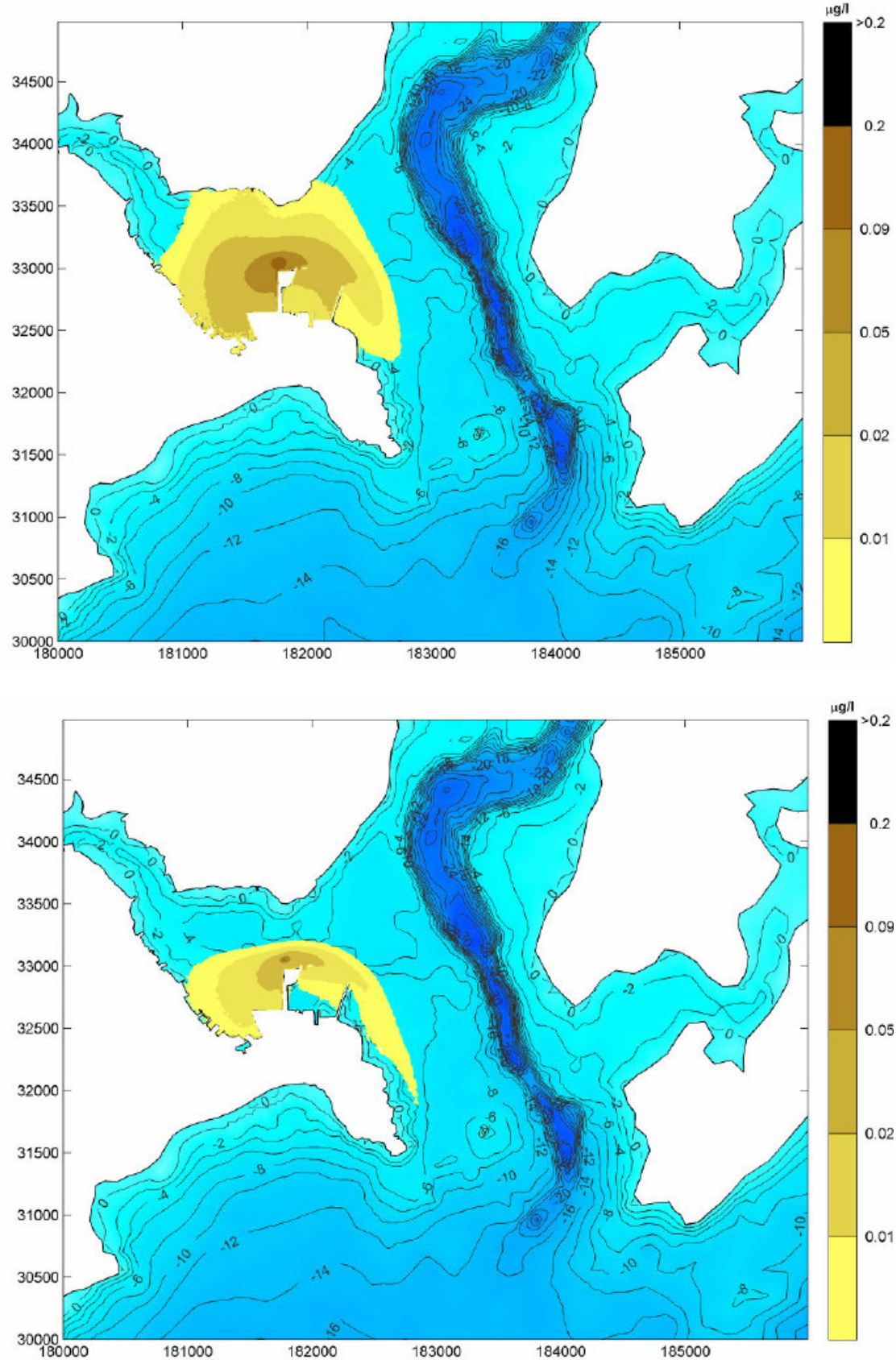


Figure 7-6 Increases in Cu Dissolved Concentrations due to Capital Dredging on Neap Tides (top) and Spring Tides (bottom)



A summary of TBT changes in the Fal Estuary at the locations shown in Figure 7-1 is presented in Table 7-8.

Table 7-8 Predicted Increases to TBT Total Concentrations in the Fal Estuary at Various Monitoring Stations: Comparison to Baseline Mean Values for TBT (µg/l)

Monitoring Station	Ref No.	Estimated Increase on Neap Tide	Estimated Increase on Spring Tide
River Fal at Vilt Buoy (estuarine water)	81910139	0, plume does not disperse this far	0, plume does not disperse this far
Penryn River – Falmouth Marina (estuarine water)	81910635	0, plume does not disperse this far	0, plume does not disperse this far
Falmouth Docks Northern Wharf (estuarine water)	H1910125	0.01, but >0.15 in plume around dredger	0.01, but 0.15 in plume around dredger
River Fal at Black Rock Buoy (sea water)	81910116	0, plume does not disperse this far	0, but <0.005 in plume to west of Black Rock Buoy

Compared to baseline conditions for metals (Cu, Hg, Pb, Zn) identified in Table 7-5, dredging will cause an increase in dissolved concentrations but, when added to the baseline's mean values, do not increase concentrations above the EQSs required by the DSD. Accordingly, the magnitude of concentration increases for metals is low.

A summary of metals changes in the Fal Estuary is presented in Table 7-9.

Table 7-9 Predicted Increases to Metal Dissolved Concentrations in the Fal Estuary at Various Monitoring Stations: Comparison to Baseline Mean Values for Cu, Hg, Pb and Zn (µg/l)

Monitoring Station	Metal	Baseline Mean	Maximum Increase	Baseline Mean + Maximum Increase	EQS
Carrick Roads	Cu	1.48	0.3	1.78	5
Carrick Roads	Hg	0.062	0.003	0.065	0.3
Carrick Roads	Pb	0.07	0.1	0.17	25
Carrick Roads	Zn	8.05	2.0	10.05	40
Penryn River	Cu	1.98	0.3	2.28	5
Penryn River	Hg	0.02	0.003	0.023	0.3
Penryn River	Pb	0.36	0.1	0.46	25
Penryn River	Zn	8.43	2.0	10.43	40
Percuil River	Cu	1.139	0	1.139	5
Percuil River	Hg	0.014	0	0.014	0.3
Percuil River	Pb	0.061	0	0.061	25
Percuil River	Zn	5.05	0	5.05	40

Water quality is regulated with regard to a European Directive (the DSD), which gives it a high level of environmental sensitivity. However, the baseline water quality conditions in the Fal Estuary exceed the EQS for TBT, and as such already breach the requirements of the DSD. This is not the case for the other indicator parameters (Cu, Hg, Pb and Zn), and baseline water quality conditions are within the EQSs.

Impact Significance

Overall, capital dredging is predicted to:

- increase concentrations of TBT to the extent that water quality requirements will be breached for the EQSs required under the DSD; and
- not increase concentrations of the other indicator contaminants to the extent that water quality requirements will be breached for the EQSs required under the DSD.

The scale of the impact on TBT concentrations will be limited in space (i.e. largely around Falmouth Docks and the harbour area) and time (i.e. over the duration of the capital dredge for contaminated sediment – 50 per cent of the dredging programme of c.26 weeks). Capital dredging is predicted to cause a temporary moderate adverse impact on water quality with regard to TBT concentrations. Normally, a high impact magnitude and high impact sensitivity would lead to a major adverse impact, but in this case the impact is put into the context of the baseline conditions where TBT is already present at concentrations exceeding the EQS and, accordingly, capital dredging will make a bad situation worse (rather than making a good situation bad).

Mitigation and Residual Impact

The impact is temporary and reversible (i.e. baseline conditions will return following the cessation of capital dredging). Like the baseline conditions, the conditions after dredging will remain above the EQS for TBT, at least in the short-term. No mitigation measures are proposed given that the best dredging option (i.e. backhoe dredging) has been proposed to minimise impacts on water quality, and that it is recommended that adverse nature of this impact be considered against the long-term, permanent benefits to water quality that are predicted to occur due to the removal of TBT from the estuarine system (see Section 7.5.1).

Without mitigation, there will remain a temporary moderate adverse impact on water quality with regard to TBT concentrations.

7.4.2 Impact on Shellfish Water Quality due to Capital Dredging

Capital dredging for the proposed new navigation channel will release sediment and associated contaminants into the overlying water column where they will disperse within the Fal Estuary, including designated shellfish waters. Some of the contaminants in the sediment to be dredged are included under the SWD. Accordingly, capital dredging may increase the concentrations of contaminants in the Fal Estuary relative to the water quality requirements of the SWD (see Table 7-2). For this impact assessment, TSS and metals (Cu, Hg, Pb and Zn) are used as indicator parameters concerning the SWD.

The sediment to be dredged is the source of the contaminants that could change water quality conditions relating to the SWD. Baseline sediment quality conditions are described in Sections 6.3.1 to 6.3.10. In summary, the surface sediment of the western part of the navigation channel including the cruise berth contains fine-grained sediment and contains elevated concentrations of the metals Cu, Hg, Pb and Zn (see Section 7.4.1) and, therefore, is the key source providing high potential for capital dredging to disperse significant concentrations of TSS and metals to the shellfish waters in the Fal Estuary.

The designated shellfish waters in the Fal Estuary (see Figure 7-3) are the potential receptors of the contaminants that could change their baseline water quality conditions relating to the SWD. Baseline water quality conditions are described in Section 7.3.2. In summary, average TSS concentrations are in the order of <10mg/kg, while metal concentrations are below the EQSs included under the DSD (see Table 7-5).

Dredging releases sediment into the overlying water in the form of a sediment plume and thereby provides a pathway for TSS and metals to affect water quality. With regard to TSS, Figures 5.9, 5.11 and 5.13 show the predicted maximum increase in concentrations over spring tides (i.e. including flood and ebb parts of the tide) for the anticipated worst case scenario associated with the proposed capital dredge. The figures clearly show that capital dredging provides a pathway for releasing TSS and contaminants into the Penryn River and Carrick Roads shellfish waters, but not into the Percuil River shellfish water since the sediment plumes do not disperse to the east of Carrick Roads. With regard to metals, Figure 7-6 shows the predicted maximum increase in Cu concentrations over a full neap tide and a full spring tide for the anticipated worst case scenario associated with the proposed capital dredge, and shows that capital dredging provides a pathway for releasing metal contaminants into the Penryn River and Carrick Roads shellfish waters, but not into the Percuil River shellfish water since the sediment plumes do not disperse to the east of Carrick Roads.

In terms of TSS, the SWD requires that “A discharge affecting shellfish waters must not cause the suspended solid content of the waters to exceed by more than 30% the content of waters not so affected”. Given a mean TSS concentration of <10mg/kg, the SWD therefore requires a discharge must not increase TSS concentration by 3mg/kg. Numerical modelling predicts that dredging will increase TSS concentrations by a magnitude of c.100mg/kg in the immediate vicinity of the dredger, and by a magnitude of 5-10mg/kg in the majority of the water area affected by the sediment plume (see Figures 5-9, 5-11 and 5-13). In essence, the change in TSS concentrations will be in breach of the SWD requirements in the Carrick Roads and Penryn River shellfish waters. For most of the affected shellfish areas, this breach will be low in magnitude (i.e. by 2-7mg/kg). For example, at the Environment Agency’s shellfish water monitoring points (see Figure 7-3) the increases are predicted to be 3-5mg/gkg in Carrick Roads and 0mg/kg in the Penryn River.

In terms of metals, the SWD requires that “The concentration of each substance in the shellfish waters…must not reach or exceed a level which has harmful effects on the shellfish and their larvae”. Since there is no quantitative standard for the metals, the EQS under the DSD has been used as a default standard for this impact assessment. As concluded in Section 7.4.1, numerical modelling predicts that dredging will increase metal concentrations but, when added to the baseline’s mean values, it does not increase concentrations above the EQSs required by the DSD (see Table 7.8). Accordingly, the magnitude of concentration increases for metals is low and does not breach the requirements of the SWD.

Impact Assessment

The Penryn River and Carrick Roads will be subject to a change in water quality conditions over part of the designated areas. Dredging will increase TSS concentrations in these two shellfish waters by more than 30% of baseline conditions (i.e. by more than 3mg/kg), particularly around the dredger (by c.100mg/kg), less so as the sediment plume

disperses with distance from the dredger (by 3-10mg/kg), and minimal at the Environment Agency's shellfish water monitoring points (by 3-5mg/gkg in Carrick Roads and 0mg/kg in the Penryn River).

In addition, the Penryn River and Carrick Roads will be subject to a change in water quality conditions for metals over part of the designated areas, but this will not be sufficient to breach the requirements of the SWD.

The Percuil River will not be subject to a change in water quality conditions over part of the designated areas, and therefore there will be no impact on water quality conditions for both TSS and metals in this shellfish water.

Overall, there will be:

- a minor-moderate adverse impact on water quality relating to TSS concentration increases in the Carrick Roads shellfish water
- a negligible-minor adverse impact relating to TSS concentration increases in the Penryn River shellfish water;
- a negligible impact on water quality relating to metal concentrations in the Carrick Roads and Penryn River shellfish waters; and
- no impact on water quality relating to TSS and metal concentrations in the Percuil River shellfish water.

The majority of the shellfish water areas over which TSS concentrations increase are not used for commercial shellfish harvesting, and therefore although the TSS concentrations will breach the requirements of the SWD, they will not affect the interests that the SWD is in place to protect (i.e. shellfish). The higher impact assessment for the Carrick Roads shellfish water reflects the increase of TSS concentrations over a larger area of the Carrick Roads shellfish water including the water quality monitoring point used by the Environment Agency.

Mitigation and Residual Impact

No mitigation measures are recommended. The preferred dredging option (i.e. using a backhoe dredger) is selected on the basis that it minimises the creation of sediment plumes and associated TSS concentrations, and is therefore the best option for minimising this impact. Furthermore, the TSS concentrations predicted by the numerical modelling are reported as peak concentrations (i.e. the highest concentrations that will occur) and are derived from conservative input conditions (i.e. conditions that will predict higher concentrations than may occur), and therefore this impact assessment is based on the worst case conditions for TSS concentrations.

Overall, there will remain:

- a minor-moderate adverse residual impact on water quality relating to TSS concentration increases in the Carrick Roads shellfish water
- a negligible-minor adverse residual impact relating to TSS concentration increases in the Penryn River shellfish water;
- a negligible residual impact on water quality relating to metal concentrations in the Carrick Roads and Penryn River shellfish waters; and
- no residual impact on water quality relating to TSS and metal concentrations in the Percuil River shellfish water.

7.4.3 Impacts on Bathing Water Quality due to Capital Dredging

Capital dredging will release sediment and associated bacterial contaminants into the overlying water column where they will disperse within the Fal Estuary, and possibly into Falmouth Bay as far as bathing waters designated under the BWD. Some of the contaminants in the sediment to be dredged are included under the BWD. Accordingly, capital dredging may increase the concentrations of contaminants in Falmouth Bay relative to the water quality requirements of the BWD (see Section 5.4.1).For this impact assessment, bacteriological parameters (faecal coliforms) are used as indicator parameters concerning the BWD.

The sediment to be dredged is the source of the contaminants that could change water quality conditions under the BWD. The baseline sediment quality conditions for the source are described in Section 6.3. In summary, the sediment to be dredged for the proposed Falmouth Cruise Project contains extremely low to non-detectable concentrations of these bacteria (i.e. at or below 100cfu/100g). At these concentrations, the source provides low potential for capital dredging to disperse significant concentrations of bacteria to the designated bathing waters in Falmouth Bay.

The designated bathing waters in Falmouth Bay (see Figure 7.4) are the potential receptors of contaminants that could change their baseline water quality conditions relative to the requirements of the BWD. Baseline water quality conditions are described in Section 7.3.3. In summary, the BWD indicator parameters are present at sufficiently low concentrations (i.e. <2,000 faecal coliforms / 100ml) that the bathing waters have been classified as achieving 'excellent' water quality since (at least) 2000.

Dredging releases sediment into the overlying water in the form of a sediment plume and thereby provides a pathway for faecal coliforms to affect water quality. With regard to the sediment plume, numerical modelling predicts the dispersion of sediment plumes from three dredging locations in the proposed new navigation channel (see Figures 5.9, 5.11 and 5.13). In all cases, the numerical modelling predicts that where sediment plumes extend beyond the Fal Estuary and into Falmouth Bay, they do not disperse as far as the designated bathing waters. Accordingly, there is no pathway for faecal coliforms between source and receptor, and there will be no impact on water quality in the bathing waters and the requirements of the BWD.

Mitigation and Residual Impact

No mitigation measures are recommended and there will remain no residual impact.

7.4.4 Impacts on Water Quality due to Accidental Spills and Leaks during Construction

During the construction period there is the potential for spills of construction materials (e.g. concrete, cement) and leaks from construction equipment (e.g. fuel, oil, lubricant) to affect the water quality of the Fal Estuary. Such an incident is not a planned part of the proposed Falmouth Cruise Project, and so it can only be considered as a risk to water quality. Although, the risk of an incident is very low, its significance will be dependent on the nature of the incident (e.g. the location, scale, type of pollutant).

Risk Management

The risk of a significant spill and/or leak can be minimised by following standard good practice with regard to pollution prevention guidance as part of the appointed contractor's environmental management plan.

It is therefore recommended that the appointed contractor undertakes the construction work in accordance with the Environment Agency's:

- Pollution Prevention Guidance PPG No. 5 on works in, near and liable to affect watercourses; and
- PPG No. 6 on working at construction and demolition sites.

It is also recommended that all concrete pouring and filling works are monitored by the appointed contractor and spill prevention and remediation measures are in place to minimise the risk and extent of spills and to rapidly deploy clean up equipment.

7.5 POTENTIAL IMPACTS DURING THE OPERATIONAL PHASE

7.5.1 Impacts on Dangerous Substances Water Quality due to Capital Dredging

As described in Section 7.3.1, the baseline conditions for water quality include TBT concentrations that exceed the EQS requirement under the DSD. The principal sources of TBT in the Fal Estuary include anti-fouling paint and discharges from outfalls (e.g. from the docks and sewage treatment plants). TBT concentrations in the water column have started to fall as inputs of TBT have been phased out through prohibiting the use of TBT in anti-fouling paints (in 1987 for vessels <25m and from 2008 for all vessels) and improved treatment for discharges (e.g. an active carbon treatment plant was installed at the docks). However, PMSP (2003) note that TBT concentrations in sediment have remained fairly stable since the 1980s and so, with the phasing out of other inputs, it is likely that contaminated sediment is the major source and contributor to the TBT affecting water quality in the Fal Estuary.

The proposed capital dredging will remove approximately 100,000m^3 of contaminated seabed material from the Fal Estuary, including TBT associated with sediment fractions and paint particles and flakes. The average TBT concentration of the nine surface sediment samples from the 2004 and 2007 surveys identified in Section 6.2.3 is 1.058mg/kg. If this concentration is applied to the upper 1m of seabed sediment in the western part of the navigation channel, including the deep water cruise berth area, then capital dredging will remove 105.8kg of TBT from the Fal Estuary.

PMSP (2003) report on calculations by Harris (2001) that estimated inputs of approximately 10kg per annum are required to account for the continued concentrations of TBT in the water column. Accordingly, after capital dredging for the proposed Falmouth Cruise Project, there could be 105.8kg less TBT in the Fal Estuary, which is the equivalent of 10.5 years of inputs based on Harris (2001).

Overall, the removal of TBT from the Fal Estuary will have a moderate beneficial impact on the water quality requirements of the DSD because it will reduce the magnitude of the key remaining source of TBT thereby improving the estuary's water quality relative to the EQS under the DSD and a future objectives and goals for water quality under the WFD.

Mitigation and Residual Impact

No mitigation measures are recommended and there will remain a moderate beneficial residual impact.

7.5.2 Impact on Water Quality due to Wastewater from the Cruise Terminal Building

The cruise terminal building will include a variety of facilities that will generate wastewater and sewage with microbiological contents that could affect the water quality requirements of the SWD, BWD and the WFD.

All the wastewater and sewage from the cruise terminal building will be collected and directed to a sewage treatment works via a dedicated drainage system connected to the mains sewerage network. Accordingly, it will be appropriately treated at a sewage treatment works prior to its discharge into receiving water and there will be no impact on the water quality requirements of the SWD, BWD and the WFD.

Mitigation and Residual Impact

No further mitigation measures are required and there will be no residual impact.

7.5.3 Impact on Water Quality due to Wastewater from Cruise Vessels

Cruise vessels will generate sewage and potentially discharge it into the sea. While it is assumed that the open ocean can generally assimilate sewage by natural bacterial and viral decay (www.imo.org), this is not the necessarily the case for coastal waters which are more susceptible to microbiological pollution and oxygen depletion, and the requirements of the DSD, SWD, BWD and the WFD.

The Merchant Shipping (Pollution) Act 2006 implements Annex IV of the MARPOL Convention (i.e. International Convention for the Prevention of Pollution from Ships, 1973 as modified by the Protocol of 1978). Coming into force in 2003, Annex IV contains a set of regulations regarding the discharge of sewage into the sea and prohibits ships from discharging sewage within a specified distance of the nearest land, unless they have in operation an approved sewage treatment plant. Coming into force in 2005, a revised Annex IV applies to new ships engaged in international voyages, of 400 gross tonnage and above or which are certified to carry more than 15 persons. Existing ships will be required to comply with the provisions of the revised Annex IV five years after the date of entry into force of Annex IV (i.e. 2008). The Annex requires ships to be equipped with either a sewage treatment plant or a sewage comminuting and disinfecting system or a sewage holding tank. The discharge of sewage into the sea will be prohibited by the Annex, except when the ship has in operation an approved sewage treatment plant or is discharging comminuted and disinfected sewage using an approved system at a distance of more than three nautical miles from the nearest land; or is discharging sewage which is not comminuted or disinfected at a distance of more than 12 nautical miles from the nearest land (www.imo.org).

With the above measures in place, there should be no impact on water quality due to an increased number and larger size of cruise vessels sailing to and from Falmouth, including the requirements of the DSD, SWD, BWD and the WFD.

Mitigation and Residual Impact

No further mitigation measures are required and there will be no residual impact.

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8 MARINE AND COASTAL ECOLOGY

8.1 INTRODUCTION

This section describes the marine benthos of the Falmouth Cruise Project EIA study area, which covers the proposed extent of capital dredging and potential areas of impact, and the wider area of Falmouth Harbour. Baseline conditions with respect to benthic infaunal and epifaunal assemblages are presented and discussed, along with potential impacts on this baseline associated with the construction and operational phases of the project.

The proposed project itself and baseline studies, potential impacts and mitigation measures relating to maerl and other sensitive features have been the subject of detailed consultation with Natural England.

Impacts associated with Natural Fish Resources, Commercial Fisheries and Marine Mammals are described in Section 11, Section 12 and Section 13 respectively.

8.2 ASSESSMENT METHOD

8.2.1 Baseline Data Collection

A literature review of the available data was carried out in order to assist in understanding the baseline characteristics of the marine communities which currently exist within the study area. A large amount of work has been carried out on the maerl communities of the Fal estuary and the effects of maerl extraction. Relevant studies include Hardiman ***et al.*** (1976), Farnham and Bishop (1985), Davies and Sotheran (1995), Perrins ***et al.*** (1995), Dyer and Worsfold (1998), Posford Haskoning (1998), SMS (2001, reported in Royal Haskoning, 2004) and Royal Haskoning (2004).

However, in isolation, this information does not provide a detailed enough foundation upon which to undertake an assessment of the potential impacts of the proposed project and therefore detailed site-specific marine ecological surveys were commissioned in order to inform the EIA process (see Section 8.2.2).

8.2.2 Survey

Objectives and Methodology

During August and September 2007 SeaStar Survey carried out a Marine Ecological Survey as a sub-consultant of Royal Haskoning. The main aims of the survey were:

- to assess the environmental impact of the proposed expansion of the docks with particular focus on the effect of major dredging of the channel on the benthic habitat and sensitive species;
- to assess an area identified as a possible site for the placement of the dredged material. Criteria for this site are:
    - an area with habitats not deemed to be of conservation value;
    - an area with habitats that could benefit from the introduced material with particular regard to the promotion of new maerl bed formation;

- to revisit a number of previously sampled stations (sampled in 2003) in areas historically subjected to commercial dredging in order to inform the EIA on recovery rates of maerl communities.

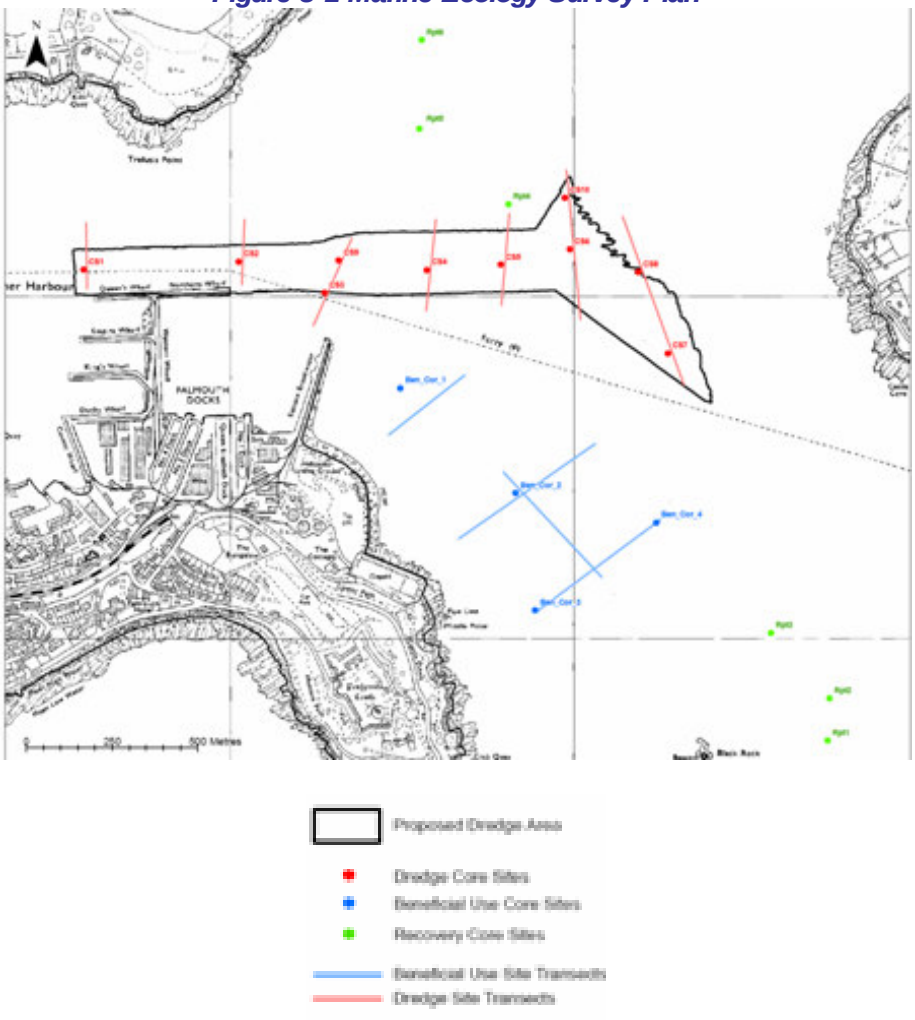
To achieve these objectives a range of techniques were used including:

- diver video transects;
- in situ diver observations; and
- diver sediment push-cores for infauna and sediment analysis.

The assessment and methods utilised were in compliance with the JNCC Marine Monitoring Handbook (2001). Diver survey video acquisition and in situ observation methodologies were based on the following Marine Monitoring Handbook Procedural Guidelines; No. 3-3, in situ survey of subtidal (epibiota) biotopes and species using diving techniques and No. 3-14, In situ survey of sublittoral epibiota using hand-held video. Sediment coring methodology was based on the Marine Monitoring Handbook Procedural Guideline Number 3–8, quantitative sampling of subtidal sediment biotopes and species using diver-operated cores. In addition, the survey specification was agreed in consultation with Natural England and Cefas.

The survey design comprised three distinct areas of interest; the sampling plan for each area is described below and illustrated in Figure 8-1.

Figure 8-1 Marine Ecology Survey Plan



Proposed Dredge Survey Area

Within the survey area, ten sites were sampled by sediment core, each consisting of three replicates for macroinfaunal community analysis and one sample for particle size analysis (PSA). Six seabed video transects measuring between 300 – 500 metres were taken in conjunction with in situ diver observations. The diver transects and observations were undertaken in order to aid interpretation of the core data, using the DAFOR scale for observed epifauna and flora. The siting of transects and cores was chosen to ensure spatial coverage of the proposed dredge area.

Potential Beneficial Use Area

The investigation of the potential beneficial use area was undertaken using four sediment core sites, consisting of three samples for macroinfauna and one for PSA. Four seabed video transects measuring 300-500 metres were taken in conjunction with in situ diver observations.

Recovery Sites

To ensure that the results of the survey were comparable to the data from previous years (Royal Haskoning 2004), the same methodology for sampling was used as in previous years. Characterisation of the recovery sites was undertaken by six sediment core sites. Each site consisted of five replicates for macroinfauna and one sediment sample for PSA.

Further details of the Marine Ecology Survey (Axelsson ***et al***., 2008) and sampling methodology are provided in Appendix C.

8.2.3 Assessment Criteria

Maerl Communities

The magnitude (spatial and temporal) of any given impact depends on a number of factors, chief among which is the sensitivity of individual species to potential change. The sensitivity of marine fauna varies with respect to impacts and their nature, for example, filter feeding species such as bivalve molluscs are sensitive to increases in turbidity, as suspended sediments may block sensitive feeding structures, whereas many species of polychaete worm are relatively unaffected by turbidity changes. Equally, following an impact such as disturbance, different species and communities will recover at different rates, leading to changes in community composition.

Maerl communities, especially live maerl are particularly sensitive to environmental change. Maerl is a UK BAP listed priority habitat and its action plan states the objectives of maintaining its range, variety and quality. A study carried out in order to review and assess the impacts of human activities on benthic biotopes and species, documents the sensitivities of both maerl species present within the study area (***Lithothamnion corallioides*** and ***Phymatolithon calcareum***) (Tyler-Walters and Hiscock, 2005). Table 8-1 below illustrates the sensitivities of both species to relevant physical and chemical factors.

Table 8-1 Maerl Species' Sensitivities to Physical and Chemical Factors (source: Tyler-Walters and Hiscock, 2005)

Impact	Intolerance	Recoverability	Sensitivity	Evidence / Confidence
Substratum loss	High	Very low	Very high	Moderate
Smothering	High	Very low	Very high	Moderate
Change in suspended sediment	High	Very low	Very high	Moderate
Desiccation	High	Very low	Very high	Moderate
Change in emergence regime	High	Very low	Very high	Moderate
Change in water flow rate	Intermediate	Moderate	Moderate	Moderate
Change in temperature	Intermediate	Moderate	Moderate	High
Change in turbidity	Intermediate	Moderate	Moderate	Moderate
Change in wave	Intermediate	Moderate	Moderate	Moderate

Impact	Intolerance	Recoverability	Sensitivity	Evidence / Confidence
exposure				
Abrasion and physical disturbance	High	Very low	Very high	Moderate
Synthetic compound contamination	Insufficient information	Insufficient information	Insufficient information	N/A
Heavy metal contamination	Insufficient information	Insufficient information	Insufficient information	N/A
Hydrocarbon contamination	Insufficient information	Insufficient information	Insufficient information	N/A

Maerl Habitat

The benthic communities associated with maerl habitats are often very high in species diversity (although dead maerl communities are generally reported to be less rich than those in live maerl beds) and often support species that are otherwise rare. These communities and the biodiversity associated with a maerl bed are dependant on a number of environmental variables. Of primary importance to dead maerl community structure is the accumulated maerl gravel depth, as this relates to the sheltering potential for infaunal burrowing species, such as amphipods. Therefore, the impacts on benthic communities associated with dead maerl (as is commonly found in the study area) are directly related to changes in maerl depth. As a result of studies on live maerl conducted by Hall-Spencer and Atkinson (1999; see Royal Haskoning 2008a), a conservative value of 1m of remaining maerl habitat has been defined as the minimum depth required for a viable associated benthic community.

8.2.4 Assessment Technique

Data Analysis

Univariate and multivariate analysis of the collected data was carried out using the software package PRIMER (Warwick and Clark, 1991), in order to provide information on species abundance, diversity and evenness and to determine any similarities or differences between samples and groupings of communities/species.

Number of individuals (N) was calculated as an average per sample for each station, in order to relate the CS stations (3 replicates) and RPT stations (5 replicates). Number of species (S) was the total number of species recorded at that station. Community diversity was calculated as species richness (Margalef's "d": (S-1)/(logeN)), Shannon-Weiner H' (Shannon and Weaver, 1949: Σpi Log2pi), and a measure of evenness (equitability: J') derived from the Shannon-Weiner diversity function, which expresses the degree of dominance between the species. This index of equitability ranges between 0 and 1, with low values indicating high dominance and 1 indicating an even distribution of individuals between species (i.e. low dominance). H' integrates the number of species and individual abundance to provide a summary value reflecting the diversity of fauna at a station. This index of diversity is influenced by both species richness (i.e. the number of species) and equitability.

Multivariate analysis was based on Bray-Curtis similarity analysis (%). Initially, the raw data were analysed; owing to the influence of the dominant amphipod species, a better

interpretation was enabled by using log-transformed data to reduce the over-influence of these taxa. Nearest-neighbour group-averaged cluster analysis from the similarity matrix allowed interpretation of community distinctions between groups of stations. A 2-dimensional interpretation was enabled using non-parametric multidimensional scaling (MDS); the values per station for the first two MDS axes were compared with environmental parameters (see below) using Spearman's Rank-correlation analysis, in order to determine which factors may be responsible for influencing the community trends.

Stepwise correlations were used to distinguish the influences of individual environmental parameters where these were auto-correlated, but in the event gave no further information, and are not discussed further.

Biomass (blotted wet weight, bww) was analysed as grams of five major taxa: worms, crustaceans, molluscs, echinoderms and "others" (sipunculans, nemerteans, phoronids, hemichordates, cephalochordates, pycnogonids, flatworms, echiurans, chaetognaths), plus total, in each case as an average per sample per station, similar to the treatment of individual numbers per station. Single large individuals, such as venerupid bivalves, which would disproportionately bias the analysis, were excluded from statistical analyses.

Presence of live maerl, dead maerl and red/green algae were quantified from the DAFOR scale as D=5, A=4, F=3, O=2, R=1, absent = 0. Sediment was analysed as the percentages of four fractions, silt & clay, sand, granule and pebble. As statistical interpretations were based on Spearman Rank-Correlation, no transformation of these data was necessary.

8.2.5 *Assessment of Impact Significance*

With regard to marine ecology, an impact is viewed as a change in the existing or baseline assemblage of species, habitats or communities, which potentially could be attributed to the construction or operation of the cruise terminal (a change can be beneficial or adverse).

Impact Magnitude

For the purposes of this assessment process the magnitude of impact with respect to maerl communities has been defined as set out in Table 8-2.

Table 8-2 Definition of Impact Magnitude for Marine Ecology Impact Assessment

Magnitude	Definition
Major	A long term/permanent and major reduction in the area of remaining maerl or a remaining depth of less than 1m of accumulated maerl gravel
Moderate	A partial reduction in the area of remaining maerl and/or depth of maerl gravel; recovery would be expected following the cessation of the impact
Minor	Small but discernable reduction in maerl area and/or depth of maerl gravel; impact generally of a short term nature or, in the longer term, full recovery would be expected following the cessation of the impact
Negligible	Possible reduction in maerl area and/or depth of maerl gravel, but difficult to discern with any confidence

Attaching sensitivity criteria (i.e. a value or importance) to the marine communities and individual species present is a somewhat subjective exercise, although there are various approaches that can be used in defining this attribute. For the purposes of this assessment a suite of criteria (see Table 8-3) have been used which take into account current levels of conservation concern and which have also been widely used in other impact assessments and/or reflect the approach proposed by the Institute of Ecology and Environmental Management (2006).

Table 8-3 Definition of Receptor Sensitivity Criteria for Marine Ecology Impact Assessment

Sensitivity	Criteria
Very high	• EU Habitats Directive, SAC designated populations or habitat
High	• Habitats or species listed on Annex II of the EU Habitats Directive (but not SAC designated population); and • Species listed as Critically Endangered, Endangered or Vulnerable on the IUCN Red List; or • CITES listed; or • Wildlife and Countryside Act 1981 (as amended) listed; or • OSPAR listed; or • BERN listed species and occurring in regionally/locally important numbers
Medium	• Species listed as Critically Endangered, Endangered or Vulnerable on the IUCN Red List; or • CITES listed; or • Wildlife and Countryside Act 1981 (as amended); or • OSPAR listed; or • BERN listed species and occurring in and resident in low numbers or occasionally; • Species listed as Near Threatened on the IUCN Red List and occurring in regionally/locally important numbers; • Species present in regionally important numbers (>1% regional population) or for which Action Plans have been developed via the Local Biodiversity Action Plan
Low	• Species listed as 'Near Threatened on the IUCN Red List and resident in low numbers or occasionally present

Impact Significance

Significance has been determined through an assessment of the likely magnitude of impact verses the sensitivity / importance of the affected resource (i.e. the benthic communities present that could be impacted by the proposal), as illustrated by Table 8-4.

Table 8-4 Significance of Potential Impact (source / adapted from: Institute of Ecology and Environmental Management, 2006)

Resource Sensitivity Impact Magnitude	Very High	High	Medium	Low
Major negative	Major	Major	Moderate	Minor
Moderate negative	Moderate	Moderate	Minor	Negligible
Minor negative	Minor	Minor	Minor	Negligible
Negligible	Minor	Negligible	Negligible	Negligible
Neutral				
Positive	Major	Major	Minor	Negligible

8.3 BASELINE ENVIRONMENTAL CONDITIONS

8.3.1 Fal and Helford Estuaries SAC

Falmouth Harbour and the study area fall within the Fal and Helford Estuaries SAC. The SAC was identified as a candidate SAC in 1996 and subsequently designated under the EC Habitats Directive (Council Directive 92/43/EEC), which is transposed into UK law by the Conservation (Natural Habitats &c.) Regulations 1994. The site was designated for a number of marine habitats and features and these include:

- 1110 sandbanks which are slightly covered by sea water all the time;
- 1140 mudflats and sandflats not covered by seawater at low tide;
- 1160 large shallow inlets and bays;
- 1330 Atlantic salt meadows (***Glauco-Puccinellietalia maritimae***);
- 1130 estuaries; and
- 1170 reefs.

The SAC is a sheltered site on the south-west coast of England, with a low tidal range and a wide range of substrates resulting in biologically one of the richest examples of sandbanks in the UK. Sublittoral sandbanks are present throughout much of the ria system and Falmouth Bay. There are particularly rich sublittoral sand invertebrate communities with eelgrass (***Zostera marina)*** beds near the mouth of both the Fal and Helford and in some channels of the rias, such as the Percuil River and Passage Cove. Of particular importance are the maerl (***Phymatolithon calcareum*** and ***Lithothamnion corallioides***) beds that occur in the lower Fal on St Mawes Bank, and the extensive areas of maerl gravel which extend throughout the Carrick Roads and Falmouth Bay. These are the largest beds in south-west Britain and harbour a rich variety of both epifaunal and infaunal species, including some which are rarely encountered, such as Couch's goby (***Gobius couchi)***.

The SAC also supports examples of sheltered intertidal mudflats and sandflats representative of south-west England, and is particularly recognised for the importance of the species living in the sediments, including amphipods, polychaete worms, the sea cucumber ***Leptopentacta elongata*** and bivalve molluscs. Most of the shores of the Fal and Helford rias, and their upper reaches, are fringed by sandflats and mudflats. Owing to the sheltered nature of the site, the sediments are stable as well as being diverse, and include muds, muddy sand and clean sand. These support particularly rich and nationally important sediment communities in the Fal/Ruan estuary, Percuil River and in Passage Cove, including beds of dwarf eelgrass ***Zostera noltii*** and diverse invertebrate communities.

8.3.2 Maerl

Maerl is a collective term for several species of calcified red seaweed: typically ***Lithothamnion corallioides*** and ***Phymatolithon calcareum*** in the south of Great Britain. It grows as unattached nodules on the seabed, and can form extensive beds in favourable conditions. Maerl is slow-growing, but over long periods its dead calcareous skeleton can accumulate into deep deposits (an important habitat in its own right), overlain by a thin layer of pink, living maerl.

Maerl beds typically develop where there is some tidal flow, such as in the narrows and rapids of sea lochs, or the straits and sounds between islands. Beds may also develop in

more open areas where wave action is sufficient to remove fine sediments, but not strong enough to break the brittle maerl branches. Live maerl has been found at depths of 40m, but beds are typically much shallower, above 20m and extending up to the low tide level.

The three-dimensional structure of maerl thalli forms an interlocking lattice that provides a wide range of niches for infaunal and epifaunal invertebrates. Therefore these beds can harbour a very high diversity of organisms, some of which are more or less confined to the maerl habitat (Birkett ***et al***., 1998). There are numerous features of maerl that contribute to its value as a habitat for other marine species (Nunn, 1992, cited in Birkett, ***et al***., 1998):

- it provides a surface to which other seaweeds (e.g. ***Plocamium cartilagineum*** can attach) and other organisms (e.g. ***Aplysia punctata*** and rissoids) then feed on these seaweeds;
- it can be grazed itself by organisms such as ***Tectura (Acmaea) virginea***;
- the algal film and detritus can also be grazed (e.g. by ***Jujubinus montagui***);
- it provides attachment sites for animals which in turn are food for others (e.g. ***Antedon bifida***, hydroids, bryozoans).
- the infauna in maerl beds includes many bivalves (e.g. ***Mya truncata, Dosinia exoleta)***;and
- its loose structure provides shelter (e.g. for small gastropods).

Bosence (1979, cited in Birkett ***et al***., 1998) carried out a community analysis of all animals associated with live maerl in Mannin Bay, Galway, classifying them into vagile (i.e. mobile) epifauna, sessile epifauna, burrowing infauna and boring infauna, and their trophic group (herbivore, carnivore/scavenger, deposit feeder, suspension feeder, commensal). The maerl bank community was characterised by abundant vagile epifauna. Gastropods were common in the lattice formed by the maerl, the most abundant species being the herbivorous gastropods, ***Bittium reticulatum*** and ***Gibbula cineraria***.

Maerl is a UK Biodiversity Action Plan (BAP) listed priority habitat. The actions plans objectives and targets include:

- maintain the geographical range of maerl beds and associated plant and animal communities in the UK subject to best available information; and
- maintain the variety and quality of maerl beds and associated plant and animal communities in the UK subject to best available information.

Maerl habitats within the SAC also form sub-features of Annex I habitat types, as:

- sandbanks which are slightly covered by seawater at all times;
- large shallow bays and inlets;
- estuaries; and
- the priority habitat, lagoons.

8.3.3 Background Data on Maerl in the Fal Estuary: Surveys up to 2003

An extensive grab survey of the Fal estuary and Falmouth Bay was undertaken by Hardiman ***et al*** in 1976. Grabs were taken from 163 stations and the percentage of live and dead maerl at each station recorded. The survey found that significant quantities of dead maerl are present in much of the Carrick Roads and Falmouth Bay. A live maerl bank is present on St Mawes Bank. They found that the fauna of the dead maerl

basically resembled that typical of fine shell gravel but with a wide range of polychaetes (samples analysed with a 2mm sieve).

In 1995, a report was produced by English Nature (now Natural England) which indicated the predicted distribution of biotopes within Falmouth Bay. This study (Davies and Sotheran, 1995) aimed to map the distribution of biotopes within the Fal Estuary and Falmouth Bay. This information could then be used to provide the necessary data to make decisions on the best approach for managing the living resource in response to exploitation. A map of the predicted distribution of biotopes within the Fal Estuary was produced based on survey work using a RoxAnn acoustic system supported by ground-truthing using a drop-down camera and grab samples.

A study was also undertaken in 1995 by Perrins ***et al***. on behalf of the National Rivers Authority (now the Environment Agency) and English Nature (now Natural England). The study comprised a comparison of the percentage live maerl and the flora and fauna on a transect on the live maerl bed of St Mawes Bank. The study compared the results of a transect in 1982 with results collected in 1992. The study recorded a reduction in the percentage of live maerl recorded on the transect. A number of possible causes were suggested for this reduction, including increases in turbidity.

A study was undertaken on behalf of Natural England by Unicomarine (Dyer and Worsfold, 1998). The Unicomarine study compared sediment distribution and macrofauna content of samples taken from three distinct areas within Falmouth Bay, namely:

- current extraction area (in the estuary mouth) (Station 1);
- previously worked station in Falmouth Bay (Station 2); and
- reference station in Falmouth Bay (Station 3).

The research indicated that the previously worked station has shown some recovery in that it is supporting a range of species some of which are identical to those found at the reference station. However the research was not conclusive because there was no baseline for comparison of the data. Furthermore the differences between the community at station 1 and stations 2 and 3 could be related to topography and hydrography rather than dredging.

In 1998, Posford Haskoning undertook a study on behalf of the Cornish Calcified Seaweed Co Ltd on the ecological effects of dredging for dead maerl in Falmouth Bay. The study was based on existing literature and examined the effect that maerl extraction within Falmouth Bay would have on the integrity of the SAC.

A survey of the estuary was undertaken by the Institute of Estuarine and Coastal Sciences of University of Hull, on behalf of Natural England to assist in monitoring and condition assessment of the SAC. No samples were taken as part of this survey from the maerl extraction areas.

In 2001, FHC commissioned Sub Marine Services Ltd (SMS) to undertake an airlift survey of the maerl resource to establish the depth of maerl in the extraction areas. Airlift was used to excavate holes at 8 locations within the Fal Estuary. The results of the survey were incorporated into the results of the study by Royal Haskoning (2004) (see below).

8.3.4 Background Data on Maerl in the Fal Estuary: Surveys in 2003

Marine ecological surveys were undertaken in 2003 for FHC in order to undertake a review of the effects of maerl extraction on the (then) cSAC. The overall objective of the survey was to determine whether maerl extraction was having an effect on the infaunal communities of the maerl beds. Alongside this general aim, were the following specific objectives:

- to characterise the nature of the seabed and infaunal communities within the extraction area and determine how these compare with surrounding communities;
- to determine the depth of the maerl resource within the extraction area and the depth of maerl that is required for a viable infaunal community to exist so that the volume of extractable maerl can be established; and
- to provide a baseline for future monitoring, should maerl extraction continue (it should be noted that this baseline will already be influenced by extraction).

In order to investigate the effects of extraction, samples were taken from a reference site (similar in characteristics but which is not extracted) and compared to samples from the extraction site. In order to provide information in the future on the effects of extraction, a no-take zone was established to monitor recolonisation post-dredging. As part of the survey, samples were taken from this area to provide a baseline against which the results of future surveys can be compared.

Data from the surveys found the benthic communities to be very diverse, containing a high number of species, with a marked variation between the northern and southern stations, the northern sites having a higher species richness (Royal Haskoning, 2004). At the majority of stations the sediments were dominated by granules and pebbles, a few stations to the east of the study area were found to have higher levels of finer sediments such as sand and silt.

A total of 234 taxa were recorded from the cores, with an average of 90 individuals of 26 taxa per core. The fauna was dominated by polychaete worms of the genus ***Sphaerosyllis*** and ***Mediomastus*** and crustaceans of the order Harpacticoida. Table 8-5 below illustrates the characteristic species and their relative contributions.

Table 8-5 Characteristic Species of the 2003 Ecological Surveys (source: Royal Haskoning, 2004)

Phylum	Genus	Average Abundance	Average similarity	Similarity: Standard deviation	Contribution %	Cumulative %
Annelida	Sphaerosyllis	13.85	2.17	1.07	6.51	6.51
Annelida	Mediomastus	10.23	2.16	0.97	6.48	12.99
Crustacea	Harpacticoida	9.52	2.02	1.2	6.05	19.04
Nematoda	Nematoda	8.23	1.73	0.9	5.19	24.23
Crustacea	Socarnes	8.23	1.65	0.83	4.96	29.19
Annelida	Kefersteinia	4.47	1.57	1.12	4.71	33.9
Crustacea	Perrierella	6.8	1.57	0.9	4.71	38.61
Crustacea	Caprella	9.12	1.25	0.8	3.76	42.37
Crustacea	Metaphoxus	3.41	1.25	1.02	3.74	46.11
Crustacea	Leptocheirus	8.64	1.25	0.72	3.74	49.85

The study concluded that there was no significant difference in the mean number of taxa per core, in the infaunal community of the maerl beds in the extraction areas and in the reference areas. However, the number of individuals per core was significantly lower in the high extraction area. In contrast, the infaunal communities of the extraction area were found to be significantly more diverse (when measured as a Shannon-Weiner diversity index) compared to the reference sites or the low extraction area.

8.3.5 *Background data on Maerl within the Study Area: Surveys in 2007*

The ecological surveys undertaken in 2007 (to inform the current study) recorded 194 taxa from the core samples taken within the study area as illustrated by Figure 8.1. 74 species were annelids (71 polychaetes, three oligochaetes), 50 crustaceans (including seven decapods), 48 molluscs and seven echinoderms. Cnidarians, flatworms, chaetognaths, sipunculans, echiurans, nemerteans, pycnogonids, phoronids, cephalochordates and hemichordates made up a further 15 taxa.

The surveys found the macrofaunal communities across the study area to be relatively diverse, with a high species richness, except towards the inner harbour where diversity levels were lower. The dominant species were peracarid crustaceans, notably the amphipods ***Leptocheirus pectinatus, Caprella linearis, Gammarella fucicola, Parametaphoxus fultoni*** and ***Socarnes erythrophthalmus***, as well as the isopod ***Janira maculosa***. Other dominant species included the brittle-star ***Amphipholis squamata***, the gastropod ***Cerithiopsis tuberculatus*** and the amphipod ***Megamphopus cornutus***. These are mainly species of coarse substrata, exploiting the interstices of gravels, shell-breccia and maerl present within the study area.

Univariate community parameters are shown in Table 8-6. The number of species per station ranged from 52 to 88, except at station CS03 where only 37 species were recorded. Average numbers of individuals per core was more variable, ranging mainly between 111 and 519, but as low as 41 at station CS03 and 69 at station CS07. Species richness (Margalef's "d") was high at all stations. Evenness ranged from comparatively low values (J'<0.9) across the area owing to high dominance of a few species, to particularly low at stations where the top-ranked amphipods were particularly numerous (dominant), e.g. CS10 and RPT, where J'<0.6). The Shannon-Weiner diversity was relatively consistent across the area, but depressed at stations with high dominance, being influenced by the evenness.

Table 8-6 Univariate Community Parameters from the 2007 Ecological Surveys (source: Axelsson et al. 2008)

Station	Species	Individuals	Species richness	Evenness	Shannon-Weiner diversity
CS01	57	206	10.51	0.778	4.539
CS02	73	178	13.89	0.816	5.051
CS03	37	41	9.673	0.886	4.613
CS04	65	308	11.17	0.751	4.523
CS05	71	516	11.21	0.656	4.035
CS06	60	111	12.52	0.829	4.895

Station	Species	Individuals	Species richness	Evenness	Shannon-Weiner diversity
CS07	52	69	12.06	0.886	5.050
CS08	83	312	14.28	0.726	4.631
CS09	66	348	11.11	0.673	4.065
CS10	60	519	9.437	0.551	3.255
RPT1	80	182	15.18	0.791	5.002
RPT2	88	370	14.71	0.697	4.501
RPT3	84	499	13.36	0.565	3.608
RPT4	73	169	14.04	0.761	4.711
RPT5	75	185	14.18	0.731	4.552
RPT6	70	184	13.23	0.709	4.347

Multivariate analysis (Bray-Curtis similarity) of the data produced three main clusters. At 50% similarity, two stations, CS07 and CS03, are isolated, as are two station-pairs, stations CS09 and CS10 (cluster A) and CS01 and CS02 (cluster C). The remaining ten of the stations form a main cluster (B), subdividing at 53% similarity into sub-clusters B1 and B2, which largely separate CS stations from RPT stations. These associations do not reflect well the proximate spatial relationship of stations other than the southern cluster of RPT stations (1 to 3) and the inner-harbour couplet of the cluster C stations, although the eastern CS stations CS04 to CS08 are associated. The dominant taxa and clusters are illustrated in Figure 8-2 and Table 8-7.

Figure 8-2 Dendrogram based on Bray-Curtis Similarity (%; log-transformed data) for All Stations (source: Axelsson et al., 2008)

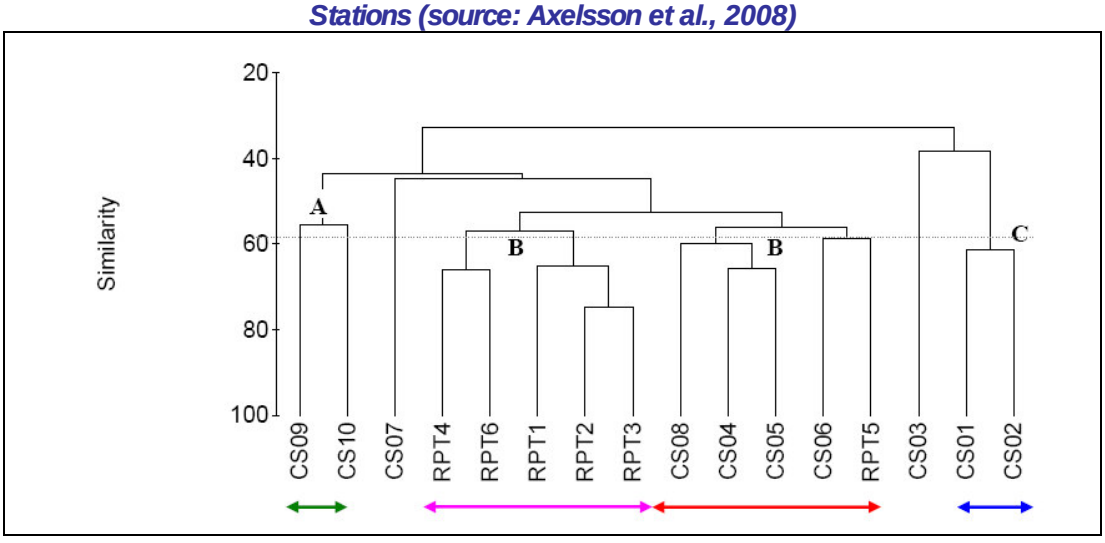
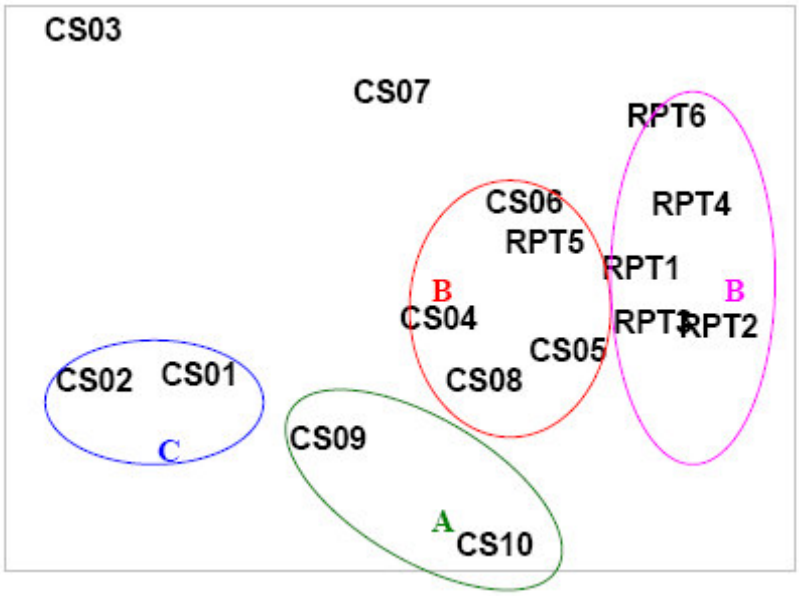


Figure 8-3 shows the MDS ordination of the stations, with the major clusters from Figure 8-2 indicated, confirming the association of stations within clusters, and the isolation of stations CS03 and CS07. The resolution is good, with a stress of 0.08 for the MDS analysis.

Figure 8-3 MDS Ordination for All Stations (log-transformed data)



The community of cluster B reflects the general amphipod dominated structure described above. Sub-cluster B1 is distinguished by the greater densities of some infaunal taxa, notably the polychaete ***Exogone verugera***. The distinction between the two sub-clusters is, however, small.

Cluster A stations, spatially more widely separated, represent a greater variation on the basic community illustrated by cluster B, largely distinguished by the absence of some species common to cluster B, namely the brittle-star ***Amphipholis squamata*** and the cumaceans ***Cumella pygmaea*** and ***Nannastacus unguiculatus,*** and the presence of two scarcely recorded amphipods. These stations are again regarded as minor variants of cluster B.

The two stations of cluster C, in the inner harbour supported a number of species associated with organic loading in the sediment, including cirratulid polychaetes, capitellids and oligochaetes. The gastropod ***Cerithiopsis tubercularis***, which was the dominant species in cluster C, is normally associated with sponges; however, it also feeds on epiphytic or epizootic detritus where abundant. The dominant amphipods were sparse at these stations, likely due to the poor opportunity for burrowing by the fine sediments at the stations. The isolated stations CS03 and CS07 were markedly impoverished, with sparse numbers of pericarid crustaceans, typical of the other stations and low overall species diversity as represented by the species number in Table 8-7.

Table 8-7 Dominant Taxa per Major Cluster (source: Axelsson et al. 2008)

A	B1	B2	C
Caprella linearis	***Leptocheirus pectinatus***		***Cerithiopsis tubercularis***
Leptocheirus pectinatus	***Caprella linearis***		***Mediomastus fragilis***
Janira maculosa	***Exogone verugera***	***Socarnes erythrophthalmus***	***Chaetozone christei***
Gammarella fucicola	***Amphipholis squamata***	***Parametaphoxus fultoni***	***Chaetozone gibber***
Ericthonius sp.	***Socarnes erythrophthalmus***	***Janira maculosa***	***Cirratulus filiformis***
Socarnes erythrophthalmus	***Cumella pygmaea***	***Apseudes latreilli***	***Tubificoides insularis***
Bathyporeia sp.	***Nannastacus unguiculatus***	***Gammarella fucicola***	***Leptocheirus pectinatus***
	Typhlotanais brevicornis	***Megamphopus cornutus***	
Mean no. of individuals			
413	293	328	213
Mean biomass, g			
2.36	0.70	0.78	2.84

There is some isolation of the recovery (RPT) stations from the proposed dredge area (CS) stations, the former having a greater proportion of sediment-associated species.

No scheduled or otherwise conservation-significant species were recorded, other than the maerl itself. One notable species, previously rarely recorded, but present across the area at cluster B stations, was the tanaidacean ***Leptognathia paramanca***, currently being considered for statutory conservation-protection.

Relation to Environmental Parameters

Environmental parameters used in the community analysis are shown in Table 8-8. Site depth was relatively consistent across the area, at between 4.8m and 8m (uncorrected data). Generally, as would be expected from maerl beds, the sediments were gravelly sands to sandy gravels. Highest silt/clay contents (>4%) were found at the stations furthest into the inner harbour (CS01, 02, 03 and 09); CS10 supported a particularly coarse sediment, with a 95% coarse fraction (>2 mm diameter). Other than station CS08, where no maerl or algae were recorded, dead maerl was common at all sites, while live maerl and algae were patchy, both being most abundant at stations CS03 and CS09.

Table 8-8 Environmental Parameters of Sediment Granulometry, and the Presence of Live Maerl, Dead Maerl and Red/Green Algae used in Statistical Analyses (source: Axelsson et al. 2008).

Station	Silt & Clay%	Sand%	Granule%	Pebble%	Depth	Live maerl*	Dead maerl*	Algae*
CS01	4.8	28.51	36.89	29.81	5.5	2	4	0
CS02	6.92	44.09	27.58	21.4	6.3	0	3	0
CS03	4.04	56.55	30.31	9.12	5.5	4	3	3
CS04	1.92	25.34	38.35	34.4	4.8	1	5	2
CS05	1.76	16.03	40.98	41.22	4.8	1	5	0
CS06	1.62	33.94	34.22	30.21	6	1	5	2
CS07	3.58	56.77	25.43	14.23	6.5	2	4	3
CS08	2.71	65.65	20.46	11.18	8	0	0	0
CS09	5.2	31.63	33.24	29.92	5	4	5	3
CS10	1.26	3.8	26.25	68.68	7.2	2	4	1
RPT1	2.25	36.68	37.48	23.59	7.5	1	4	1
RPT2	2.69	30.24	51.53	15.54	8	1	4	3
RPT3	2.94	12.44	52.74	31.88	7.7	1	5	2
RPT4	1.29	28.2	27.84	42.67	6	1	4	2
RPT5	2.52	41.27	30.52	25.69	5.4	2	4	2
RPT6	1.68	41.9	37.83	18.59	5.2	1	5	3

* Note: abundance is based on the DAFOR scale as D=5, A=4, F=3, O=2, R=1 and absent = 0

The MDS station coordinates from the community analysis were compared with these environmental parameters by Spearman rank-correlation. The significant results ($p<0.05$) were found for the following parameters:

- silt/clay % - the correlation with silt/clay% relates to the highest proportion of this fraction occurring in the stations mostly located towards the inner harbour (CS01, 02, 03 and 09), including stations of cluster C, with their organically-associated infaunal-annelid community, and the impoverished station CS03;
- species/individual number - correlations with numbers of species and of individuals are biased by, in the former case the very low diversity at station CS03, and in the latter case the low faunal densities at the impoverished isolated stations CS03 and CS07, and the high faunal densities at stations of cluster A;
- species richness - the species richness follows number of species, while evenness trends are not considered realistic, being an artefact of the high level in CS03 owing to the sparsity of fauna and lack of dominance;
- biomass - Correlations with biomass reflect the highest levels of worm biomass occurring in cluster C stations (low on axis MDS1), of echinoderm biomass at stations of cluster B1 (high on MDS1), and of crustaceans and molluscs, and thus of total biomass, in stations of clusters C and A, low on axis MDS2. These data repeat the findings of the annelid dominance in cluster C, and the comparative restriction to peracarid crustaceans in cluster A stations; and
- algal presence - the correlation with algal presence is caused by the absence of algae from cluster C stations, and its low presence in stations CS05, CS08 and

CS10, all low on axis MDS2. These stations support the highest densities of the top-dominant amphipods and ***Gammarella fucicola***, and the weed presence does appear to be having a secondary influence on the community structure.

Diver Transects

The proposed dredging zone and the recovery sites had a similar community, as was discovered for the infauna, although the former had slightly more dense populations of some larger sessile invertebrates, while macroalgal cover was more conspicuous at the recovery sites. In terms of these large errant species, macroalgae and epifaunal taxa, the recovery sites were more sparsely covered: the average number of taxa per transect was 8.2, compared with 8.6 in the dredging zone. However, the distinction between these two is not considered significant.

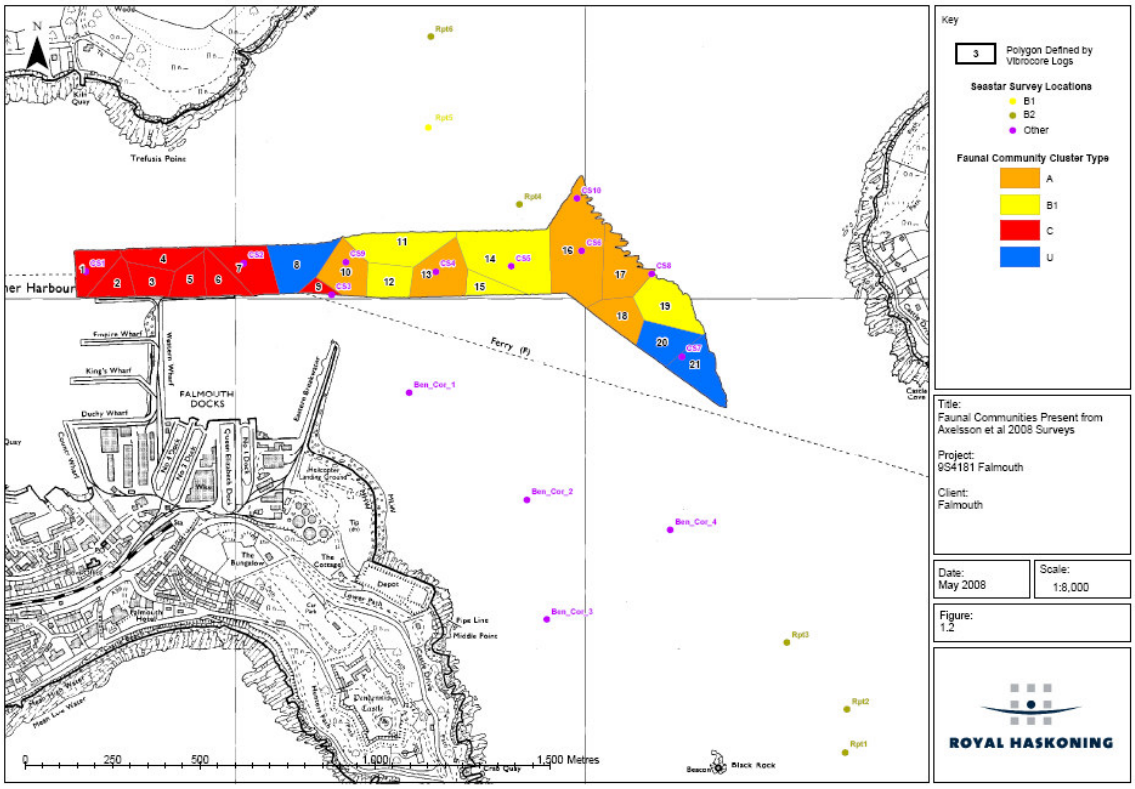
Potential Beneficial Use Areas

The beneficial use transects had a well-developed and mature epibiota, particularly dominated by red/green and larger algae (***Laminaria saccharina, Saccorhiza polyschides)*** but also associated epizooites (the hydroid ***Obelia geniculata***, the bryozoan ***Membranipora membranacea***) , as well as a similar density of live maerl. The average number of taxa present per beneficial-use-transect was 9.3.

Conclusions of the 2007 Survey

The community gives some clear indications of differences between parts of the survey area. The stations of the inner harbour (CS01, CS02, cluster C) have a community reflecting a greater fine fraction to the sediment, and potentially higher organic loading, with an atypical dominance of infaunal annelids, at station CS03 the fauna is severely impoverished and uncharacterized in comparison with the surrounding stations (see Figure 8-4). These are the stations nearest to the Falmouth marinas and Dock Basin. The diver survey of Dredged Site Transect 1 confirmed the substratum to be predominantly of mud, and that of transect 2 as sand. Paradoxically, station CS03, and the adjacent CS09, also supported high densities of live maerl; heterogeneity of habitat along transect 3, which includes these two sampling stations, was observed by the diving survey.

Figure 8-4 Faunal Community Types recorded during the 2007Survey



Stations CS09 and CS10, both with good live-maerl cover, supported a denser community of peracarid crustaceans of lower species richness, with lower presence of infaunal species, in the case of CS10 likely to be related to the coarseness of the sediment. There is no common environmental cause between these two stations. CS10, as well as CS06, lies on diver transect 6, where coarse gravels were observed along with coarse sand as mounds and in depressions.

Station CS07, close to the deeper channel of Carrick Roads, has an impoverished community, and despite the good presence of maerl, has a smaller coarse fraction. There is no other apparent environmental cause for this impoverishment.

The remaining stations support a relatively consistent and diverse community, dominated by species which are consistent with a habitat of gravel, shell breccia and maerl. There is some isolation of the RPT stations from the CS stations, the former having a greater proportion of sediment-associated species (despite the granulometry data not showing any significant distinction).

Comparison of 2007 Survey with 2003 Survey

The infauna communities sampled in 2003 and 2007 were significantly different in terms of the number of individuals and number of taxa recorded. In 2007 a much higher total number of individuals were recorded with the average per core increasing from 90 to 265. Interestingly the total number of taxa recorded decreased by 23 in 2007, although in contrast the average per core increased by over 30%.

Diversity (measured using the Shannon-Wiener index) was generally high across the sites surveyed, sites 2, 5 and 8 having high values in both 2003 and 2007. The lowest Shannon-Wiener values were from sites 16, 15 and 13 in 2003. In 2007, this diversity measure increased substantially at these sites, making them as diverse as the northern sites in both 2003 and 2007.

Multivariate analysis identified a clear separation of samples from 2003 and 2007. In 2003 northern sites 2, 5 and 8 were similar in community composition whereas southern sites 16, 15 and 13 were different from the north and also more varied amongst themselves. In 2007 the community composition shifted so that all sites were very similar to each other as compared to the communities previously sampled in 2003. In addition, the MDS and cluster analysis indicated that all communities sampled in 2007 were different (in varying degrees of difference) from those communities sampled in 2003.

Investigating these differences further revealed a number of taxa which colonised the sites or increased in number between the two survey times. In general more species colonised than were removed from the samples. Taxa present within the 2007 samples which were not present in the 2003 sample include ***Typhlotanais*** sp.***, Nannastacus*** sp.***, Cumella*** sp.***, Syllis*** sp.***, Parametaphoxus*** sp.***,*** and ***Exogone*** sp. Whereas organisms from the genus ***Psamathe*** sp., ***Verruca*** sp. and ***Pomatoceros*** sp. were not found within the 2007 samples, but were present in the 2003 survey. ***Sphaerosyllis*** sp was also reduced considerably in numbers between the two surveys, with only 6 individuals recorded in 2007.

Organisms of the genus ***Exogone***, ***Sylli***s, ***Parametaphoxus***, ***Amphipholis*** and ***Socarnes*** were characteristic across the 2007 samples, whereas in 2003 similarities between sites were caused by organisms of the genus Pomatoceros, Psmathe, ***Sphaerosyllis, Polycirrus*** and ***Socarnes***. One of the main differences observed between 2003 and 2007 was the presence of large numbers of ***Exogone*** spp. (notably ***E. verugera***) within all 2007 samples, where none were recorded in 2003. Other taxa identified as contributing to differences between the two year groups are ***Syllis, Parametaphoxus, Leptocheirus, Amphipholis, Cumella and Caprella.***

It is possible that this shift in community composition is as a result of seasonal variation, the 2003 samples being taken in early July whereas the 2007 samples were taken in August and September. However other factors could be influential including change in sediment type at the sites. Analysis of the particle size distributions reveal changes in the sediment type between the two surveys; with sediments becoming finer in 2007 (see data in Appendix B). This finer sediment is more likely to support increased numbers of polychaetes such as ***Exogone*** sp. and ***Syllis*** sp., absent in the 2003 samples.

8.3.6 Intertidal Areas

The intertidal zone within Falmouth Harbour comprises areas of gently to steep sloping riprap, existing quay infrastructure and harbour walls. No specific intertidal surveys were undertaken in order to characterise the site, due to its disturbed nature and the limited potential for intertidal species of interest. Photographs of the intertidal were taken during a terrestrial Phase I habitat survey and a subsequent site visit to facilitate characterisation of the communities present.

The communities are generally characterised as fucoids on sheltered marine shores on low energy littoral rock, LR.LLR.F, backed by some salt tolerant plant species in the supralittoral fringe (splash zone) (see Figures 8-5 and 8-6). These species are common and typical of the disturbed environment present within the harbour and are not of any conservation importance.

Figure 8-5 Gently Sloping Riprap with Fucoids and Green Algae



Figure 8-6 Inner Harbour Wall with Fucoids and Salt Tolerant Plant Species



8.4 POTENTIAL IMPACTS DURING THE CONSTRUCTION PHASE

8.4.1 Loss of Maerl in the Proposed New Navigation Channel due to Capital Dredging

The capital dredging required for the proposed Falmouth Cruise Project would remove the sediments, maerl and associated benthic community within the dredge footprint. Consequently the benthic fauna, maerl and the habitat provided by the maerl in these areas would be impacted. Maerl is a UK BAP listed priority habitat and its action plan includes the objectives of maintaining its range, variety and quality. It is also a slow growing species and an important habitat for a diverse number of species.

Maerl Sensitivity

Section 8.2.3 describes live maerl sensitivities. In summary, live maerl is both highly sensitive to the effects of physical disturbance and slow growing. In studies investigating the impacts of scallop dredging on live maerl communities, Hall-Spencer and Moore (2000) found that dredging led to a greater than 70% reduction of live maerl thalli, which showed no sign of recovery in four years of monitoring. Studies by Hall-Spencer (1995) in the Firth of Clyde found that the scallop dredger's teeth penetrated 10cm into the maerl, crushing maerl fragments and killing them by burial (preventing the maerl from photosynthesis). Four months after scallop dredging there were less than half as many live maerl thalli as in control un-dredged areas. The study also showed that the community structure was altered in favour of opportunistic species such as scavengers.

Impact Assessment

In order to define the effects of the proposed dredge for the Falmouth Cruise Project on the maerl habitats present within the footprint of the proposed new navigation channel, it is necessary to first determine any alterations to the type of habitat that will remain in the new navigation channel area following dredging, and the habitats relative value. In order to value the remaining maerl habitat post dredge, the depth of maerl habitat that is required to ensure that the full range of potential associated species can colonise it must also be defined.

As discussed in Section 8.3.5, the habitats currently present within the proposed new navigation channel comprise mainly dead maerl with mixed sedimentary material. Axelsson ***et al*** (2008) recorded live maerl communities as rare at the majority of stations surveyed in 2007. Axelsson ***et al*** (2008) recorded occasional live maerl cover at three stations within the proposed new navigation channel (CS01, CS07, CS10; see Figure 8-1) and abundant at two stations (CS03 and CS09; see Figure 8-1). The live maerl is only present as a thin overlying layer and it will be completely removed from within the dredge footprint.

As a result of studies on live maerl by Hall-Spencer and Atkinson (1999) (see Royal Haskoning 2008a), a conservative value of 1m of maerl has been defined as the minimum depth required for a viable associated community. In order to calculate the predicted changes in area of viable (i.e. enabling a full range of species to colonise the habitat) maerl habitat (both mixed communities and maerl only), data from the Gardline and Mojo Maritime surveys (2007) was used to estimate pre-dredge areas of maerl communities to a depth of 1m and areas of maerl to a depth of 1m that would be present post-dredge (Table 8-9).

Table 8-9 Viable Maerl Areas Pre- and Post-Dredge within the Proposed New Navigation Channel[2]

Maerl habitat type	Area (ha)		Change in area (ha)
	Pre-dredge	Post-dredge	
Pure maerl	2	4	+2
Mixed maerl	17	11	-6
Total maerl	19	15	-4

The proposed capital dredge will increase the area of viable pure maerl habitat by c.2ha and will reduce the area of viable mixed maerl habitat by c.6ha, thereby causing a net loss of maerl habitat with a magnitude of c.4ha. It is not possible to estimate this change in terms of percentage loss of maerl habitat resource within the SAC as no quantitative data is available for live and/or dead maerl habitat area within the SAC.

Overall, capital dredging will cause the loss of any live maerl in the new navigation channel and the loss of approximately four hectares of maerl habitat. Given the scale of this loss and the sensitivity of the SAC, this will represent a major adverse impact.

Mitigation and Residual Impact

Seabed habitat mitigation is proposed as part of the Falmouth Cruise Project in order to replace the viable maerl habitat that will be lost due to capital dredging (see Section 2.2.1). It is proposed that specific areas within the new navigation channel will be dredged to levels approximately 1m deeper than required taking into account the maximum over-dredge requirement (i.e. 1m deeper than -8.6m CD). The exposed seabed will then be overlain with the mixed maerl sediment that will be removed from other areas within the new navigation channel during the capital dredging. Four areas have been identified for placement of the maerl material (see Figure 2-3) which equate to polygons 17, 18, 20 and 21 on Figure 8-4).

This mitigation will offset the net loss of viable maerl habitat from the SAC. However, it is unlikely to offset the loss of the live maerl identified by Axelsson ***et al*** (2008). While some of the live maerl may remain with the replaced sediment maerl matrix, it is likely to be damaged to some degree by the dredging action (based on the work of Tyler-Walters and Hiscock (2005)) and any recovery will take a number of years given its slow growth rate (approximately 1mm per year).

Monitoring will be required in order to identify the success of the mitigation. Appropriate monitoring will be agreed in consultation with Natural England and the relevant regulatory bodies, but is likely to involve bathymetry surveys and drop-down video and/or remote sampling.

With mitigation maintaining the overall area of viable maerl habitat, it is considered that the loss and disturbance of live maerl caused by capital dredging will reduce to a

[2] These values are gross predictions only as the boundaries are only indicative based on available data and are not considered to be representative of the actual situation.

moderate adverse impact after mitigation and a minor adverse impact over time with recovery.

8.4.2 Loss of Benthic Communities in the Proposed New Navigation Channel due to Capital Dredging

As a result of the proposed scheme benthic communities within the dredge footprint will be completely removed during dredging.

Benthic Communities Sensitivities

As discussed in Section 8.2.3 the sensitivity of marine fauna varies with respect to impacts and their nature. Equally, following an impact such as disturbance, different species and communities will recover at different rates, leading to changes in community composition. The communities currently present within the study area, as discussed in Section 8.3.5, are species-rich and characteristic of the maerl and coarse sediment habitats present within the site.

Section 24.4.2 discusses the sensitivities and recovery of maerl associated benthic communities in detail. Populations of benthic communities have been widely studied in investigations of the integrated effects of disturbance from a variety of natural and other sources. Recovery rates are generally most rapid in highly disturbed sediments in estuaries that are dominated by opportunistic species. In general, recovery times increase in stable gravel and sand habitats dominated by long-lived components with complex biological interactions controlling community structure. A review of recovery in various habitats from many different sources revealed that a realistic recovery time for gravels and sands where there is no resulting substrate change would be between 2-4 years, but that this time may increase to more than 5 years in coarser deposits, including coral reefs (Newell ***et al***., 1998).

Impact Assessment

Capital dredging for the proposed new navigation channel will cause the loss of the benthic fauna and a loss of the maerl habitat available for colonisation by benthic fauna within the footprint of the dredge. This loss is likely to result in a permanent shift in the communities present, from a species rich fauna associated with heterogeneous dead maerl habitat, to one dominated by opportunistic communities associated with the more homogenous fine sediments that would be exposed post-dredge. The resulting fauna is, therefore, likely to be dominated by high numbers of opportunistic species that are commonly found in disturbed environments associated with fine sediments, such as polychaete worms. A small number of successful opportunistic species are likely to dominate the disturbed area, resulting in low species diversity. Therefore, the loss of the species rich and maerl associated communities and the consequent shift in the communities within the footprint of the dredge will result in a moderate adverse impact.

Mitigation and Residual Impact

As discussed in Sections 2.2.1 and 8.4.1, it is proposed that specific areas within the new navigation channel will be subject to mitigation that will replace the mixed maerl habitat lost to capital dredging.

During the 2007 ecological survey, samples were taken from 'recovery' stations (that had previously been dredged for the commercial extraction of maerl in 2003 and 2004) and compared with stations within the proposed dredge area (see Royal Haskoning, 2008b). Generally, the fauna from the recovery stations was described as typical of coarse substrata, with no species of conservation importance other than the maerl itself. From the survey data recovery was found to be successful to the point that distinctions in the infaunal communities were minor and insignificant, with live maerl present at both groups of sites (at low levels) (Axelsson ***et al.,*** 2008). This is similar to the results of a study carried out by Grall and Glémarec (1997), who compared various indices of biological health for exploited and control maerl beds at the Isles of Glénan, and found few significant differences between the sites, except for a reduction in the number of individuals of each species counted in samples.

Therefore, with the proposed mitigation to replace maerl habitat, a similar response can be expected in the area affected by capital dredging: species outside the proposed new navigation channel will re-colonise the substrate of the new seabed, including the habitat mitigation areas (see Section 23.4.2; Royal Haskoning, 2008a).

Hydrodynamic modelling by HR Wallingford (2008; see Sections 5.5.1 and 5.5.2 and Appendix A) has shown that there will be only very small changes to currents and waves as a result of the dredging induced change in bathymetry. This will encourage the recolonisation of similar communities.

Owing to the following factors, it is likely that there would be recolonisation of the habitats in the new navigation channel following capital dredging, with little difference in the communities present:

- presence of other maerl communities within Falmouth Harbour and outside the area to be affected;
- the typical faunal communities currently present in the proposed new navigation channel which occur widely on a mixture of substrate types;
- no net loss of area of the dead maerl habitat within the post-dredge footprint given the mitigation proposed (see Sections 2.2.1 and 8.4.1);
- the small scale changes to hydrodynamic and sedimentary conditions predicted by HR Walligford (2008; see Appendix A); and
- the past evidence for recovery from regular maerl extraction from areas within the study area (Royal Haskoning, 2004).

With the proposed mitigation and the successful recolonisation of the maerl habitat, there will be a minor adverse residual impact.

8.4.3 Physical Impacts to Benthic Fauna from Increased TSS Concentrations due to Capital Dredging

As described in Sections 5.4.1 and 7.4.2, capital dredging will increase suspended sediment concentrations in the water column. This change to water quality may affect the wellbeing of the benthic fauna exposed to this change, particularly live mearl.

Where present beyond the proposed new navigation channel, live mearl was recorded by Axelsson ***et al*** (2008) as rare at RPT5 (see Figure 8-2) and present as only a thin layer over deeper dead maerl deposits. Live maerl is much more extensive to the east of the lower part of Carrick Roads, off St Mawes. Where present within the new navigation

channel, the live maerl communities will be lost to the capital dredging and, therefore, are not relevant to this impact assessment.

Benthic Species Sensitivities

Dredging induced sediment plumes can increase turbidity and reduce light penetration in the water column and, thereby, potentially inhibit the growth of photosynthetic species, including maerl and other algal species. As identified in Table 8-1, Tyler-Walters and Hiscock (2005) identify live mearl species ***Lithothamnion corallioides*** and ***Phymatolithon calcareum*** to be moderately sensitive to the effects of increased turbidity.

TSS Concentration Increases Associated with the Dredge

The Environment Agency water quality monitoring data from 1999 to 2007 indicates the background levels of TSS are 3-17.2mg/l in Carrick Roads, 3-12.7 mg/l in the Penryn River and 3-15mg/l in the Percuil River. TSS concentrations will increase by c.100mg/kg in the water area immediately around the dredger and will reduce as the sediment plume disperses with distance from the dredger. Away from the dredger, TSS concentrations over parts of the lower Penryn River and lower Carrick Roads will generally increase by up to 5-10mg/l depending on the location of the dredger and the state of the tide (see Figures 5-9, 5-11 and 5-13).

Overall, although tidal regimes and monthly tidal cycles (neap and spring tides) will affect the extent of sediment dispersal and TSS concentrations, it is predicted that capital dredging will increase TSS concentrations beyond the range of natural variation in different parts of the lower Fal Estuary at different times over the six month period of capital dredging. Figures 5-9, 5-11 and 5-13 show a general confinement of suspended sediment concentrations associated with the plume to the western side of Falmouth Harbour with even the plume from the easternmost release point keeping to the western side of the deep water channel in Carrick Roads. The plumes from the release points further west are confined between Falmouth's inner harbour area and the western side of the harbour entrance.

Impact Assessment

Many estuaries are by their nature turbid and include intertidal areas comprising fine sediment types. Accordingly, estuarine species are able to tolerate periods when TSS concentrations are elevated above background levels and the rate of sedimentation is increased. However, background TSS concentrations in the Fal Estuary are quite low and the TSS concentration increases predicted to occur (especially within the vicinity of the dredger) will be higher than species within the study area typically experience under natural conditions.

As discussed in Section 8.3.5, the benthic fauna within the study area is dominated by mobile epifauna, which is characteristic of coarse sediments and therefore not sensitive to the effects of increased TSS. Live maerl is highly sensitive to the effects of both increased TSS, however, the largest increases are expected to be experienced in the dredge area where both the benthic fauna and maerl will be removed (and therefore not subject to this impact). Increases in TSS beyond the new navigation channel are anticipated to be within the range of naturally occurring background levels. It is therefore, not anticipated that there will be any impact on the large live maerl bank present at St

Mawes Bank. Overall, due to the small, temporary and localised nature of the increases predicted, the impacts associated with increased TSS are not anticipated to have a significant effect on either the surrounding live maerl or the associated benthic fauna. A minor adverse impact as result of sediment mobilisation is, therefore, anticipated.

Mitigation and Residual Impact

No mitigation is proposed. Hence, there will be a minor adverse residual impact due to sediment mobilisation during dredging.

8.4.4 Physical Impacts to Benthic Fauna from Increased Sediment Deposition due to Capital Dredging

As described in Sections 5.4.2 and 6.4.2, capital dredging will cause sediment deposition on some seabed areas beyond the proposed new navigation channel which may affect the wellbeing of the benthic fauna exposed to this effect as a result of increased siltation and smothering.

Benthic Species Sensitivities

Most of the seabed beyond the proposed new navigation channel comprises coarse sediments that provide habitat for mobile epifauna, active burrowers and sessile organisms such as filter feeding bivalves. Mobile epifauna and burrowers are least likely to be affected by siltation and smothering. Sessile organisms are more sensitive.

Some of the seabed provides habitat for live mearl, but it is generally recorded as rare by Axelsson ***et al*** (2008) in the area around the proposed new navigation channel. Live maerl is much more extensive areas exist to the east of Carrick Roads, particularly off St Mawes. Live maerl is highly sensitive to the effects of siltation and smothering. In terms of siltation, MarLIN (2008) note that “increased siltation will cause deposition of a thin layer of material on the surface of the algae blocking incident light and preventing photosynthesis. There is no mechanism for clearing this material. Increased siltation may also fill up the spaces between the nodules changing the substratum. ***Phymatolithon calcareum*** is found on a wide variety of substrata so this is likely to be less of a problem”. In terms of smothering, MarLIN (2008) note “smothering will block light penetration to the algal thalli preventing photosynthesis”.

Sediment Deposition Associated with the Dredge

In order to quantify the magnitude of smothering, the results of numerical modelling of sediment dispersion and deposition were reviewed to establish the likely extent and depth of deposition. As described in Section 5.4.2, Table 5.4 and Figures 5.10, 5.12, 5.14 and 5.15, numerical modelling indicates that, in total, capital dredging will cause very small average deposition rates between 0.5mm and 1.7mm across the western side of the lower Fal Estuary, but not to the east of Carrick Roads. These deposition rates are unlikely to change the nature of the bed in the areas studied, although the presence of finer factions of sediment may be detectable in particular areas.

Impact Assessment

As discussed in Section 8.3.5 the benthic fauna within the study area is characteristic of coarse sediments and the area surrounding and the proposed new navigation channel is dominated by mobile epifauna that are generally not sensitive to the effects of increased siltation and smothering at the magnitudes predicted. Live maerl is highly sensitive to the effects of increased siltation and smothering, but is rare in the area surrounding the proposed new navigation channel. Sediment deposition is predicted not to occur to the east of Carrick Roads and therefore it is not anticipated that there will be any impact on the large live maerl bank present at St Mawes Bank. Overall, due to the small, temporary and localised nature of the increases predicted, the impacts are predicted to have a minor adverse impact on benthic fauna.

Mitigation and Residual Impact

No mitigation is proposed and therefore there will remain a minor adverse residual impact from sediment deposition during dredging.

8.4.5 Chemical Impacts on Benthic Fauna from Increased Contaminant Concentrations in the Sediment due to Capital Dredging

As described in Sections 6.4.3, capital dredging in the western part of the new navigation channel will release sediment and the associated contaminants into the water column and deposit sediment and the associated contaminants onto the seabed within the lower Fal Estuary, which may affect the wellbeing of benthic species in terms of toxicological effects.

Benthic Species Sensitivity to Chemical Contaminants

Many chemical contaminants, such as metals TBT, PCBs and PAHs, can bioaccumulate**,** in the tissues of living organisms and become more concentrated through the food chain.

Little data exists on the sensitivities of maerl to contaminants, including metals and TBT. MarLIN (2008) does not identify mearl sensitivity to a range of chemical contaminants due to “insufficient information”. However studies by Wilson ***et al***. (2004) noted that live maerl was less sensitive to the effects of heavy metals than anticipated. During the study the algae were initially negatively affected, but after one week they appeared to have assimilated all the contamination and recovered normal photosynthetic values. Recovery is probably due to the absorption of heavy metals onto the wall matrix or some other non-metabolic component of the algae. In the natural environment, however, the algae might be affected worse by chronic pollution than by a single event. The lowest concentration of effluent used appeared to increase photosynthesis of the thalli after one week, suggesting that, at this level, added metals had some nutritional benefit.

Impact Assessment

Survey work and data review was undertaken specifically to characterise the sediments within the proposed new navigation channel in relation to the Canadian Sediment Quality Guidelines for the Protection of Aquatic Life. As described in Section 6.2.4, the Canadian guidelines comprise a lower Threshold Effects Level (TEL) and higher Probable Effect

Level (PEL). The two levels form three biological effects ranges for chemical contaminants as follows:

- minimal effect range below the TEL where adverse biological effects occur rarely;
- possible effect range between the TEL and PEL where adverse biological effects occur occasionally; and
- probable effect range above the PEL where adverse biological effects occur frequently.

The Canadian sediment quality guidelines are derived from biological effects data and are intended to establish benchmarks for protecting benthic organisms and for assessing potential impacts of contaminants in sediment on biota (CCME, 1999), and therefore provide useful criteria for assessing this impact.

The results of the survey work indicate that the surface sediments of the western part of the navigation channel, including the cruise berth, contain concentrations of organo-tins (TBT and DBT), some metals (As, Cu, Hg, Pb and Zn), PAHs and total PCBs that are generally elevated above the Canadian TEL or PEL. The sub-surface sediments of the western part of the navigation channel, including the cruise berth and the surface and sub-surface sediments of the eastern navigation channel contain concentrations of organo-tins, metals, PAHs, total PCBs and OCPs that are generally much lower, below the Canadian TEL. In addition, Sections 6.3.9 and 6.3.10 identify that the present seabed around Falmouth Docks (based on the most contaminated sediment) can cause a range of lethal and sub-lethal effects, reflected by mortality and reduced casting endpoints respectively. However, the endpoints are not statistically significant for all bioassay tests and comparison to other assessment criteria indicates a sediment quality ranges from good to impaired. Accordingly, sediment deposition resulting from capital dredging of the western part of the proposed new navigation channel poses most risk to benthic fauna.

Figures 5-10 predicts the extent of sediment deposition beyond the new navigation channel to be limited to the seabed area around the western docks and beyond the Eastern Breakwater, and the depth of deposition to be at a very low magnitude: up to 0.05mm. Chemical changes can be summarised as follows:

- assuming the sediment quality of the seabed area around the western docks to be represented by impact receptor areas 1, 2 and 3 (see Figure 6-3), then there will be no impact to sediment quality because data from the 2007 survey shows that the sediment quality of the affected seabed area is similar to the western part of the navigation channel; and
- assuming the sediment quality of the seabed area beyond the Eastern Breakwater to be represented by impact receptor area 12 (see Figure 6-3), then there will be a negligible impact to sediment quality because although the data from the 2007 survey shows that the sediment quality of the affected area of seabed is less contaminated than the western part of the navigation channel, the magnitude of deposition will be very small.

Given that sediment toxicity is related to chemical contaminant concentrations, it is reasonable to assume that sediment toxicity changes will be similar to chemical changes. Accordingly, sediment toxicity changes can be summarised as follows:

- assuming the sediment quality of the seabed area around the western docks to be represented by impact receptor areas 1, 2 and 3 (see Figure 6-3), then there will be no impact to sediment quality because data from the 2007 survey shows

that the sediment quality of the affected seabed area is similar to the western part of the navigation channel; and

- assuming the sediment quality of the seabed area beyond the Eastern Breakwater to be represented by impact receptor area 12 (see Figure 6-3), then there will be a negligible impact to sediment quality because although the data from the 2007 survey shows that the sediment quality of the affected area of seabed is less contaminated than the western part of the navigation channel, the magnitude of deposition will be very small.

In summary, capital dredging of the upper sediments within the western part of the new navigation channel will deposit small quantities of sediment and associated chemical contaminants to a limited extent beyond the new navigation channel. Changes to sediment quality in the affected areas are predicted to be negligible (see Section 6.4.2); however, given the sensitivity of live maerl and its occasional presence at impact receptor site 12, there will be a minor adverse impact on benthic fauna.

Mitigation and Residual Impact

No mitigation measures are recommended and there will remain a minor adverse residual impact.

8.4.6 Impacts on Benthic Ecology due to Wharf Improvements

The cruise quay improvement works are proposed to provide 400m of continuous quay along the combined length of the existing Queens and Northern Wharves. This will require improvement works, especially to the Northern Wharf, including construction of two lengths of open piled quay comprising c.750mm vertical tubular piles overlain by a concrete deck; which is similar to the structure of the existing Queens Wharf. One length will be constructed over an existing rock revetment, and the other length will replace the existing dilapidated timber piled quay.

As a result of the proposed construction, pile installation will cause a small loss of subtidal habitat within the footprint of the piles. In addition, the existing timber piles will be replaced by steel tubular piles.

Benthic Species Sensitivity

The closest infaunal survey station to the proposed piling is station CS02, which falls within the western extent of the proposed dredge footprint. As detailed in Section 8.3.5, the fauna at CS02 are characterised by the inner harbour community (Group C), reflecting a greater fine fraction to the sediment, and potentially higher organic loading. This group showed an atypical dominance of infaunal annelids, and not the mearl communities found further out of the harbour. No live maerl or algae was recorded at the site.

The epifaunal communities associated with the existing timber pile structures are likely to be typical of epifaunal colonisers of artificial substrates and widespread throughout the study area and wider area.

The existing communities are therefore likely to be resistant to elevated levels of TSS and sedimentation that regularly occurs around the wharves due to vessel movements.

Impact Assessment

During the wharf improvements, piling will cause some minor sediment disturbance. However, the magnitude of disturbance will be negligible compared to disturbance caused by vessel movements and the proposed capital dredging. It will also be localised to the area of piling and short term in nature. This issue is therefore not considered to be of a magnitude relevant to this impact assessment.

The removal of the existing timber structure will result in a loss of the epifauna associated with the timber piles. These piles will be replaced with vertical tubular piles (steel), which will eventually be colonised by marine species, thereby offsetting the loss of the habitat provided by the existing piles. Studies investigating the colonisation of artificial structures generally record some colonisation after three to six months of immersion by macrobenthic epifauna such as barnacles, bryozoans and ascidians and opportunistic algae (e.g. Hatcher, 1998; Hawkins ***et al.*** 1983). Longer lived species and their associated fauna are likely to take longer to colonise the area (up to four years), eventually serving to increase habitat complexity and species diversity.

Overall, due to the low magnitude of the impact and the low sensitivity of the species likely to be affected by the proposed wharf improvement works, the impact on subtidal ecology is predicted to be of negligible significance.

Mitigation and Residual Impact

No mitigation is proposed and a negligible residual impact will remain.

8.4.7 Impacts on Intertidal Ecology due to Coastal Erosion Protection

The existing waste disposal tip in the eastern part of the docks estate is subject to erosion on its seaward face, to the extent that its contents appear to be exposed and slumping onto the foreshore. To arrest the erosion, it is proposed to re-grade and stabilise the waste tip's seaward face using treated contaminated dredged material and rock armour. The proposed work will extend eastwards as far as the existing rock armoured structure. During the works to the tip, there is the possibility that the intertidal communities around the site may be impacted by the works through burial and compaction.

Intertidal Species Sensitivity

The intertidal area within the study area and around the tip is described in Section 8.3.6. In summary, the intertidal communities are characterised by brown seaweeds on low energy rock, backed by some salt tolerant plant species in the splash zone (see Figures 8-5 and 8-6). These species are common and typical of the disturbed environment present within the harbour and are not of any conservation importance.

Impact Assessment

The impacts during the proposed works relate only to the burial and compaction of intertidal species within the surrounding area. Due to the existing disturbed nature of the intertidal communities at the site, there is likely to be rapid recolonisation to establish a

similar community as is currently present. Overall, there will be a temporary minor adverse impact on the intertidal ecology.

Mitigation and Residual Impact

No mitigation is required and a minor adverse residual impact will remain.

8.4.8 Physical Impact on Benthic Fauna from Sediment Deposition due to the Disposal of Dredged Material

The deposition of dredged material at the Falmouth Bay offshore disposal site may impact benthic fauna by smothering and burying the ecological resource on the seabed within and potentially beyond the site's boundary.

Sensitivity

Regular sediment deposition activity at the offshore disposal site over previous years is likely to have resulted in the formation of intermediate communities, dominated by fauna of opportunistic species such as polychaete worms, with some slower growing species that are commonly found in the surrounding area and associated with fine sediments. These species are not likely to be sensitive to the effects of increased siltation, but may be sensitive to smothering and burial depending on the resulting depth of the deposited sediment.

Sediment Deposition Increases in Falmouth Bay

Based on predictions derived from numerical modelling, Section 5.4.3 describes the extent and depths of sediment deposition due to the disposal of dredged material, including the changes caused by an individual disposal event (see Figure 5-18) and the total of all disposal events (see Figure 5-19). In summary, after the dredged material has been disposed of:

- depths from 0.1m to 0.5m are predicted within the disposal site's boundary;
- depths of 0.01m to 0.05m are predicted within 800m of the disposal site's boundary; and
- depths below 0.005m (i.e. 5mm) are predicted beyond 1km of the disposal site's boundary.

Impact Assessment

The disposal site in Falmouth Bay is designated to receive deposits of dredged material. Records show that the site has been used every year since 1985 and, therefore, the benthic community at the site is expected to be already effected to some degree. However, the proposed Falmouth Cruise Project will require the disposal of much larger quantities than has occurred in previous years and the potential for smothering and burial will be correspondingly higher.

Mobile benthic fauna found associated with fine sediments (such as bivalve molluscs) often exhibit vertical migration to avoid smothering, however, due to the depths of deposition predicted within the disposal site boundary (up to 0.5m) and the potentially long-term nature of the deposition, it is likely that any benthic species within the disposal site's boundary will be smothered and buried, thereby causing defaunation. The

magnitude of this impact is likely to be an area of approximately 100ha of the seabed. Smaller amounts of sediment will be deposited in the surrounding areas up to 1km from the site's boundary (up to 5cm), is not anticipated to have any affect on the benthic communities.

Following the cessation of disposal activities, it is anticipated that the affected seabed within the disposal site will recover to a similar community to that that currently, as disposal activities are not anticipated to result in a significant physical alteration to the characteristics of the sediments that are already present within the site's boundary. Mobile opportunistic species are likely to settle on the newly available substratum first, by moving in from the surrounding unimpacted communities. Over time, there is likely to be a succession to an intermediate community, with longer lived taxa becoming established and eventually serving to increase biodiversity, although recovery will be subject to the successive effects of subsequent disposal activities from other licensed disposal activities not connected to the Falmouth Cruise Project.

Overall, the disposal of dredged material would impact on a localised area of seabed that is already subject to similar disturbance (albeit at a much lower scale), and mostly within the designated disposal site, and is therefore likely to have a minor adverse impact on benthic ecology.

Mitigation and Residual Impact

No mitigation measures are proposed and there will remain a minor adverse residual impact.

8.5 POTENTIAL IMPACTS DURING THE OPERATIONAL PHASE

8.5.1 Impacts to Marine Ecology from Changes to Hydrodynamics and Sediment Transport due to the New Navigation Channel

During the operational phase, there is the potential for alteration to the hydrodynamic and sedimentary regime as a result of the proposed new navigation channel. These alterations have the potential to impact benthic ecology for reasons such as changes to currents, waves, turbidity, siltation and smothering.

Sensitivity

As discussed in Section 8.2.3, live maerl is sensitive to a number of physical and chemical factors, including alterations to hydrodynamics and sedimentation. Tyler-Walters and Hiscock (2005) class maerl species as being moderately sensitive to changes in wave exposure and water flow rate and maerl distribution is thought to be dependant on a number of environmental variables, particularly tidal flow. Live maerl is classed as highly sensitive to increases in sedimentation and turbidity. Therefore, any alterations to hydrodynamics and sedimentary regime are likely to impact live maerl.

The communities currently present within the study area, as discussed in Section 8.3.5, are species-rich and characteristic of the maerl and coarse sediment habitats present within the site. They are dominated by mobile epifauna, such as amphipods, which are unlikely to be sensitive to alterations in sedimentary and hydrodynamic regime. The limited number of filter feeding organisms, such as sponges, which are present are likely

to be more sensitive. The presence of live maerl is generally rare in the harbour and concentrated in the beds at St Mawes Bank to the east of Carrick Roads.

Hydrodynamic and Sediment Transport Changes in the Lower Fal Estuary

Modelling undertaken as part of the current study has identified a number of potential changes to waves, tidal flows, mud and sand transport; these are described in full in Sections 5.5.1 to 5.5.4.

With regard to waves, as described in Section 5.5.1, numerical modelling showed small alterations to wave height east of Western Wharf and around Queens Wharf, but nothing significant.

As described in Section 5.5.2, numerical modelling predicts a decrease of tidal current velocity compared to the existing conditions of up to 0.07m/s during spring tide and less than 0.03m/s during neap tide. These predicted changes in tidal current velocity are very small related to the relatively low ambient currents and cover a small area in and around the new navigation channel.

As described in Section 5.5.3, numerical modelling predicts a small increase in fine-grained sediment deposition associated with the proposed project (i.e. 610m^3/yr), which will not significantly change the fine sediment transport regime in the lower Fal Estuary.

As described in Section 5.5.4, numerical modelling predicts a very small net change in medium-grained sediment deposition associated with the proposed project (i.e. 20m^3/yr), but some small areas of deposition in the range 0.2-0.3m/yr in the south-eastern corner of the new navigation channel, less than 0.1m/yr in the southern side of the new navigation channel, and less than 0.02m/s on the northern side of the new navigation channel.

Impact Assessment

The small alterations in wave height predicted in the modelling are not anticipated to have any impact on marine ecology.

The predicted changes in current speed are very small compared to baseline conditions and only occur over a small area within the harbour. However, even a small permanent reduction in the already low ambient currents present at the site may have a negative impact on any areas of live maerl outside of the new navigation channel and may prevent the re-establishment of live maerl within and surrounding the area. It is not anticipated, that these alterations in current speed will directly affect the large live maerl habitat at St Mawes Bank or the benthic fauna within the study area.

The low level of fine sediment predicted to accrete within the new navigation channel will cause an increase over baseline conditions from 2360m^3/yr to 2970m^3/yr. This will result in a maximum increase in sediment deposition of up to 24mm/yr at two spot locations within the new navigation channel and generally up to 10mm/yr across the new navigation channel. Overall, a small amount of sediment deposition already occurs and the new navigation channel will increase this slightly, and therefore the changes are unlikely to have implications for the re-establishment and recovery of benthic communities within the new navigation channel. Live maerl is particularly sensitive to

sediment deposition, but it is not anticipated that the predicted changes will affect the large live maerl habitat at St Mawes Bank.

The modelling predicts that will be a change in accretion of an extra 20m^3/yr over a baseline of c. 5,500m^3/yr. This magnitude of change is not anticipated to affect benthic communities.

Owing to the sensitivities of maerl habitats and communities and their designated status within the SAC, a precautionary approach should be taken to assessing the impacts associated with the project. The predicted changes to tidal flows and mud transport, although very minor and localised are permanent and have the potential to affect live maerl communities within the harbour and reduce the re-establishment of live maerl within the new navigation channel. Accordingly, there will be a minor adverse impact on the benthic ecology.

Mitigation and Residual Impact

No mitigation measures are recommended but monitoring of the seabed habitat mitigation will be required in order to ensure the success of the mitigation and the recovery of the maerl habitats to a state similar to those that are currently present at in the proposed new navigation channel, including the re-establishment of live maerl. Appropriate monitoring will be agreed in consultation with Natural England, but is likely to involve bathymetry surveys and drop-down video and/or remote sampling.

With monitoring, it is considered that any negative impacts associated with changes to sedimentary and hydrodynamic regime will be detected and the need for further action identified. Therefore, with suitable monitoring and subsequent action if necessary, there will a minor adverse residual impact.

9 ORNITHOLOGY

9.1 INTRODUCTION

This section describes the ornithological interest of the Fal Estuary system and adjacent coastal areas in general, and specifically the waterbird interest of areas within the immediate vicinity of the site of the proposed development and dredging.

9.2 ASSESSMENT METHODOLOGY

9.2.1 Study Area

The study area covers the Fal Estuary to take into account the available baseline data as shown in Figures 9-1 and 9-2.

9.2.2 Baseline Data Collection

The information in this section is composed primarily of data obtained from the Wetland Bird Survey (WeBS). WeBS is the scheme which monitors non-breeding wetland birds in the UK to identify population sizes, determine trends in numbers and distribution and to identify important sites for wetland birds. The WeBS is divided into two national schemes.

9.2.3 Survey

Given the availability of WeBS data, no survey was undertaken to inform the EIA process.

9.2.4 Assessment Criteria and Technique

Impacts to ornithology have been assessed using the Guidelines for Ecological Impact Assessment in the United Kingdom which has been drawn up by the Institute of Ecology and Environmental Management (IEEM). These guidelines have been developed by IEEM to promote good practice in Ecological Impact Assessment (EcIA) relating to terrestrial, freshwater and coastal environments to the mean low water mark in the UK. The guidelines can be viewed at http://www.ieem.net/ecia/index.html.

9.2.5 Assessment of Impact Significance

Impact significance has been assessed using the methodology set out in Section 1.4.3 and using the terms identified in Table 1-1.

9.3 BASELINE ENVIRONMENTAL CONDITIONS

9.3.1 Designated Sites and Species

Falmouth Harbour does not lie within or adjacent to any international, national or local sites designated for their ornithological interest. It does, however, support a nationally important population of black-tailed godwit (***Limosa limosa***), which is included in the Birds of Conservation Concern Red List (high conservation concern). The estuary also supports good numbers of divers and rarer grebes (Conway, 1996), including a number of species which are listed on Annex 1 of the Birds Directive such as black-throated diver

(***Gavia artica***), red-throated diver (***Gavia stellata***), great northern diver (***Gavia immer***) and Slavonian grebe (***Podicpes auritus***). Growing numbers of little egret (***Egretta garzetta***) are also found within the Fal Complex.

The estuary, particularly the sheltered waters of Carrick Roads, is of county importance for supporting the county's largest concentrations of goldeneye (***Bucephala clangula***) and wintering red-breasted merganser (***Mergus serrator***) (Langston ***et al***., 2003; ERCCI 2004).

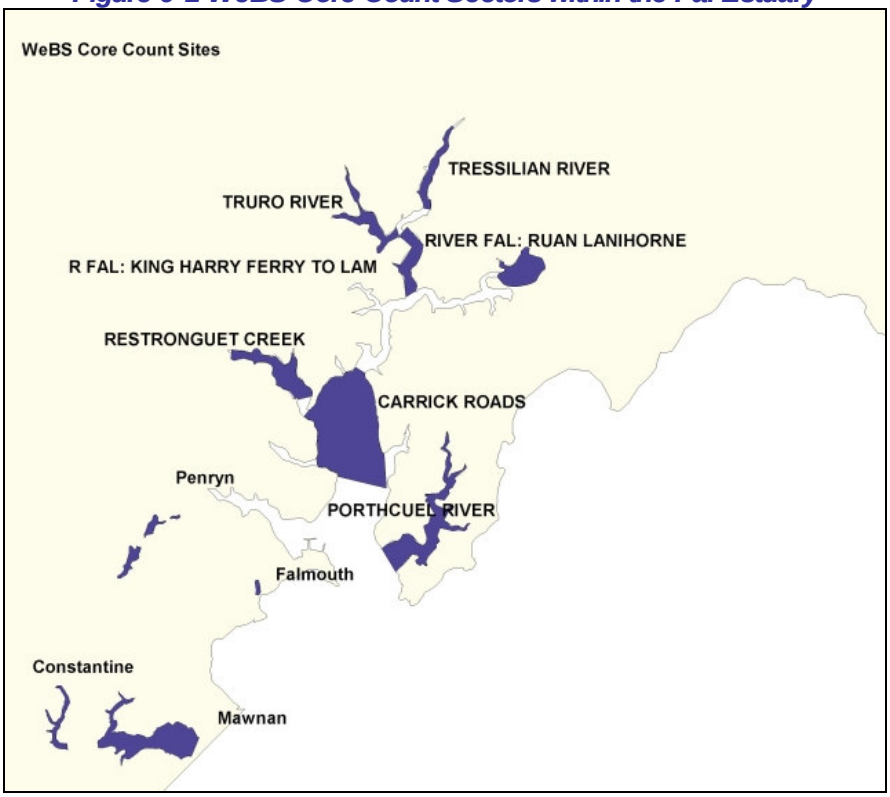
Other species commonly found on the estuary include dunlin (***Calidris alpina***), curlew (***Numenius arquata***), oystercatcher (***Haematopus ostralegus***), redshank, (***Tringa totanus***), greenshank (***Tringa nebularia***), shelduck (***Tadorna tadorna***), teal (***Anas crecca***) and wigeon (***Anas penelope***).

9.3.2 WeBs Data

Core Counts

Core Counts are made once monthly, normally on pre-selected dates, concentrating on the winter period. On estuaries, such as the Fal Estuary, these counts are usually made at high tide when birds are most easily counted at roosts. When describing the importance of a site for wetland birds, it is recommended to use five-year synopses data which provide the average count from five consecutive years for each species in each month, the winter peaks for each species, the mean peak counts, and the proportion of national/international populations present.

Figure 9-1 WeBS Core Count Sectors within the Fal Estuary



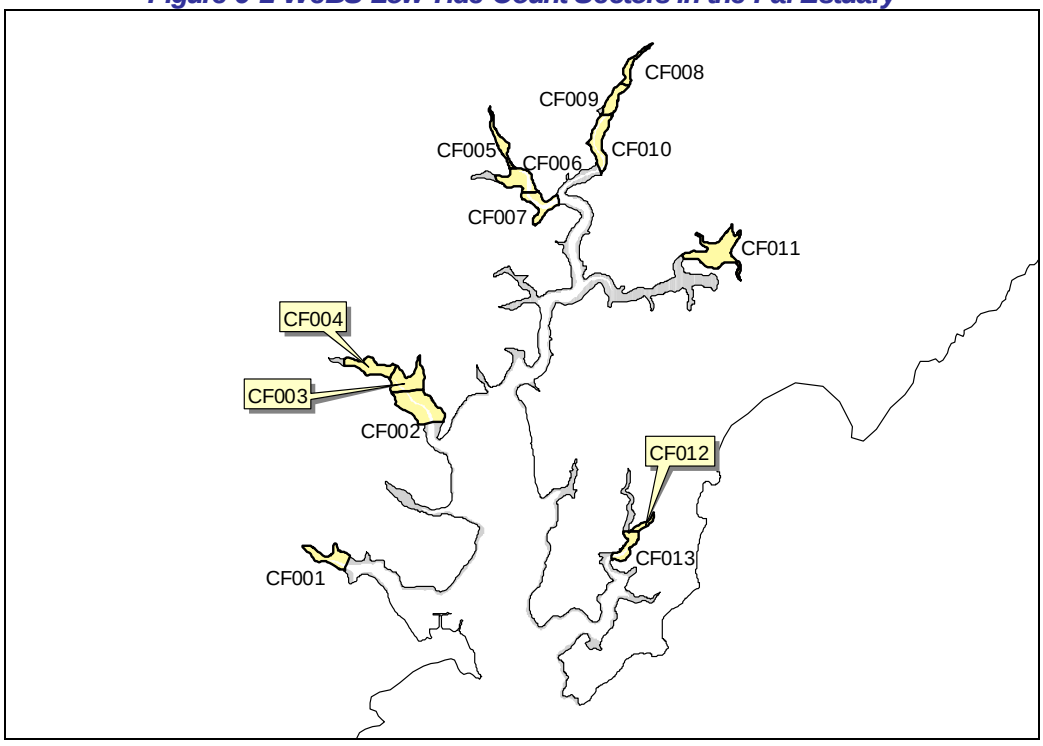
Core Count data was obtained for the period 2001/2006 for the 'Fal Complex' and represents summed data of all of the constituent sectors of the estuary, as illustrated in Figure 9-1. No core count data is available for the estuary inlet where Falmouth Docks is located. This lack of coverage is most likely due to poor volunteer coverage, difficulty in accessing these sites or a reflection of the low bird numbers in this area of the estuary (WeBS, pers. com.).

Low Tide Counts

Low Tide Counts are conducted at least one winter every six years, with up to four counts being made through the period November - February. The exposed substrate at low tide is divided into small count areas (sectors) enabling the distribution of feeding and roosting birds to be determined in fine detail. Low Tide Counts are designed to complement estuarine Core Counts, and are principally concerned with illustrating bird distributions.

Low Count data was obtained for the winter 2004/2005 for seven sectors in the lower Fal Estuary, CF001-CF004 and CF012-CF014, as illustrated in Figure 9-2. (At the time of writing this report data for 2005/2006 had not been published.) This data includes the upper section of the estuary inlet where Falmouth Docks is located.

Figure 9-2 WeBS Low Tide Count Sectors in the Fal Estuary



Wetland Birds Assemblage of the Fal Complex

The Fal Estuary covers a total area of 2,482 ha of which 69.9% is subtidal (Barne ***et al.,*** 1996). The estuary does not contain extensive tracts of mud or sandflats to support large populations of waders and wildfowl. The upper reaches of the estuary, around Truro, provide the best habitat for wetland birds.

Table 9-1 summarises the overall numbers of wetland birds utilising the Fal Estuary over the period 2001/2002 to 2005/2006 and shows the five-year mean peak for these years as well as the five-year mean autumn (July to October inclusive to describe autumn passage), winter (November to March inclusive to describe the wintering population) and spring (April to June inclusive to describe spring passage) peak figures.

Table 9-1 Summary of the overall numbers of wetland birds utilising the Fal estuary (2001/2002 to 2005/2006)

Year	Peak Monthly Total	Autumn Peak	Winter Peak	Spring Peak
01/02	3822 (JAN)	1954	5035	791
02/03	4841 (JAN)	3724	5922	787
03/04	3567 (JAN)	3669	4598	685
04/05	3428 (DEC)	3361	4190	877
05/06	4459 (FEB)	3813	5818	1285
MEAN		3304	5113	885

Table 9-2 summarises the five-year mean of peak counts for each species of wetland bird recorded in the Fal Complex for autumn, winter and spring. The table also indicates the percentage of the relative qualifying level of national and international importance for each species that this figure represents (e.g. 50% indicates that the five-year mean peak count is half that required for the site to qualify as nationally or internationally important as appropriate for each species).

Table 9-2 Summary of Five-year Mean of Peak Counts and the Percentage of the National and International Thresholds

	National Threshold			International Threshold			5 year mean of peaks		
Species	Autumn	Winter	Spring	Autumn	Winter	Spring	Autumn	Winter	Spring
Mute Swan	8%	9%	9%	10%	10%	11%	31	33	35
Whooper Swan	0%	7%	0%	0%	2%	0%	0	4	0
Canada Goose	N/A	N/A	N/A	N/A	N/A	N/A	97	42	10
Shelduck	7%	37%	24%	2%	10%	6%	58	290	190
Wigeon	1%	8%	0%	0%	2%	0%	26	329	4
Gadwall	0%	0%	1%	0%	0%	0%	0	0	1
Teal	3%	7%	0%	1%	3%	0%	52	137	2
Mallard	3%	7%	1%	1%	1%	0%	104	230	44
Pintail	0%	2%	0%	0%	1%	0%	0	5	0
Eider	0%	0%	0%	0%	0%	0%	0	3	0
Common Scoter	0%	0%	0%	0%	0%	0%	0	1	0
Surf Scoter	N/A	N/A	N/A	N/A	N/A	N/A	0	1	1
Velvet Scoter	*0%	*7%	*0%	0%	0%	0%	0	2	0
Goldeneye	0%	6%	0%	0%	0%	0%	1	16	0
Red-breasted Merganser	6%	82%	18%	0%	5%	1%	6	80	18
Red-throated Diver	*0%	*2%	*0%	0%	0%	0%	0	1	0
Black-throated Diver	*0%	*14%	*0%	0%	0%	0%	0	1	0
Great Northern Diver	*0%	*7%	*3%	0%	4%	2%	0	2	1
Little Grebe	10%	24%	4%	0%	0%	0%	8	19	3
Great Crested Grebe	0%	1%	0%	0%	0%	0%	0	2	0
Red-necked Grebe	*0%	*50%	*0%	0%	0%	0%	0	1	0

Species	National Threshold			International Threshold			5 year mean of peaks		
	Autumn	Winter	Spring	Autumn	Winter	Spring	Autumn	Winter	Spring
Slavonian Grebe	*0%	*29%	*0%	0%	4%	0%	0	2	0
Black-necked Grebe	*400%	*2300%	*100%	0%	1%	0%	4	23	1
Cormorant	15%	14%	8%	3%	3%	2%	34	33	18
Shag	N/A	N/A	N/A	1%	1%	1%	20	24	18
Little Egret	N/A	N/A	N/A	5%	4%	3%	60	46	36
Grey Heron	N/A	N/A	N/A	1%	1%	1%	32	29	30
Water Rail	N/A	N/A	N/A	0%	0%	0%	0	2	1
Moorhen	0%	0%	0%	0%	0%	0%	6	13	5
Coot	0%	0%	0%	0%	0%	0%	1	1	0
Oystercatcher	5%	4%	1%	2%	1%	0%	161	137	33
Avocet	*0%	*6%	*0%	0%	0%	0%	0	2	0
Little Ringed Plover	N/A	N/A	N/A	0%	0%	0%	2	0	0
Ringed Plover	4%	1%	1%	2%	0%	1%	13	3	4
Golden Plover	0%	1%	0%	0%	0%	0%	0	20	0
Grey Plover	0%	0%	0%	0%	0%	0%	1	0	0
Lapwing	0%	1%	0%	0%	1%	0%	5	144	0
Knot	0%	0%	0%	0%	0%	0%	1	6	0
Little Stint	N/A	N/A	N/A	0%	0%	0%	2	0	0
Curlew Sandpiper	N/A	N/A	N/A	0%	0%	0%	1	2	0
Dunlin	1%	8%	0%	1%	3%	0%	76	450	25
Ruff	*14%	*0%	*0%	0%	0%	0%	1	0	0
Snipe	N/A	N/A	N/A	0%	0%	0%	2	21	0
Black-tailed Godwit	38%	86%	5%	12%	27%	2%	57	129	8
Bar-tailed Godwit	0%	1%	0%	0%	1%	0%	2	8	0
Whimbrel	N/A	N/A	N/A	0%	0%	0%	3	2	17
Curlew	37%	33%	5%	7%	6%	1%	556	502	80
Common Sandpiper	N/A	N/A	N/A	0%	0%	0%	9	2	2
Green Sandpiper	N/A	N/A	N/A	0%	0%	0%	3	1	0
Spotted Redshank	N/A	N/A	N/A	1%	1%	0%	6	5	0
Greenshank	*650%	*600%	*233%	2%	2%	1%	39	36	14
Redshank	23%	22%	2%	10%	10%	1%	278	267	23
Turnstone	0%	2%	2%	0%	1%	1%	2	9	8
Black-headed Gull	9%	N/A	1%	9%	N/A	1%	1733	(2281)	124
Mediterranean Gull	N/A	N/A	N/A	N/A	0%	0%	(0)	1	1
Common Gull	0%	0%	0%	0%	0%	0%	0	34	0
Lesser Black-backed Gull	8%	6%	6%	1%	1%	1%	41	29	29
Herring Gull	N/A	12%	9%	N/A	9%	7%	(342)	536	408
Great Black-backed Gull	7%	33%	7%	1%	3%	1%	26	131	28
Sandwich Tern	N/A	N/A	N/A	0%	0%	0%	0	1	0
Common Tern	N/A	N/A	N/A	0%	0%	0%	1	0	0

* indicates species where the qualifying threshold for a species is less than 50 (e.g. the qualifying threshold for red-necked grebe is 2 therefore the winter 5 year peak of 1 bird represents 50%).

Distribution of Wetland Birds in the Lower Fal Estuary

Table 9-3 summarises the peak and mean Low Tide Counts for individual species recorded in the lower sections of the Fal Estuary that are WeBS sectors (see Figure 9-2) providing an indication of the distribution of individual species.

Table 9-3 Peak and Mean (in brackets) Low Tide Counts for Individual Species in the Lower Fal Estuary Count Sectors for 2004/2005.

	WeBS Low Tide Count section						
Species	**CF001**	**CF002**	**CF003**	**CF004**	**CF012**	**CF013**	**CF014**
Little Grebe						3 (1)	
Cormorant	3 (1)	4 (3)	2 (1)	1 (0)		1 (0)	
Little Egret	3 (2)	11 (6)	11 (4)	1 (0)	4 (3)	2 (2)	7 (3)
Grey Heron	1 (1)	3 (1)	2 (1)		2 (1)	2 (2)	1 (1)
Mute Swan	9 (5)	24 (8)			2 (1)	2 (1)	
Shelduck	2 (1)	10 (4)	35 (14)		5 (3)	15 (13)	6 (2)
Wigeon				12 (3)			
Teal				12 (3)			
Mallard	12 (6)	12 (5)	4 (3)	5 (2)	7 (4)	27 (19)	9 (2)
Red-breasted Merganser						2 (1)	
Oystercatcher	2 (1)	1 (0)	2 (1)	2 (1)		9 (6)	11 (7)
Ringed Plover				2 (1)			
Lapwing	1 (0)		14 (7)			42 (21)	
Dunlin			25 (6)	125 (64)			
Black-tailed Godwit			7 (3)	49 (32)			
Whimbrel			11 (3)				4 (2)
Curlew	9 (6)	11 (6)	22 (8)	33 (19)	15 (4)	52 (25)	3 (1)
Spotted Redshank			4 (2)	1 (0)	2 (1)		
Redshank	17 (10)	28 (8)		63 (52)	5 (3)	15 (7)	6 (3)
Greenshank	2 (1)	1 (0)	1 (1)	2 (2)	9 (3)	9 (5)	3 (2)
Common Sandpiper					1 (0)		
Turnstone	8 (2)		3 (1)				
Kingfisher					1 (1)		

None of the Annex 1 listed species of grebe or divers were recorded in the lower estuary sectors during the 2004/2005 Low Tide Counts. This is probably due to the nature of the survey and the behaviour of this type of bird; Low Tide Counts survey the exposed foreshore at low tide and grebes/divers remain on the water to feed and rarely come onto land.

Black-tailed godwit, of which the Fal Estuary population is considered to be of national importance, was recorded in two eastern sectors of the lower estuary (sectors CF003 and CF004). Red-breasted merganser was recorded to be present in low numbers in only one sector (CF013).

The most widespread and numerous bird species of the lower Fal Estuary in the year 2004/2005 were redshank, curlew and mallard. Little egret and greenshank were recorded in small numbers throughout all sectors. The highest peak count for any

species occurring in the lower sectors of the estuary was for dunlin in sector CF004 (125).

Twelve species of wetland bird were recorded in the estuary inlet closest to Falmouth Docks (CF001). The majority of these were recorded in low numbers with only redshank and mallard having peak counts into double figures. Turnstones were recorded as being more prevalent in this sector than in any of the other lower sectors, although their numbers were still low.

9.3.3 Terrestrial Birds

Scrub habitat within the harbour provide sub-optimal foraging habitat for common breeding birds (as described in Section 10).

9.4 POTENTIAL IMPACTS DURING THE CONSTRUCTION PHASE

9.4.1 Temporary Loss of Breeding and Foraging Habitat due to Construction

Scrub habitats within the dock will be removed for the duration of the construction period 26 weeks. This will result in a reduction in low quality breeding and foraging habitat for common bird species.

All wild birds are afforded protection under the Wildlife and Countryside Act 1981 (as amended). It is an offence to:

- intentionally kill, injure or take any wild bird;
- take, damage or destroy a nest (whilst in use or under construction);
- take, damage or destroy its eggs; and
- possess wild birds (dead or alive) or their eggs.

In order to avoid prosecution under the Wildlife and Countryside Act 1981 (as amended) it will be necessary to remove any potential nesting habitat that lies within the footprint of the works outside the breeding bird period (March-August).

The scrub habitats within the dock are small and are not of high quality, in addition, good quality scrub habitat is present in the wider area, particularly at Pendennis Point. Furthermore, on completion of the construction period it is likely that this habitat will recolonise within the dock. The impact is considered to be a short term, reversible impact of negligible significance.

Mitigation and Residual Impact

No mitigation measures are recommended and there will be a negligible residual impact.

9.4.2 Noise Disturbance to Waterbirds due to Construction

Each of the elements of construction will result in noise which has the potential to disturb wildfowl and waterbirds in the Fal Estuary. It should be noted that there is no intertidal habitat adjacent to the docks and that the optimal feeding habitat is located many kilometres distant, near Truro. Noise associated with construction will include piling to construct the new cruise quay between the Queens and Northern Wharves. As noted in Section 17.4.1, piling noise will affect receptors within Falmouth and Trefussis Beach.

These locations do not provide suitable intertidal foraging areas for wildfowl and waterbirds, and therefore the impact to ornithology is considered to be negligible.

Mitigation and Residual Impact

No mitigation measures are recommended and there will be a negligible residual impact.

9.4.3 Light Disturbance to Waterbirds due to Construction

It is anticipated that the treatment of contaminated dredged material will be undertaken 24 hours a day, six days a week for up to 30 weeks. Night time operations will require lighting, which has the potential to disturb wildfowl and waterbirds in the Fal Estuary. However, the existing dock operations are currently 24 hours and lighting is common overnight, particularly when vessels are being repaired in the dry dock. Given the existing level of lighting within the docks estate, the lighting for construction will have a negligible impact on birds.

Mitigation and Residual Impact

No mitigation measures are recommended and there will be a negligible residual impact.

9.5 POTENTIAL IMPACTS DURING THE OPERATIONAL PHASE

9.5.1 Disturbance to Feeding and Roosting Waterbirds due to Increased Shipping Activity

Shipping activity can disturb birds, through noise generated by the vessels. The impact of ship-generated noise on human receptors is addressed in Section 17.5 and concluded that the only significant impact will be from the public address system on vessels, which could affect receptors in Falmouth and Trefussis Beach. These locations do not provide suitable intertidal foraging areas for waterbirds, therefore the impact to birds is considered to be negligible.

Mitigation and Residual Impact

No mitigation measures are recommended and there will be a negligible residual impact.

10 TERRESTRIAL ECOLOGY

10.1 INTRODUCTION

This section considers how the proposals described in Section 2.2 may affect terrestrial ecology (excluding ornithology, which has been described in Section 9).

No significant terrestrial ecology issues were identified in the scoping report (Royal Haskoning, 2006). Nevertheless, a walkover survey was proposed to identify the habitat types within the proposed cruise terminal and surrounds. A second walkover was undertaken in April 2008 to identify the habitats in the vicinity of the existing cruise carpark.

The report of the Phase 1 Habitat Survey is included in the ES as Appendix D.

10.2 ASSESSMENT METHODOLOGY

10.2.1 Study Area

The study area covers Falmouth Docks, with particular focus on the terrestrial areas to be affected by the proposed project, as covered in the survey (see Section 10.2.3).

10.2.2 Baseline Data Collection

There was a lack of available baseline terrestrial ecology data for Falmouth Docks. Accordingly, a survey was undertaken.

10.2.3 Survey

An ecological walkover survey of the relevant areas of Falmouth Docks was undertaken in March 2007. Standard Phase 1 Habitat Survey methodology was employed (JNCC, 1990) which involved walking the study area and surrounds and noting each habitat type. This methodology was extended to include searching for habitats that may support fauna species of nature conservation interest. The findings of the survey are presented in Appendix D.

10.2.4 Assessment Criteria and Technique

Impacts to terrestrial ecology have been assessed using the Guidelines for Ecological Impact Assessment in the United Kingdom which has been drawn up by the Institute of Ecology and Environmental Management (IEEM). These guidelines have been developed by IEEM to promote good practice in Ecological Impact Assessment (EcIA) relating to terrestrial, freshwater and coastal environments to the mean low water mark in the UK. The guidelines can be viewed at http://www.ieem.net/ecia/index.html.

10.2.5 Assessment of Impact Significance

Impact significance has been assessed using the methodology set out in Section 1.4.3 and using the terms identified in Table 1-1.

10.3 BASELINE ENVIRONMENTAL CONDITIONS

10.3.1 Terrestrial Habitat

The Phase 1 Habitat survey identified the following habitats within the study area:

- vegetated walls;
- scrub;
- rough grassland; and
- hardstanding.

The majority of the habitat within Falmouth Docks is hard standing comprised of gravel or concrete. Other habitats identified within Falmouth Docks are common and of low nature conservation interest comprising ruderal, scrub and coastal species.

The rock revetment between the Queens Wharf and Northern Wharf (see Figure 10-1) is dominated by butterfly-bush (***Buddleja davidii***) and bramble (***Rubus fruticosus*** agg.) with abundant willow (***Salix*** sp), frequent gorse (***Ulex europaeus***) and occasional holm oak (***Quercus ilex***). This habitat type is patchy, comprises common species which have little potential to supported protected fauna and is therefore considered to be of low nature conservation interest.

Figure 10-1 Vegetated Rock Revetment between Queens Wharf and Northern Wharf (left) and Willow and Gorse Scrub adjacent to Northern Wharf (right)



The car parking areas in the eastern part of the Docks estate comprise hard standing areas of gravel or concrete. This habitat type is of no nature conservation interest due to the absence of flora and fauna, although the seaward edge is situated adjacent to the Fal and Helford Estuaries SAC (see Section 8 on Marine Ecology).

10.3.2 Protected Species Habitat

Suitable habitat for breeding birds, reptiles and bats was searched for during the Phase 1 survey. No suitable habitat for bats or common lizard was identified.

Sub-optimal breeding bird habitat was identified within the study area. This habitat is sparse and exposed to the elements and the docks are relatively noisy from the presence of humans, machinery and traffic. The woodland habitats on Pendennis Point provide more suitable cover, breeding and foraging habitat. Impacts arising from the loss of this habitat are assessed in Section 9 on Ornithology.

10.4 POTENTIAL IMPACTS DURING THE CONSTRUCTION PHASE

10.4.1 Loss of Habitat due to Construction of the Cruise Terminal Building and Improvements to the Car Parking Areas

The creation of the cruise terminal building and works to the car park will result in the loss of vegetated walls, scrub and rough grassland habitats. These habitats comprise common species and are of low nature conservation value. On completion of construction it is anticipated that these habitats would re-colonise within the harbour and dock area. The temporary loss of these habitats will be of negligible significance.

Mitigation and Residual Impact

No mitigation measures are recommended and there will be a negligible residual impact.

10.5 POTENTIAL IMPACTS DURING THE OPERATIONAL PHASE

There are not anticipated to be any impacts to terrestrial ecology as a result of the operation of the proposed project.

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11 FISH AND SHELLFISH RESOURCE

11.1 INTRODUCTION

The following section concerns the natural fish and natural and farmed shellfish resources of the study area and assesses the potential impacts of the proposed Falmouth Cruise Project on these biological resources.

During the consultation process the main concerns raised have been related to the oyster beds and changes in tidal or current regime, increased suspended sediment, contaminants remobilisation (e.g. TBT), disposal of waste material, loss of habitat and decreased water quality. The likely impacts on fish and shellfish species can be broadly split into three categories:

- physical effects such as substrate loss, smothering, increased suspended sediments etc;
- chemical effects such as increased contaminants (e.g. TBT) in the water column; and
- biological effects such as the introduction of microbiological pathogens and parasites.

The main impacts relate to the disturbance, dispersion and deposition of sediment and any associated contaminants which will occur as a result of capital dredging.

11.2 ASSESSMENT METHODOLOGY

11.2.1 Study Area

The study area includes the Fal Estuary and Falmouth Bay, thereby covering the areas over which fish and shellfish resources are distributed including the Truro oyster fishery (see Figure 11-1).

11.2.2 Baseline Data Collection

In order to determine the baseline conditions, data from a wide variety of sources has been used. Reports, data from surveys and consultation with stakeholders have been used within this section, which links closely with the importance and impacts to the commercial fisheries and shellfisheries, which is presented in Section 12. The following paragraphs identify the sources and describe the data collected to establish the existing baseline environment for the natural fish and shellfish resources

High-Level Data

Defra's fish landings data provide a high-level, regional overview of catches within study area at each port. The data do not fully represent catches as there is no statutory requirement under either EU or national legislation for vessels <10m in length to declare their catches. Information for this vessels <10m in length is collected with the co-operation of the industry and it comprises log sheets and landing declarations voluntarily supplied by fishermen and assessments of landings derived from market sources and by correspondents located in the ports.

Annual stock assessment reports are produced by specific working groups within the International Council for the Exploration of the Seas (ICES). These reports provide information on the resource status and state of key stocks, and management advice. They also propose biological reference points for parameters such as fishing mortality and spawning stock biomass. Overall, the data give a high-level overview of the state of key fish stocks in the study area.

Local Survey Data

The Environment Agency have recently conducted a survey to collect data on fish species as part of a long-term 'State of the Environment' study to underpin the requirements of the Water Framework Directive.

In addition, the Truro oyster fishery survey is undertaken annually by Cefas and the Maritime Division of Carrick District Council to investigate the distribution and abundance of native oysters in the Fal Estuary.

Literature

In order to fully assess potential impacts on natural fish and shellfish resources, information on the biology (spawning, migrations) of key species has been collated from the literature cited and referenced.

11.2.3 Surveys

Given the spatial and temporal extent of the fish and shellfish resource data that is available, no further surveys have been undertaken to inform the EIA process. However, further information was gathered through consultation and advice from local stakeholders.

The Cornwall Sea Fisheries Committee (CSFC) provided qualitative summaries of fisheries activities and the Falmouth & Truro Port Health Authority provided information on oyster beds and fisheries in the Fal and Helford Estuaries.

In addition, questionnaires were issued requesting fishermen to provide information relating to species targeted within the study area. Maps and questionnaires were sent to the Cadgwith, Helford and District Fisherman's Association, the Cornish Federation of Sea Anglers, St Mawes and District Fisherman's Association, and the Cornish Inshore Scallopers' Association.

11.2.4 Assessment Technique

Where possible, impacts are assessed in the context of statutory requirements and the results of numerical modelling compared to known threshold levels identified in scientific literature.

11.2.5 Assessment of Significance

The significance of predicted impacts was assessed using the classification criteria and terminology outlined in Table 1-1 in Section 1.4.3 concerning the EIA process.

11.3 BASELINE ENVIRONMENTAL CONDITIONS

11.3.1 Finfish Resource

Fal Estuary

The Fal Estuary contains high fish species diversity, possibly as a result of the diverse range of habitats present. Historically, over 110 species of fish have been recorded from the Fal and Helford Estuaries (Potts and Swaby, 1993), including sturgeon ***Acipenser sturio***, which have been reported from Falmouth and St Mawes as recently as 1970, and angel shark ***Squatina squatina*** (Potts and Swaby, 1993).

Recent surveys conducted by the Environment Agency (2002; 2003; 2005; 2006; and 2007) have recorded 43 species in the Fal Estuary (see Table 11-1). The commonest fish species by number are sand smelt ***Atherina presbyter***, sprat ***Sprattus sprattus*** and common goby ***Pomatoschistus microps***. Rarer species include the Norwegian topknot ***Phrynorhombus norvegicus***, warm water species such as gilt head bream ***Sparus auratus***, and a single seahorse ***Hippocampus spp*** caught during routine monitoring at Carrick Roads (Environment Agency, 2008). Other rare species include the Couch's goby ***Gobius couchi***, which has only been recorded from four locations in the British Isles, one of which is the adjacent Helford Estuary, although none are known to have been recorded from the Fal Estuary.

Generally, the majority of estuarine fish species tend to be most abundant in autumn. This temporal characteristic is supported by the Environment Agency's surveys in the Fal Estuary, which recorded 31 species of fish present in the spring and 43 species present in the autumn.

Some fish of potential commercial importance are also present and include grey mullet ***Liza ramada***, mackerel ***Scomber scombrus***, lemon sole ***Microstomus kitt***, whiting ***Merlangius merlangus***, flounder ***Platichthys flesus***, pollack ***Pollachius pollachius***, plaice ***Pleuronectes platessa***, cod ***Gadus morhua***, saithe ***Pollachius virens***, dab ***Limanda limanda*** and Dover sole ***Solea solea*** (Environment Agency, 2003).

The estuary also includes other smaller species such as dragonet ***Callionymus spp***, blennies ***Blennidae***, wrasse ***Labridae spp***, sea-scorpions and small gadoids such as pouting ***Trisopterus luscus***. There are also many other small species of fish which live under rocks and are rarely caught by normal survey methods due to their cryptic nature.

The Fal and Helford Estuaries are noted for their populations of elasmobranch species such as thornback ray ***Raja clavata***, and historically large localised populations of spotted ray ***Raja montagui*** and greater spotted dogfish ***Scyliorhinus stellaris*** (Environment Agency, 2004).

Falmouth Bay

Falmouth Bay (including the area of the dredged material disposal site) supports a number of fish species, including some of commercial importance. Local vessels are known to target shellfish, sole and monkfish as well as a variety of mixed demersal species in the area.

Beam trawl surveys carried out by Cefas in 2007 as part of the Fisheries Science Partnership Western Channel Sole and Plaice survey included a station in the vicinity of Falmouth Bay. Out of ten selected retained species and in order of abundance, records show catches of red gurnard ***Aspitrigla cuculus***, sole, plaice, monkfish ***Lophius piscatorius*** and hake ***Merluccius merluccius***. Catches of sole were recorded at a rate of 11 fish per hour (Engelhard ***et al***., 2007). Squid ***Loligo sp.*** species are also known to occur widely in Falmouth Bay and egg masses are often found attached to static gear such as pots and nets (Cotter ***et al***., 2006).

Table 11-1 Fish Species in Carrick Roads (2002-2007) (source: Environment Agency, 2008)

Common name	Latin Name	Catch No. as % of fish caught	
		Spring	Autumn
European Pilchard	***Sardina pilchardus***	0.2	44.5
Sand Smelt	***Atherina presbyter***	69.5	22.3
Sprat	***Sprattus sprattus***	3.5	21.5
Sand Goby	***Pomatoschistus minutus***	9.4	5.1
Thick Lipped Mullet	***Chelon labrosus***	1.0	1.8
Common Goby	***Pomatoschistus microps***	12.2	1.6
Golden Grey Mullet	***Liza aurata***	0.5	0.9
Bass	***Dicentrarchus labrax***	0.1	0.6
Herring	***Clupea harengus***	1.7	0.3
Corkwing Wrasse	***Crenilabrus melops***	0.1	0.2
Two-spotted Goby	***Gobiusculus flavescens***	0.0	0.2
Ballan Wrasse	***Labrus bergylta***	0.0	0.2
Horse Mackerel	***Trachurus trachurus***	0.0	0.2
Fifteen-spined Stickleback	***Spinachia spinachia***	0.3	0.1
Flounder	***Platichthys flesus***	0.2	0.1
Pollack	***Pollachius pollachius***	0.1	0.1
Painted Goby	***Pomatoschistus pictus***	0.1	0.1
Common Dragonet	***Callionymus lyra***	0.0	0.1
Goldsinny Wrasse	***Ctenolabrus rupestris***	0.0	0.1
Dover Sole	***Solea solea***	0.0	0.1
Transparent Goby	***Aphia minuta***	0.2	0.0
Thin Lipped Mullet	***Liza ramada***	0.2	0.0
Mackerel	***Scomber scombrus***	0.2	0.0
Giant Goby	***Gobius cobitis***	0.1	0.0
Black Goby	***Gobius niger***	0.1	0.0
Rock Goby	***Gobius paganellus***	0.1	0.0
Sea Trout	***Salmo trutta***	0.1	0.0
Greater Pipefish	***Syngnathus acus***	0.1	0.0
Sandeel	***Ammodytidae***	0.0	0.0
Garfish	***Belone belone***	0.0	0.0
Solenette	***Buglossidium luteum***	0.0	0.0
Fivebeard Rockling	***Ciliata mustela***	0.0	0.0
Long Snouted Seahorse	***Hippocampus guttulatus***	0.0	0.0
Dab	***Limanda limanda***	0.0	0.0
Whiting	***Merlangius merlangus***	0.0	0.0

Common name	Latin Name	Catch No. as % of fish caught	
		Spring	Autumn
Striped Red Mullet	***Mullus surmuletus***	0.0	0.0
Shorthorn Sculpin	***Myoxocephalus scorpius***	0.0	0.0
Butterfish	***Pholis gunnellus***	0.0	0.0
Plaice	***Pleuronectes platessa***	0.0	0.0
Thornback Ray	***Raja clavata***	0.0	0.0
Lesser Spotted Dogfish	***Scyliorhinus canicula***	0.0	0.0
Long-spined Sea Scorpion	***Taurulus bubalis***	0.0	0.0
Pouting	***Trisopterus luscus***	0.0	0.0
Tub Gurnard	***Trigla lucerna***	0.0	0.0
Tompot Blenny	***Parablennius gattorugine***	0.0	0.0
Norwegian Topknot	***Phrynorhombus norvegicus***	0.0	0.0
Nursehound	***Scyliorhinus stellaris***	0.0	0.0

11.3.2 Distribution and Behaviour of Finfish Species of Commercial or Conservation Importance

Bass (Dicentrarchus labrax)

Bass grow and mature slowly and may not breed until they are seven years old. Adult bass tend to enter coastal waters and river mouths, estuaries and lagoons during the summer. Adult bass often move offshore during the winter to deeper waters, returning in spring and not moving very far from their coastal sites over the summer and early autumn.

Juveniles are found in the Fal Estuary and in particularly large numbers in the small creeks around the upper estuary. Juvenile bass surveys found the best sites in the estuary for bass to be Lamorran and Gorrangorras Creek (Goodwin, 2002).

Twaite Shad (Alosa fallax) and Allis Shad (Alosa alosa)

The shad is a member of the herring family, found in small numbers in shallow coastal areas and estuaries in a few locations around the UK. In the past they were fished in considerable numbers but have now become rare. In many rivers their rarity is due to their migration being affected by pollution and the deterioration of their natural habitat, especially man-made obstructions blocking their river migration paths. For these reasons, as well as over fishing, they have become rare throughout Europe and are thus also protected under Annex II and V of the Habitats Directive, Appendix III of the Bern Convention, Schedule V of the Wildlife and Countryside Act 1981 and as a Priority Species in the UK Biodiversity Action Plan.

There have been historic reports of shads in the Fal and Helford Estuaries where they were caught as a by-catch of bass and mullet fishing activities (Potts & Swaby, 1993). The most recent report of Allis shad were from the adjacent Helford Estuary in 2002 (Hillman R. pers. comm., 2008), although no shad were noted from the Environment Agency's surveys in Carrick Roads between 2002 and 2007.

Thick-lipped grey mullet (Chelon labrosus)

This species is found in coastal inshore waters of estuaries, harbours and sandy bays, and is often encountered in low salinity environments and lagoons. Grey mullet migrate to deeper waters in winter and returns into estuaries and lagoons in spring/summer and both adults and juveniles are found in large numbers throughout the Fal Estuary where they were historically fished (Potts and Swaby, 1993).

Sole (Solea solea)

Adult sole migrate from offshore areas into nearshore and estuarine areas in spring (March-May) in order to spawn. Following spawning, many of these adults migrate offshore once again to offshore feeding grounds. Juvenile sole grow quickly over the summer and autumn period, moving seaward near the end of the year with reducing water temperature.

Based on the most recent estimate of Spawning Stock Biomass (SSB) and fishing mortality, the ICES classifies the stock as being at risk of reduced reproductive capacity and being harvested unsustainably. SSB has declined since 1980 when fishing mortality increased and was estimated to be at a historic low in 2006.

Sole tend to be the species targeted by the offshore beam trawling fleet, which is concentrated off the south Cornish coast, and also takes an important by-catch of plaice and anglerfish and, at times, cuttlefish ***Sepia officinalis*** as part of a diverse mixed fishery. Sole are targeted by local fisheries in the offshore areas, including Falmouth Bay and the vicinity of the dredged material disposal site.

Skates and Rays

The thornback ray ***Raja clavata*** is one of the most abundant rajids in the north-eastern Atlantic and Mediterranean, and is an important component of mixed demersal trawl fisheries. It is also taken by set nets and targeted by recreational anglers. There is evidence of a decline in catch rates in northwest European waters.

Numerous tagging experiments have been carried out on skates and rays. All have shown that species movement occurs over a small distance, mainly from offshore areas to inshore areas in spring, but none have shown any extensive movement or large-scale seasonal migration of this species. The life history traits of rays, in particular their low fecundity, late age and large size at maturity means they are particularly vulnerable to exploitation.

The Fal and Helford Estuaries are noted for their populations of elasmobranch species such as thornback ray ***Raja clavata***, and historically large localised populations of spotted ray ***Raja montagui*** (Environment Agency, 2003).

Anglerfish (Lophius piscatoris and L.budegassa)

Anglerfish occur in coastal waters all around Britain and Ireland, and are predominantly recorded on the west coasts of England, Wales and Scotland. It is present in waters from low inter-tidal down to depths of 550m, although they may migrate as deep as 2000m in offshore waters in order to spawn, and is mostly found on sandy or muddy bottoms,

though occasionally also present on shell, gravel or rocky area. Based on most recent estimates of SSB and fishing mortality ICES classifies the stock as having full reproductive capacity and being harvested sustainably.

Anglerfish are targeted by the local fishing fleets in the southwest with ground existing in Falmouth Bay, including the vicinity of the dredged material disposal site.

11.3.3 Spawning and Nursery Areas

Fal Estuary

The Fal Estuary is considered an important nursery ground for bass and much of the waters surrounding the area of the proposed Falmouth Cruise Project are a designated bass nursery area. This designation prohibits the fishing for bass from a boat between 30th April and 1st January or fishing with live sandeel.

As well as being a designated bass nursery area, it is likely that the estuary is a good nursery ground for a number of other fish species such as flounder, mackerel and whiting (Coull ***et al***, 1998), gilthead bream and grey mullet (Goodwin, 2002). The estuary offers protection from marine predators and storms, and provides rich food supplies. Juvenile fish typically live close inshore and migrate back to sea as they become mature. Details of the nursery and spawning periods for key commercial species that may utilise the general area are presented in Table 11-2.

Table 11-2 Spawning and Nursery Periods for Key Commercial Finfish Species (source: www.cefas.co.uk)

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Lemon sole												
Sprat												
Mackerel												
Whiting												

Spawning period Nursery period

Note: Nursery periods are considered to commence two months after spawning and last for a two month period.

Falmouth Bay

The Western Approaches is particularly important as a nursery area for mackerel, and the 'Mackerel Box' was introduced in 1986 in order to reduce pressure on the juvenile stock. Falmouth Bay falls within this area which is also used as a nursery ground by whiting. Spawning maps also indicate that sprat also use the area for as a spawning ground, although spawning is widespread. Squid are also known to use Falmouth Bay for spawning and egg masses are often found attached to static fishing gear (Cotter ***et al***., 2006).

11.3.4 Migratory Species

The River Fal and its tributaries support populations of sea trout ***Salmo trutta*** and salmon ***Salmo salar***, although the latter are scarce. The main sea trout runs occur up the Tresillian River (Hillman R. pers. comm., 2008). Adult salmon and trout pass from sea to freshwater habitats year round, with peak activity occurring in the spring and lowest

activity from November to February. Juveniles migrate out of the freshwater habitats during the spring (although trout may move as early as February).

Allis shad ***Alosa alosa*** have historically been recorded in the River Helford (Potts and Swaby, 1993), and as recently as 2002, although these were immature fish probably feeding in the estuary and it is unlikely there are spawning populations in the Fal and Helford Estuaries (Hillman R. pers. comm., 2008).

Twaite shad ***Alosa fallax*** were recorded from the Fal Estuary in 1985 and caught as a by-catch of mullet and bass fishing activities (Potts and Swaby, 1993).

European eel ***Anguilla Anguilla*** and brook lamprey ***Lampetra planeri*** are also present within the estuary using it to migrate between sea and freshwater, although they are not found in large numbers (Hillman R. pers. comm., 2008).

11.3.5 Shellfish Resource

Fal Estuary

The study area supports a wide range of shellfish, many of which are of high commercial importance. Prawn ***Palaemon serratus***, green crab ***Carcinus maenas,*** edible crab ***Cancer pagurus***, lobster ***Homarus gammarus***, crawfish ***Palinurus elephas***, whelk ***Bucinum undatum***, mussel ***Mytilus edulis*** and Pacific and European oyster (***Crassostrea gigas*** and ***Ostrea edulis*** respectively) are noted for their occurrence in the area. During diver surveys covering the proposed new navigation channel, spider crab ***Maja squinado*** and velvet swimming crab ***Necora puber*** were also observed during certain transects with the occasional abundance of scallop ***Pecten maximus*** at most sites surveyed (Axelsson ***et al.,*** 2008). A video sled scallop survey undertaken by Cefas in the Fal and Helford SAC seemed to indicate scallop abundances were generally evenly distributed (Palmer D. pers. comm., 2008).

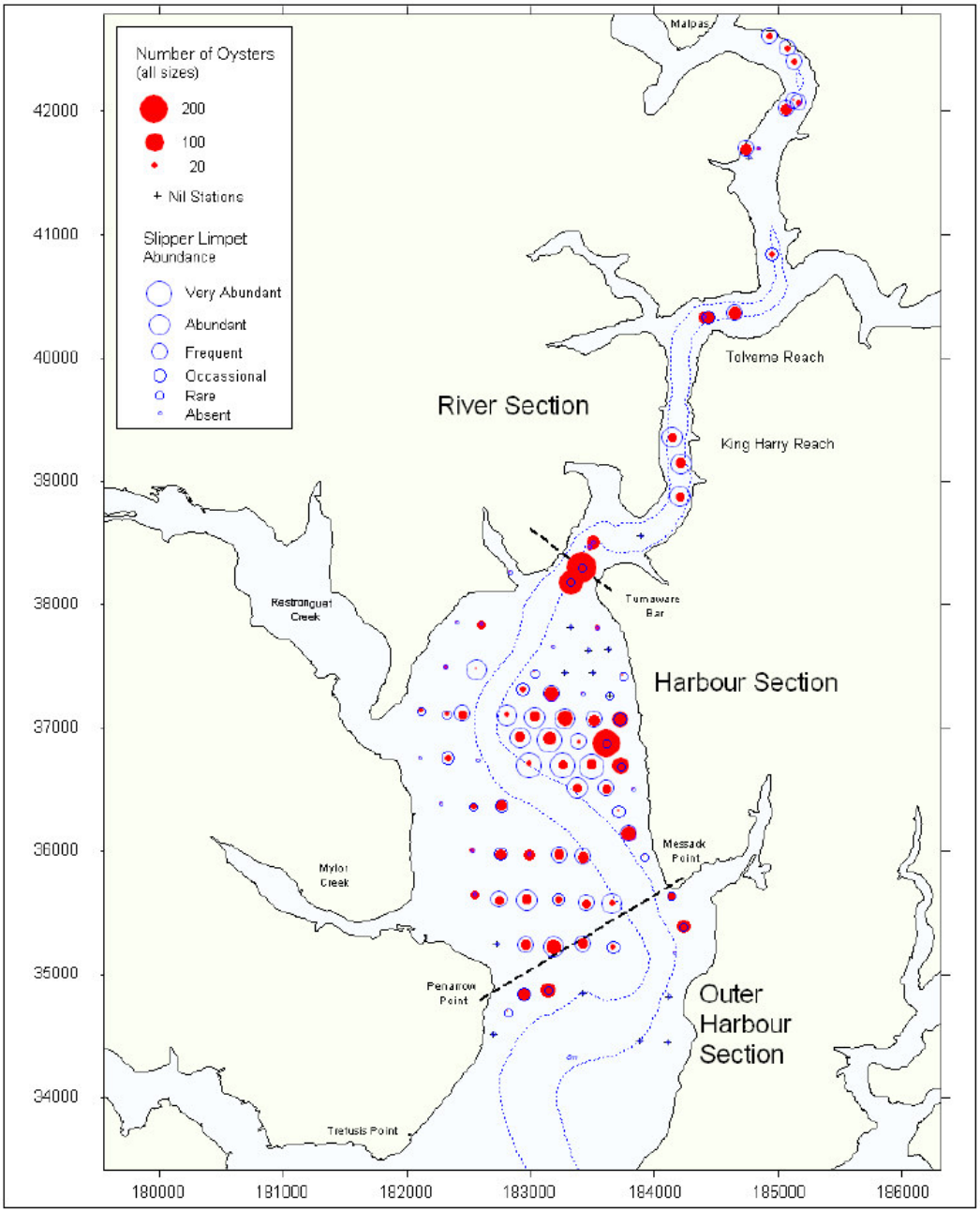
The main oyster beds in the Fal Estuary are situated to the north of Pennarow Point, with the main grounds for crab and prawn in the Carrick Roads (Environment Agency, 2004). Mussel production currently takes place north of Carrick Roads with beds located just below the King Harry Ferry. A detailed map of native oyster distributions indicates the oyster beds are largely situated upstream of a line drawn from Penarrow to Messack Point (see Figure 11-1). Although production areas for oysters historically extended into the Penryn and Percuil Rivers, poor water quality under the Shellfish Hygiene Directive (e.g. the Penryn River is classified as C) means there is currently no commercial activity in these areas. No oyster beds were noted during the diver surveys of the proposed new navigation channel (Axelsson ***et al.,*** 2008).

Oysters are sensitive to numerous parasites and diseases, with the accidental introduction of the parasitic protozoan ***Bonamia ostreae*** causing mass mortalities all over Europe and in the Fal Estuary's oyster beds in the 1980s. Similarly, the introduction of the slipper limpet ***Crepidula fornicate*** has caused serious problems for oyster beds as it competes for space and the build up of its faeces and pseudofaeces smothers oysters and renders the substrate unsuitable for settlement.

11.3.6 Truro Oyster Fishery Surveys

Yearly surveys of oyster abundance and distribution are carried out jointly by Cefas and the Maritime Division of Carrick District Council. Catch rates of larger oyster size groups in 2008 were generally lower than in the 2006 and 2007, although they remained high in historic terms. This suggests that oyster production from the fishery in the 2008/9 season should be similar to that in the last few years, given no unexpected mortalities (Walker and Burnett, 2008). Similarly, catch rates of under-35 mm oysters were high, suggesting fishery prospects are good beyond 2009/10, given no unexpected large-scale mortalities (Walker and Burnett, 2008).

Figure 11-1 Truro Oyster Fishery Survey 2008 showing Oyster Abundances and Slipper Limpet Associations (source: Walker and Burnett, 2008)



11.3.7 Shellfish Water Quality and Hygiene

Commercial shellfish cultivation requires good water quality in order to prevent contamination. Oysters and mussels can be particularly sensitive to pollution as they are filter-feeders (draw water across their sieve-like gills which can rapidly accumulate micro-organisms, heavy metals and organic contaminants).

Water quality in the southwest's shellfish waters is consistently good, with 87% meeting the mandatory standards of the Shellfish Waters Directive (SWD) in 2003. There were four failures in 2003 (an increase on the year before), one of these being the Fal Estuary for dissolved oxygen; probably resulting from high temperatures (Food Standards Agency 2007). This was a slight decline on 2002 when around 97% met these mandatory standards (compared to 90.8% in England and Wales for the same year). More data concerning the SWD is presented in Section 7 Water Quality.

A number of commercially important shellfish beds are found within the estuary and have been classified into a number of production areas, in accordance with the Shellfish Hygiene Directive (SHD). The overall production areas for ***O. edulis*** for Truro, Tresillian and the Fal Rivers can be seen in Figure 11-2. The different classification criteria and requirements are outline in Table 11-3. Monitoring of shellfish for human consumption is carried out by local authorities under the SHD and the data is compiled nationally by the Food Standards Agency.

Table 11-3 Shellfish Hygiene Classification Categories (source: Food Standards Agency, 2007)

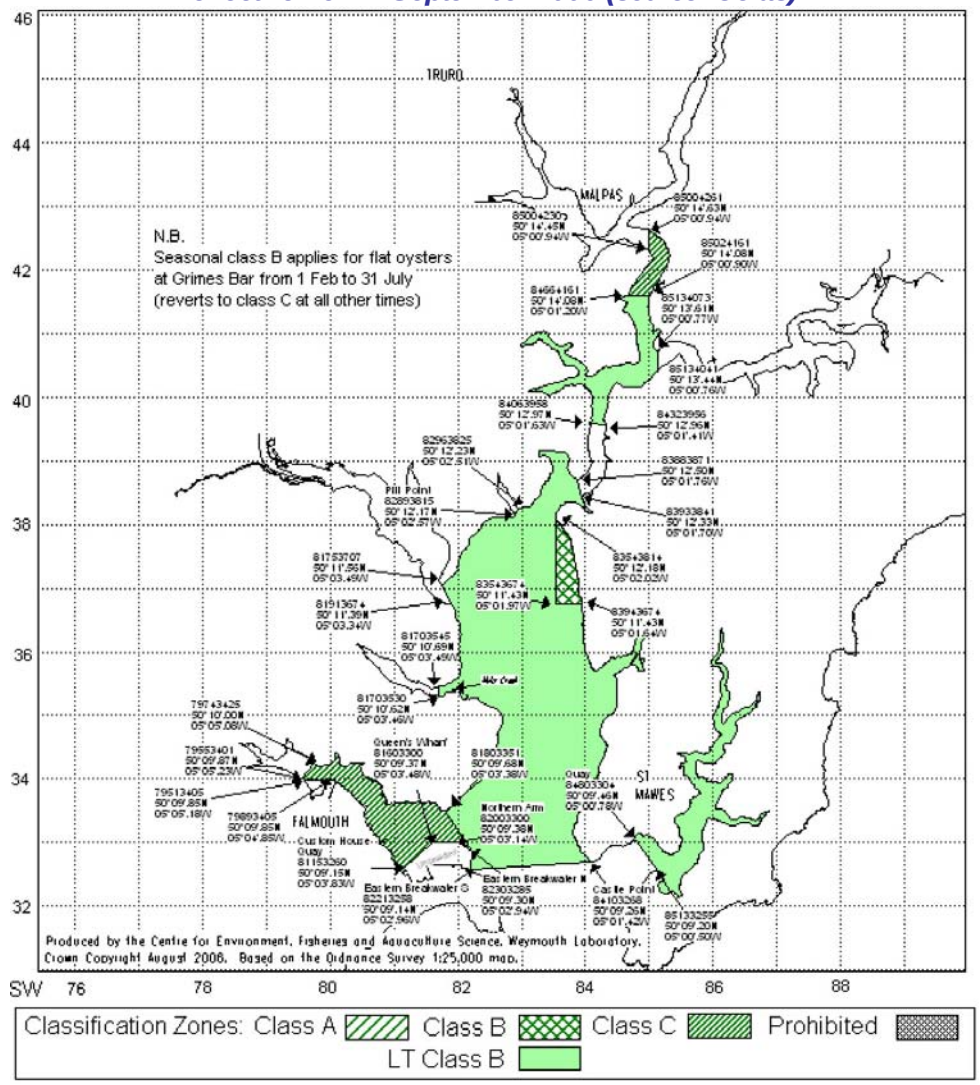
Class	Criteria (*E. coli* per 100g)	Requirements
A	<230	Can be collected for direct human consumption
B	<4,600	Must be purified or relayed to meet class A; may also be heat treated by an approved method
C	<46,000	Must be relayed for a long period (at least 2 months) to meet class A; may also be heat treated by an approved method
LT		Denote that Long Term classification applies

As can be seen by the results for 2006-2007 (as shown in the Table 11-4), the majority of the Fal Estuary's shellfish waters fell in to the B or C classification, which signifies levels of ***E. coli*** at 4,600 and 46,000 per 100 grams of flesh.

Table 11-4 Fal Estuary's Shellfish Production Areas and Classifications (source: Food Standards Agency, 2007)

Production Area	Bed Name	Species	Class	Exploratory Note
Truro River	Grimes Bar	***Ostrea edulis***	B	Seasonal classification1 Feb to 31 July (reverts to class C at all other times)
	Maggoty Bank	***Ostrea edulis***	B - LT	
	Tregothnan / Ruan Pontoon	***Mytilus spp.***	B	Seasonal classification 1 May to 30 September (reverts to class C at all other times)
	Calenick Creek	***Mytilus spp.***	C	
	Lambe Creek	***Mytilus spp.***	C	
	Malpas	***Mytilus spp.***	C	
Tresillian River	All beds	***Mytilus spp.***	C	
Fal	Ruan Creek	***Mytilus spp.***	B - LT	
	King Harry Reach mussel lines	***Mytilus spp.***	B	Seasonal classification 1 April to 30 September (reverts to class C at all other times)
	Mylor Creek	***Mytilus spp.***	B	Seasonal classification 1 April to 31 October (reverts to class C at all other times)
	Flushing	***Ostrea edulis***	C	
	Falmouth Wharves	***Ostrea edulis***	C	
	Meads	***Ostrea edulis***	C	
	Mylor Bank	***Ostrea edulis***	B - LT	
	Turnware Bar	***Ostrea edulis***	B	
	Tolverne	***Ostrea edulis***	B - LT	
	East Narrows	***Ostrea edulis***	B - LT	
	Coombe Creek	***Ostrea edulis***	B - LT	
	East Bank	***Ostrea edulis***	B - LT	
	St Mawes Bank	***Ostrea edulis***	B - LT	
	Parsons Bank	***Ostrea edulis***	B - LT	
	Mylor Creek	***Ostrea edulis***	B - LT	
	Pill Creek	***Ostrea edulis***	B - LT	
	Restronguet Creek	***Mytilus spp.***	B	
Percuil	All beds	***Ostrea edulis***	B - LT	
	All beds	***C. gigas***	B - LT	

Figure 11-2 Classification of O. edulis production areas for Truro, Tresillian & Fal effective from 1 September 2006 (source: Cefas)



Scale 1:90000

11.3.8 *Distribution and Behaviour of Shellfish Species of Commercial or Conservation Importance*

European Oyster (Ostrea edulis)

The native European oyster is associated with highly productive estuaries and shallow coastal waters living sub-tidally on firm sediments or rock. It is also artificially laid on beds made of broken shell called 'cultch'. It is found around many parts of the Britain but less so on the east coast.

The Fal Estuary supports one of the major populations found around England. This population was decimated by ***Bonamia*** in the 1980s, a parasitic shellfish wasting disease which is thought to have originated in the US and brought to Europe with imported non-native oysters. This disease, along with habitat destruction, competition from introduced

species such as ***Crepidula fornicata*** and over-exploitation has resulted in wild populations around the whole of the country being a fraction of their historical sizes. There are oyster production areas recorded in many parts of the Fal Estuary (see Table 11-4). Although classified as production areas, many including those around Flushing and Falmouth Wharves are no longer commercially used and the main exploited oyster beds are those of the Truro Oyster Fishery (Table 11-4).

Pacific Oyster (Crassostrea gigas)

The Pacific oyster was introduced for cultivation in the southwest and southeast of England. It is a hardy species with rapid growth (they can grow to over 75mm in their first 18 months) and reproductive rates, making it the most cultivated species of shellfish in the world. Successful cultivation has lead to their spread and the establishment of wild populations throughout the UK. It is found on the lower shore and shallow sub-littoral to a depth of around 80m.

In early trials by Seasalter Shellfish Ltd on the Percuil River, Pacific oysters showed very poor growth. During the late 1970s growth rates of Pacific oysters in much of the UK and elsewhere declined dramatically. The decline was traced to growth inhibitions caused by TBT in antifouling paints and did not improve until the paints were banned for vessels of <25m in length in 1987 (MacAlister Elliott and Partners Ltd, 1999). TBT levels in the sediments at Percuil Creek have in recent years improved. Mid-estuary levels as high as 3.3345mg/kg where recorded in 1997 surveys, which dropped dramatically in the 2005/06 surveys to <0.157mg/kg. TBT levels <1mg/kg are classified as low under the Environment Agency's classification system (Langston and Burt, 2007).

Mussel (Mytilus edulis)

The common mussel is very common throughout the UK. It occurs from upper intertidal zones down to 5m offshore. In the Fal Estuary, mussel beds are located in the northern extents of Carrick Roads and mussel culture takes place immediately below King Harry Ferry.

Studies show that ***Mytilus edulis*** is relatively tolerant of turbidity and siltation, thriving in areas that would be harmful to other suspension feeders. Mussels are not particularly selective feeders and are not dependent on favourable phytoplankton abundance and composition, happily feeding on detritus and dissolved organic matter. They also possess efficient shell cleaning and pseudofaeces expulsion mechanisms to remove silt. Mussels are also able to adjust their position and can thus move after disturbance or smothering.

Edible Crab (Cancer pagarus)

This is a common and widely distributed species in the UK. It occurs from the upper inter-tidal zone down to 100m offshore. There is a relationship between size and distribution, with juveniles settling (during late summer/early autumn) and remaining in the intertidal zone until their carapace is about 6-7cm wide (3-4 years of age), then moving into the subtidal zone and being found with an average carapace width of 14cm below 25m water depth. Below this depth the average size increases again, with carapace width for males being around 18cm below 55m (Neal and Wilson, 2008).

Population densities are highest in the western English Channel with important fisheries off Salcombe (south Devon) and around south and north Cornwall. Crabs occur in Carrick Roads, Falmouth Bay and surrounding the coastal areas where they are targeted by local potting vessels working out of Falmouth, St Mawes and Mylor (Walmsley and Pawson, 2007).

Common European Spider Crab (Maja squinado)

This crab species is usually found on flat and sandy substrates and sometimes amongst rocks and seaweed. Spider crabs migrate inshore in large numbers during the summer to molt and mate with the main breeding season in southwest England occurring between July and September. Spider crabs are targeted by local vessels fishing pots and tangle nets out of local ports around the Fal Estuary, and are generally exported to the continent.

Lobster (Hommarus gammarus)

Lobsters live in rocky substrata, occupying holes and excavated tunnels from the low tide limit to around 60m offshore. They leave these refuges at night to forage the seabed within the vicinity, normally returning to the same hideaway. They demonstrate a high level of loyalty to particular reefs but some may undergo short seasonal migrations of several kilometres. Mating occurs in the summer, and newly berried (i.e. carrying eggs) females begin to appear from September to December in all areas where lobsters are present, on both inshore and offshore grounds. Lobsters are found in the Carrick Roads and the surrounding coastal areas, generally occurring close inshore where they are targeted by local potting boats.

Prawn (Palaemon serratus)

This species is usually present in small groups in crevices and under stones from inter-tidal pools to the shallow sub-littoral. It is also found in estuaries and seagrass beds and down to depths of 40m offshore.

Prawns are found in Carrick Roads and have in recent years supported a thriving potting fishery. The fishery targets grounds on the east of Carrick Roads from St Anthony's Head to Turnaware Point. Breeding occurs between November and June, when prawns move into deeper water and are found in the channel in Carrick Roads. The planktonic larvae settle in July or August.

11.4 POTENTIAL IMPACTS DURING THE CONSTRUCTION PHASE

This section discusses and assesses the impacts of the proposed Falmouth Cruise Project on finish and shellfish resources.

11.4.1 Physical Impacts to Shellfish from Increased TSS Concentrations due to Capital Dredging

As described in Sections 5.4.3 and 7.4.2, capital dredging will increase suspended sediment concentrations in the water column which may affect the wellbeing of shellfish resources exposed to this change.

There are many listed production areas in the vicinity of the Fal Estuary (Table 11-4). Consultation with the Port Health and Harbour Authority has indicated that the only oyster beds currently commercially fished are those beds of the Truro Oyster Fishery, and these beds are therefore the main beds considered in this impact section.

Shellfish Sensitivity

Shellfish may be sensitive to changes in TSS concentrations due the effect on their ability to filter feed and other stresses. An overview is provided in CIRIA (2000).

In general, filter-feeding shellfish are susceptible to elevated TSS concentrations as the sediment can clog gills (Newell ***et al***, 1989, in CIRIA 2000), impair feeding, and impair respiratory and excretory functions (Sherk, 1971, in CIRIA 2000). For example, oysters respond to an increase in suspended sediment by increasing pseudofaeces production, along with occasional rapid closure of their valves (i.e. pumping) to expel accumulated silt both of which exert an energetic cost, and cause metabolic stress. In adult oysters, pumping rates reduce significantly at TSS of 100mg/l and can cease at higher TSS concentrations potentially leading to mortality after prolonged exposure (Loosanoff, 1961, in CIRIA 2000). Growth rates may also decrease as a result of increased shell deposition and reduced feeding efficiency.

A review of oyster sensitivity by Jackson (2007) suggested levels of filtration in oysters was completely inhibited by 10mg/l of particulate organic matter and significantly reduced by 5mg/l. The impacts on oyster larvae found growth to be impaired at 0.75g/l TSS or above, but that oyster larvae survived seven days exposure to up to 4g/l TSS with little mortality. Variation in suspended sediment and silted substratum is also considered an important factor restricting oyster spatfall (i.e. recruitment). Therefore, TSS increases may have long-term effects on oyster populations by inhibiting recruitment, especially if the increase coincided with the peak settlement period in summer.

The native oyster is less well adapted to turbid water conditions than other species and is considered intolerant of turbid environments (Jackson, 2007).

TSS increases are also thought to adversely affect growth rates in the great scallop and excessive particle bombardment may threaten the viability of feeding apparatus (Marshall and Wilson, 2008).

Overall, studies indicate that filter-feeding shellfish, particularly bivalves, are highly adaptable to TSS concentration increases from occasional events such as storms and dredging, and can maintain their feeding activity (Newell ***et al***, 1989, in CIRIA, 2000).

TSS Concentration Increases in the Lower Fal Estuary

The Environment Agency water quality monitoring data from 1999 to 2007 indicates the background levels of TSS are 3-17.2mg/l in Carrick Roads, 3-12.7 mg/l in the Penryn River and 3-15mg/l in the Percuil River. TSS concentrations will increase by c.100mg/kg in the water area immediately around the dredger and will reduce as the sediment plume disperses with distance from the dredger. Away from the dredger, TSS concentrations over parts of the lower Penryn River and lower Carrick Roads will generally increase by up to 5-10mg/l depending on the location of the dredger and the state of the tide (see Figures 5-9, 5-11 and 5-13). The total organic carbon content of the dredge sediments

composes approximately 1.5% (based on mean data values from Table 7 in Appendix B2) which, based on an increase in TSS of 10mg/l would equate to 0.15mg/l.

Overall, although tidal regimes and monthly tidal cycles (neap and spring tides) will affect the extent of sediment dispersal and TSS concentrations, it is predicted that capital dredging will increase TSS concentrations beyond the range of natural variation in different parts of the lower Fal Estuary at different times over the six month period of capital dredging.

TSS Concentration Increases in the Truro Oyster Beds

Numerical modelling of peak TSS concentrations indicates that only capital dredging at the easternmost end of the proposed new navigation channel creates sediment plumes that can extend to the southern limit of the Truro oyster beds on flood tides (see Figure 5-13).

Numerical modelling of sediment dispersion indicates the maximum TSS concentrations which may impact oyster beds just south of Penarrow Point to be of a magnitude in the region of 3-5mg/l (Figure 5-13). Assuming a maximum value of 5mg/l and taking into consideration the background levels of TSS, it is likely that TSS concentrations could double over their median concentration (4.3mg/l for Carrick Roads) at the southern extent of the oyster beds due to capital dredging at the eastern end of the new navigation channel. Based on the reviewed literature concerning oyster sensitivity to TSS concentrations, it is unlikely filtration would be significantly impaired and it is not anticipated that larval recruitment on the Truro oyster beds will be significantly impacted.

TSS Concentration Increases at Other Production Areas

Historic production areas are also present in and around Falmouth such as at Flushing and Falmouth Wharves. These areas are likely to be affected by increased levels of TSS although modelling indicates the TSS concentrations are likely to remain below 50mg/l (see Figure 5-13).

Impact Assessment

Dredging operations are not conducted on a continuous basis. Currents also carry sediment plumes in various directions effecting different areas over time. Consequently, the chronic exposure of an aquatic community to resuspended sediments is less likely to occur compared to more short-term acute impacts.

The impact would be temporary and reversible (i.e. return to baseline conditions on cessation of capital dredging) and given that the TSS concentrations experienced will be generally within the limits of natural variation (i.e. 3-17.2 mg/l in Carrick Roads), there will be a minor adverse impact on the Truro oyster beds. Other production areas such as any adjacent to Falmouth Docks may also be exposed to increased TSS levels, although given they are no longer commercially used and that levels are not likely to exceed 50mg/l. Overall it is anticipated that there may be a minor adverse impact on oyster beds close to the capital dredging area. The impact will be negligible for most of the Truro oyster beds

Mitigation and Residual Impact

No mitigation measures are recommended and the impact will remain minor adverse.

11.4.2 Physical Impacts to Finfish from Increased TSS Concentrations due to Capital Dredging

As described in Sections 5.4.3 and 7.4.2, capital dredging will increase suspended sediment concentrations in the water column which may affect the wellbeing of finfish resources exposed to this change.

Finfish Sensitivity

Finfish may be sensitive to changes in TSS concentrations for a number of reasons during both early life stages and adulthood. An overview is provided in CIRIA (2000).

In general, turbid water conditions is generally negatively correlated with larval fish abundance since it can affect the survival of eggs and larvae, growth in adult fish, and pathological effects on gill epithelia. For example, Westerberg ***et al*** (1996, in CIRIA, 2000) tested the effect of suspended sediment on fish eggs and found that sediment particles can adhere to an egg's surface and thereby cause a loss of buoyancy. If an egg sinks to the seabed, it will (in most cases) be lost to predation. Accordingly, TSS concentrations can affect spawning and reproductive success.

The main sensitivities of adult fish are physiological effects resulting from the impingement of sediment particles on gill tissues which can result in reduced gill function. In addition, very high TSS concentrations and the resulting turbidity and transparency conditions in the water column can result in reduced foraging and feeding ability due to a reduced visual range (CIRIA, 2000).

Sediment plumes can disrupt fish migration by blocking migratory routes or by inhibiting the ability of fish to find migration routes (e.g. an estuary or river mouth) (CIRIA, 2000).

TSS Concentration Increases in the Lower Fal Estuary

TSS concentration increases are described in Section 11.4.1.

Impact Assessment

Many estuaries are by their nature turbid and include intertidal areas comprising fine sediment types. Accordingly, fish within estuaries are able to tolerate periods when TSS concentrations are elevated above background levels. However, background TSS concentrations in the Fal Estuary are quite low and the TSS concentration increases predicted to occur (especially within the vicinity of the dredger) will be higher than finfish typically experience under natural conditions.

Fish are able to exhibit avoidance reactions to localised changes to TSS conditions. For example, Westerberg (1976, in CIRIA, 2000) recorded avoidance behaviour in adult cod and herring as a response to a 3mg/l change in TSS concentrations by withdrawing from a channel when increases were initiated (i.e. well before the formation of a sediment

plume of higher TSS concentrations). This ability differs between species, and adult fish can generally avoid adverse conditions more rapidly and effectively than juvenile fish.

While capital dredging could cause TSS concentrations that may reduce upstream migration of the salmonid species known to occur in the Fal Estuary (i.e. sea trout), numerical modelling predicts that the sediment plumes will not extend across the whole estuary and, therefore, will not form a barrier to migration and should not inhibit location of the estuary's mouth.

Overall, the predicted TSS concentration increases within the lower Fal Estuary are predicted to have a negligible impact on adult finfish, including migrating species. Fish eggs and larvae are known to be more sensitive to increased levels of TSS and as a result, some mortality of eggs or larvae may occur. Given the size of the Fal Estuary and the relatively small size affected by TSS at any one time, however, any impacts on egg or larvae survival are likely to be small and the impact on fish populations as a whole is considered to be negligible.

Mitigation and Residual Impact

No mitigation measures are recommended and a negligible impact will remain.

11.4.3 Physical Impacts to Shellfish from Increased Sediment Deposition due to Capital Dredging

As described in Sections 5.4.2 and 6.4.2, capital dredging will cause sediment deposition on some seabed areas which may affect the wellbeing of shellfish resources exposed to this effect. Various stakeholders including the Cornwall Wildlife Trust have raised the concern of disturbed sediments from the capital dredge works smothering oyster beds.

Shellfish Sensitivity

Shellfish may be sensitive to changes to sediment deposition due the effect of smothering through burial including mortality, and non-lethal effects such as reduced respiration, feeding and excretion. An overview is provided in CIRIA (2000), but generally sensitivity depends on the magnitude of smothering (particularly in relation to background sedimentation rates) and the tolerance of the species affected. For example, smothering by sediment would prevent the flow of water though the oyster and limit respiration, feeding and the removal of waste. ***Ostrea edulis*** is permanently fixed to the substratum and unable to burrow up though deposited material. Oysters can respire anaerobically and are known to survive for many weeks out of water at low temperatures used for storage after culture (Jackson, 2007). However, it is likely that at normal environmental temperatures the population would be killed by smothering. Layers of settled material of 1-2mm have been reported to prevent satisfactory oyster settlement, reducing effective recruitment.

Sediment Deposition Increases in the Lower Fal Estuary

In order to quantify the magnitude of smothering, the results of numerical modelling of sediment dispersion and deposition were reviewed to establish the likely extent and depth of deposition. As described in Section 5.4.2, Table 5-4 and Figures 5-10, 5-12 and 5-14, numerical modelling indicates that, in total, capital dredging will cause very small

average deposition rates between 0.5mm and 1.7mm across the lower Fal Estuary. These deposition rates are unlikely to change the nature of the bed in the areas studied, although the presence of finer factions of sediment may be detectable in particular areas.

Given the magnitude and spatial extent of the levels of deposition predicted by numerical modelling, and the distribution and abundance of the oyster beds as highlighted in the Truro Fishery Oyster Stock Survey, it is anticipated that the predicted sediment deposition increases will have a minor adverse impact on the fished oyster beds in the lower Fal Estuary. Diver observations carried out as part of the marine ecological surveys in the proposed new navigation channel did not indicate the presence of oyster beds in this area (Axelsson ***et al.,*** 2008). Considering that there may be other oyster populations present between the dredge channel and the Truro oyster beds which may be affected, a minor adverse impact will arise.

Mitigation and Residual Impact

No mitigation measures are recommended and a minor adverse residual impact will remain.

11.4.4 Physical Impacts to Finfish from Increased Sediment Deposition due to Capital Dredging

As described in Sections 5.4.2 and 7.4.2, capital dredging will cause sediment deposition on some seabed areas which may affect the wellbeing of finfish resources exposed to this effect.

Finfish Sensitivity

Finfish may be sensitive to changes to sediment deposition due the effect of smothering and/or substrate change. An overview is provided in CIRIA (2000). Sediment deposition can either smother or damage the eggs of species that release their eggs at the seabed (e.g. herring, dogfish skate and rays) (Oakwood Environmental, 1999, in CIRIA, 2000). In addition, sediment deposition can change the substrate of a spawning or nursery area which can prevent the eggs from adhering to the seabed and thereby affect reproduction, as shown for herring (ICES, 1992, in CIRIA, 2000). Only certain fish species such as flatfish and rays spend considerable periods on the sea bed, although it is likely given the relatively small levels of deposition that adult fish species will be able to undertake avoidance responses.

Given that fish are mobile and able to swim away it is unlikely they will be affected by smothering and this is true for both benthic and pelagic species. Small fish species such as the goby might be more affected as the deposition of sediment on the substratum could destroy shelter, reduce food availability, impair growth and lower the survival rate of eggs and fish larvae. After pelagic shoaling species such as pilchard, smelt and sprat (see Table 11-1) gobies are the most common species found in Carrick Roads. Gobies are also a brooding species laying their eggs under shells which are then guarded by the male; as a result gobies are likely to be more intolerant of smothering during the breeding season.

Sediment Deposition Increases in the Lower Fal Estuary

Sediment deposition increases are described in Section 11.4.3.

Impact Assessment

Juvenile fish, larval stages and fish eggs are more sensitive to impacts from sediment deposition. The main nursery areas for commercially important fish species such as bass are generally found in the shallow estuary inlets and creeks which are found higher up the estuary (Goodwin, 2002) and are not likely to be impacted by sediment deposition as a result of the dredging activities. Some bottom living brooding species such as gobies may be impacted by increased rates of sediment deposition. Given that gobies are the commonest bottom living fish in most estuaries, breed rapidly and have huge population sizes, it is anticipated the levels of deposition occurring as a result of the dredging will have a negligible impact on goby populations in Carrick Roads.

Mitigation and Residual Impact

No mitigation measures are recommended and a negligible residual impact will remain.

11.4.5 Chemical Impacts to Shellfish from Increased Contaminant Concentrations in the Water due to Capital Dredging

As described in Sections 7.4.1 and 7.4.2, capital dredging in the western part of the new navigation channel will release sediment and the associated contaminants into the water column within the lower Fal Estuary, which may affect the wellbeing of shellfish resources exposed to this effect in terms of toxic responses. Various stakeholders including the Duchy of Cornwall Oyster Farm and Fishery have raised the concern of capital dredging causing the release of contaminants, and specifically TBT, in relation to the oyster beds.

Shellfish Sensitivity to Metals

Suspension feeding bivalves process large volumes of water and as a result are vulnerable to both water soluble contaminants and contaminants adsorbed onto particles. Mussel and oyster larvae are routinely used as a larval bioassay to test the toxicity of chemicals in water quality samples. Although chosen for their sensitivity, mussel larval stages are less sensitive than adults. This may in part be due to their reliance on energy reserves provided by the parent, rather than on direct feeding, and the absence of a developed nervous system, an important site of toxic action.

An overview is provided in CIRIA (2000). Generally, shellfish can bioaccumulate metals which, depending on the species sensitivity, can cause a range of toxic effects including tumours, deformation and mortality. For example, in heavily polluted estuaries including Restronguet Creek in the upper Fal Estuary, oyster flesh is known to turn green due to the accumulation of copper. In addition, concentrations of copper and zinc in shellfish flesh are known to accumulate at levels too toxic for healthy human consumption. Although oysters are tolerant of high levels of metals, larval stages may be more intolerant, especially to cadmium, copper, mercury and zinc. For example, for mercury Bryan (1984) reported a 48hr LC_{50} of 1-3.3ppb in ***Ostrea edulis*** larvae compared with a 48hr LC_{50} of 4,200ppb in adults. Therefore, although the adults may be tolerant of metal

pollution, the larval effects suggest that recruitment may be impaired resulting in a reduction in the population over time.

Shellfish Sensitivity to TBT

An overview is provided in CIRIA (2000). Generally, shellfish (and particularly mollusc species) that are exposed to TBT are reported to exhibit a range of toxic effects including imposex in dog whelks and shell thickening in oysters. For example, TBT bioaccumulates in oysters and can affect populations by reducing growth rate of spat, preventing the production of larvae in adults, and retarding normal sex change (male to female) (Jackson, 2007).

Contaminant Increases in the Lower Fal Estuary

In terms of water quality, Sections 7.4.1 and 7.4.2 identify that capital dredging is predicted to:

- increase concentrations of TBT in the lower Fal Estuary to the extent that water quality requirements will be breached for the EQSs required under the DSD;
- not increase concentrations of the metals in the lower Fal Estuary to the extent that water quality requirements will be breached for the EQSs required under the DSD;
- Increase concentrations of metals in the Carrick Roads and Penryn River shellfish waters but not to the extent that water quality requirements will be breached with respect to the SWD; and
- not increase concentrations of metals in the Percuil River shellfish water with respect to the requirements of the SWD.

Impact Assessment

As described in Section 7.4.1 and shown on Figure 7-5, the scale of the impact on TBT concentrations will be limited in space (i.e. largely around Falmouth Docks and the harbour area) and time (i.e. over the duration of the capital dredge for contaminated sediment – 50 per cent of the dredging programme of c.26 weeks). Numerical modelling of the plumes of dissolved and suspended levels of TBT indicate that high suspended levels of TBT do not disperse as far as the Truro oyster fishery. The extent of dissolved TBT is highest when dredging occurs on spring tides (see Figure 7-5), and the plume extends seawards on the ebb tide with TBT concentrations generally below 0.005µg/l. Given the baseline TBT concentrations in the lower Fal Estuary and adding the predicted TBT concentrations during capital dredging, the increased TBT concentrations could reduce the growth of new spat when considered against the criteria derived from Jackson (2007) (see Table 11-5)

Table 11-5 Levels of TBT and Effects on Oysters (source: Jackson, 2007)

Level	Effect
20ng/l (0.02µg/l)	reduced growth of new spat
60ng/l (0.06µg/l)	50% reduction in growth, although older spat grew normally at 240ng/l (0.24 µg/l) for 7 days
240 and 2,620ng/l (0.24 and 2.62µg/l)	prevented the production of larvae in adults exposed for 74 days

Given the background levels already present in the lower Fal Estuary and the modelling results, the TBT concentration increases arising as a result of capital dredging are predicted to have a minor adverse impact on the Truro oyster fishery.

Mitigation and Residual Impact

The impact is temporary and reversible (i.e. baseline conditions will return following the cessation of capital dredging). Like the baseline conditions for water quality, the conditions after dredging will remain above the EQS for TBT, at least in the short-term. No mitigation measures are proposed given that the best dredging option (i.e. backhoe dredging) has been proposed to minimise impacts on water quality, and that it is recommended that adverse nature of this impact be considered against the long-term, permanent benefits to water quality and, indirectly on shellfish resources, that are predicted to occur due to the removal of TBT from the estuarine system (see Section 7.5.1).

Without mitigation, there will remain a temporary minor adverse impact on shellfish resources with regard to TBT concentrations.

11.4.6 Chemical Impacts to Shellfish from Increased Contaminant Concentrations in the Sediment due to Capital Dredging

As described in Sections 6.4.3, capital dredging in the western part of the new navigation channel will release sediment and the associated contaminants into the water column and deposit sediment and the associated contaminants onto the seabed within the lower Fal Estuary, which may affect the wellbeing of shellfish resources exposed to this effect in terms of toxic responses. Various stakeholders including the Duchy of Cornwall Oyster Farm and Fishery have raised the concern of capital dredging causing the deposition of contaminants, and specifically TBT, in relation to the oyster beds.

Shellfish Sensitivity to Metals and TBT

Shellfish sensitivity is described in Section 11.4.3

Contaminant Increases in the Lower Fal Estuary

As described in Section 6.4.2 and shown on Figure 5-10, numerical modelling predicts that capital dredging of the upper sediments within the western part of the new navigation channel will deposit small quantities of sediment and associated chemical contaminants to a limited extent beyond the new navigation channel (i.e. largely within the western docks and beyond the Eastern Breakwater). Accordingly, deposition will not occur within the Truro oyster beds and there will be no impact on sediment quality and the shellfish resource.

Mitigation and Residual Impact

No mitigation measures are required and no residual impact will remain.

11.4.7 Chemical Impacts to Finfish from Increased Contaminant Concentrations in the Water due to Capital Dredging

As described in Sections 7.4.1 and 7.4.2, capital dredging in the western part of the new navigation channel will release sediment and the associated contaminants into the water column within the lower Fal Estuary, which may affect the wellbeing of finfish resources exposed to this effect in terms of toxic responses.

Finfish Sensitivity to Contaminants

Elevated concentrations of contaminants such as TBT, metals and organic substances (i.e. PCBs, PAHs) can be of concern because of their toxicity, environmental persistence and tendency to bioaccumulate in living organisms. For example, TBT is toxic to fish, although the toxicity is highly variable with 96-hr LC_{50} ranging from 1.5 to 36µg/l, with larval stages being more sensitive than adults (Riley, 2003). Cadmium, mercury, lead, zinc and copper are highly persistent and are considered very toxic to fish. In goby species ***Pomatoschistus sp.*** very low concentrations of cadmium, copper and lead (0.5g/l Cd^{2+}; 5g/l Cu^{2+}; 20g/l Pb^{2+}) brought about changes in activity and an obstruction to the gill epithelia by mucus (Riley, 2003). PCBs have the potential to bioaccumulate significantly and are known to be very toxic to invertebrates but their toxicity to fish is unclear.

Contaminant Increases in the Lower Fal Estuary

Contaminant increases are described in Section 11.4.5. Only TBT increases are of a magnitude that affects water quality conditions with respect to the requirements of the DSD and SWD.

Impact Assessment

As described in Section 7.4.1 and shown on Figure 7-5, the scale of the impact on TBT concentrations will be limited in space (i.e. largely around Falmouth Docks and the harbour area) and time (i.e. over the duration of the capital dredge for contaminated sediment – 50 per cent of the dredging programme of c.26 weeks). In terms of toxicity to fish species, the elevated levels are not predicted to affect fish species but the temporary, localised change to water quality is predicted to have a minor adverse impact on finfish resource.

Mitigation and Residual Impact

The impact is temporary and reversible (i.e. baseline conditions will return following the cessation of capital dredging). Like the baseline conditions for water quality, the conditions after dredging will remain above the EQS for TBT, at least in the short-term. No mitigation measures are proposed given that the best dredging option (i.e. backhoe dredging) has been proposed to minimise impacts on water quality, and that it is recommended that adverse nature of this impact be considered against the long-term, permanent benefits to water quality and, indirectly on finfish resources, that are predicted to occur due to the removal of TBT from the estuarine system (see Section 7.5.1).

Without mitigation, there will remain a temporary minor adverse impact on finfish resources with regard to TBT concentrations.

11.4.8 Physical Impacts to Shellfish and Finfish from Sediment Deposition due to the Disposal of Dredged Material

The deposition of dredged material at the offshore disposal site in Falmouth Bay may impact shellfish species utilising the seabed including scallops, crabs and lobsters as well as finfish species such as rays, sole, plaice and monkfish.

Shellfish and Finfish Sensitivity

Shellfish and finfish sensitivities to sediment deposition are described in Sections 11.4.3 and 11.4.4 respectively.

In addition, most adult finfish species will be able to move rapidly enough to take avoidance action if threatened by smothering or burial. Scallops also have some degree of mobility and if smothered by a 5cm layer of fine sediment juveniles and adults can lift themselves out as they are capable of jumping and swimming (Marshall and Wilson, 2008). Crabs are also able to escape from under silt and able to relocate away from an area affected by sediment deposition (Neal and Wilson, 2008). Studies of sediment disposal on ***Cancer magister*** indicated that the loss of respiratory pathways is a key factor in burial effects. Crabs were found to take some time to emerge from burial, suggesting that multiple deposition events over the same area could increase vulnerability, and male and larger crabs were found survive better with lower burial depths (Vavrinec ***et al.,*** 2007). Like crabs, lobsters are mobile enough to relocate from sediment deposition.

Sediment Deposition Increases in Falmouth Bay

Based on predictions derived from numerical modelling, Section 5.4.3 describes the extent and depths of sediment deposition due to the disposal of dredged material, including the changes caused by an individual disposal event (see Figure 5.16) and the total of all disposal events (see Figure 5.17). In summary, after the dredged material has been disposed of:

- depths from 0.1m to 0.5m are predicted within the disposal site's boundary;
- depths of 0.01m to 0.05m are predicted within 800m of the disposal site's boundary; and
- depths below 0.005m (i.e. 5mm) are predicted beyond 1km of the disposal site's boundary.

Impact Assessment

The disposal site in Falmouth Bay is designated to receive deposits of dredged material. Records show that the site has been used every year since 1985, and therefore the seabed is already regularly subject to some degree of smothering and burial. However, the proposed Falmouth Cruise Project will require the disposal of much larger quantities than has occurred in previous years, and therefore the potential for smothering and burial will be correspondingly higher.

Fish species such as sole and monkfish as well as crab are known to occur within the vicinity of the disposal site and the grounds are fished commercially (see Figure 12-2).

Many adult fish are likely to be able to avoid deposited sediment although it is likely that some fish may be impacted, particularly young fish which are less capable of escape. It is possible that some crab species may be impacted directly by the deposition of sediment at the disposal site. Overall, the disposal of dredged material would impact on a localised area of seabed, mostly within the designated disposal site. When combined with the fact that a relatively small number of individuals would be expected to be impacted compared to the availability of surrounding habitat, there is predicted to be a minor adverse impact.

Mitigation and Residual Impact

No mitigation measures are required and there will remain a minor adverse residual impact.

11.4.9 Impacts to Shellfish and Finfish from Direct Uptake by Dredgers due to Capital Dredging

Capital dredging of the new navigation channel will involve mechanical backhoe dredgers to excavate sediment from the seabed. There is the potential for shellfish, fish and fish eggs to suffer physical disturbance, damage and potentially mortality as a result of the dredging, particularly if organisms are excavated with the sediment.

Sensitivity

The fish most likely be to affected by capital dredging are those benthic species with the lowest swimming speeds since fish with higher swimming speeds are more likely to be able to escape. Given that swimming speeds are largely a function of size, it is likely smaller more vulnerable benthic species such as gobies are likely to be impacted.

Shellfish

Diver surveys of the proposed dredge areas have indicated that shellfish such as scallops are occasionally present in the capital dredge area (Axelsson ***et al.,*** 2008). Although scallops are mobile they spend the majority of their time recessed into the sediment and as such it is likely that some scallops may suffer from direct uptake by the dredger.

Impact Assessment

Assuming gobies to be the most sensitive species to this impact, then losses of finfish are unlikely to result in appreciable reductions in the populations of these species since gobies are the commonest bottom living fish in most estuaries (including the Fal Estuary) and coastal waters and are found in large numbers. These species are widely distributed, breed rapidly, have huge population sizes and are not commercially exploited.

Shellfish such as scallops and juvenile crab species may also be impacted due to their lower mobility and tendency to be recessed into sediment substrates.

Overall, although there would inevitably be direct uptake of fish and shellfish during capital dredging, the impact is perceived to be of low magnitude due to the fact that the

fish present in the area will tend to show avoidance reactions and move away from the source of the disturbance. Similarly, scallops are generally evenly distributed across suitable habitat and as such any small losses occurring as a result of the dredging activity would not be anticipated to adversely affect the population or its breeding potential.

The fish species present in the dredging area are also likely to be widely distributed in the estuary and as such there will be no overall effects on population levels. Given the small proportion of the overall fish resource likely to be impinged, the small bucket size and the temporary nature of any disturbance, there is predicted to be a negligible impact on resources.

Mitigation and Residual Impact

No mitigation measures are required and there will remain a negligible residual impact.

11.5 POTENTIAL IMPACTS DURING THE OPERATIONAL PHASE

11.5.1 Impacts to Shellfish from Changes in Hydrodynamics and Sediment Transport due to the New Navigation Channel

Recruitment in ***Ostrea edulis*** is sporadic and dependant on local environmental conditions, including the hydrodynamic and sediment regimes.

Sensitivity

In terms of hydrodynamics, oyster larvae have a 10-12 day free swimming period before settling, and therefore they are sensitive to changes to hydrodynamic conditions such as tidal current velocities.

In terms of sediment transport, shellfish are sensitive to sediment deposition where this could change the substrate type, as described in Section 11.4.3.

Hydrodynamic and Sediment Transport Changes in the Lower Fal Estuary

As described in Section 5.5.2, numerical modelling predicts a decrease of tidal current velocity compared to the existing conditions of up to 0.07m/s during spring tide and less than 0.03m/s during neap tide. These predicted changes in tidal current velocity are very small related to the relatively low ambient currents and cover a small area in and around the new navigation channel (see Figures 5-23 and 5-24).

As described in Section 5.5.3, numerical modelling predicts a small increase in fine-grained sediment deposition associated with the proposed project (i.e. 610m^3/yr), which will not significantly change the fine sediment transport regime in the lower Fal Estuary (see Figure 5-25).

As described in Section 5.5.4, numerical modelling predicts a very small net change in medium-grained sediment deposition associated with the proposed project (i.e. 20m^3/yr), but some small areas of deposition in the range 0.2-0.3m/yr in the south-eastern corner end of the new navigation channel, less than 0.1m/yr in the southern side of the new navigation channel, and less than 0.02m/s on the northern side of the new navigation channel (see Figure 5-26).

Impact Assessment

The very small changes to tidal current velocities will occur around the new navigation channel and will not affect key shellfish resource areas such as the Truro oyster beds (see Figures 5-23 and 5-24). The small changes to sediment transport will cause localised deposition within the new navigation channel but will not affect key shellfish resource areas. As a result there will be a negligible impact on the shellfish resource in the lower Fal Estuary.

Mitigation and Residual Impact

No mitigation is required and a negligible residual impact will remain.

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12 COMMERCIAL FISHERIES AND SHELLFISHERIES

12.1 INTRODUCTION

This section describes the commercial fishing activity that currently takes place within the study area and discusses the potential impacts of the proposed Falmouth Cruise Project on commercial fishing activity. It is partly informed through consultation with organisations representing local commercial fishing interests and notably the Helford and Cadgwith Fishermen's Association.

Commercial sea-fishing makes an important economic contribution to the coastal areas in South West England, and although the fishing industry is a small sector it is more important to the regional economy than typical nationally. For example, the 2001 Census found that 0.1% of southwest England's residents worked in the fishing industry, which is almost four times the proportion for England as a whole.

12.2 ASSESSMENT METHODOLOGY

12.2.1 Study Area

The study area includes the commercially fished areas within the Fal Estuary (see Figure 12-1) and Falmouth Bay (see Figure 12-2).

12.2.2 Data Collection

In order to determine the baseline conditions, data from a wide variety of sources has been used. Reports, data from surveys and consultation with stakeholders have been used within this section, which links closely with the baseline data and impacts to the fish and shellfish resources, which is presented in Section 11. The following paragraphs identify the sources and describe the data collected to establish the existing baseline environment for commercial fishery interests.

High Level Data

High level data was collected from a number of organisations including Cefas (e.g. classifications of shellfish production areas within the Fal Estuary), Defra (e.g. Explanatory Memorandum to the Fal and Helford (Prohibition of Scallop Dredging) Order 2004. No. 2567) and the Cornwall Sea Fisheries Committee (CSFC) and the Environment Agency (e.g. ***Bass Fishing in the Fal Estuary and Coastal Area. A Guide to Fisheries Regulations***, 2003).

Local Survey Data

In addition to the data described in Section 11.2.1, local information and knowledge regarding fishing areas and seasons was collected through consultation with a number of stakeholders including the Environment Agency, the St Mawes & District Fishermen's Association, the Cadgwith, Helford & District Fishermen's Association (CHAD), the Cornish Inshore Scallopers' Association, Cornwall Sea Fisheries Committee (CSFC) and the Cornish Federation of Sea Anglers.

Literature

Additional information was collected from the literature cited and referenced. Useful literature includes Goodwin's Bass Investigations in the Fal and Helford Estuaries Complexes, which includes previous study notes and surveys on bass in the Fal Estuary by DF Kelley and the JP Bridger (in Myles (Ed), 2002).

12.2.3 Surveys

As described in Section 11.2.2.

12.2.4 Assessment Criteria and Technique

The impacts on fishing activity have been assessed using the results from hydrodynamic and sediment modelling which have predicted effects on water quality, sediment quality and tidal patterns.

12.2.5 Assessment of Significance

The significance of predicted impacts was assessed using the classification criteria and terminology outlined in Table 1-1 in Section 1.4.3 on the EIA process.

12.3 BASELINE ENVIRONMENT

12.3.1 Fisheries Regulation

There are various bodies that control and have powers to regulate certain fishing activities within the Fal Estuary and coastal areas. The Environment Agency regulates commercial fishing as far downstream as the mouth of the Fal Estuary (St Anthony's Head to Pendennis Point), and also has powers under the Salmon and Freshwater Fisheries Act 1975 (SAFFA) up to the 6 nautical mile offshore limit. In addition, Falmouth and Truro Harbour Authority also have regulations and bye-laws concerning fishing in the Fal Estuary and Carrick Roads. The Cornwall Sea Fisheries Committee (CSFC) regulates commercial fishing seaward of the estuary's mouth as far offshore as the six nautical mile limit, after which commercial fishing falls within the jurisdiction of the MFA. .

Within the estuary, the Cornwall River Board Sea Fishery Byelaws 1896, the Sea Fisheries Regulation Act 1966, and the Salmon & Freshwater Fisheries Act 1975 all apply. Key restrictions determined by legislation include:

- no fixed nets for any fish;
- no trawling;
- no scallop dredging; and
- a minimum landing size for bass of 37.5cm total length.

The bass nursery areas in the Fal Estuary (Figure 12.1) are regulated by the Environment Agency who act as the authority for sea fish in these areas. Fishing from a boat between 30th April and 1st January or fishing with live sandeel within these nursery areas is prohibited.

Carrick District Council (CDC) regulates the mussel and oyster fisheries under the Truro Port Fishery (Variation) Order 1975. This order provides CDC with the legal right of

regulating a fishery for oysters and mussels in the Truro and Falmouth Harbours and on the bed of Truro, Fal and Tresillian Rivers; an area covering 1,101 hectares.

The Fal Estuary is part of the Fal and Helford Estuaries SAC and supports extensive rich sediment communities including the largest and most south-westerly maerl ***Phymatolithon calcareum*** bed in the UK at St Mawes Bank. The Fal and Helford Designated Area (Fishing Restrictions) Order 2008 came into force on 1st October 2008 and prohibit the dredging for shellfish and demersal trawling in the designated area.

12.3.2 The Local Fishing Fleets

Warmsley and Pawson (2007) describe the coastal fisheries within England and Wales. The following information from their report describes the fisheries by port relevant and adjacent to the Fal Estuary area.

The river itself contains a native oyster fishery employing up to 70 men (12 smacks and 11 punts in 2005) and the fishery known as the Port of Truro Oyster Fishery is unique in that it is the last oyster fishery in t he world still fished under sail.

Falmouth

Twelve boats operate out of Falmouth port, two of >10m dredge for scallops, three are netters, and one potter of >10m. The six remaining <10m boats use nets, longlines, pots and handlines. The majority of static gear boats set nets part-time for a variety of species, and also use rod and line or handlines for bass and mackerel in season. Some boats charter angling trips.

St Mawes

At St Mawes two >15m boats fish for scallops within 12 miles of the coast, with one boat often changing to beam or otter trawling to target demersal fish. A further two boats use trawls all year round, with four vessels operating static gear. Native oysters are also cultivated in the Percuil River, although stocks have remained low since the ***Bonamia*** outbreak in the 1980s.

Mylor

There are a variety of boats working out of Mylor, including three boats using nets and three setting pots, with the largest netter (>12m) fishing the deep water offshore grounds to the south-west of Falmouth for hake. The rest of the fleet are <10m and use gill nets for cod, pollack and ling, tangle nets for rays, turbot and monkfish, or set between 250 and 300 pots each for lobsters and brown and velvet crabs. Two scallop dredgers also operate from Mylor.

Flushing

Fishing boats based out of Flushing include two 12-15m vessels, one dredging for scallops and the other using nets or long lines for ling and conger eel.

Penryn

Three boats operate out of Penryn, setting nets for demersal fish.

12.3.3 Commercial Fishing Activity within the Fal Estuary

The majority of fishing effort in the Fal Estuary is directed towards potting for crabs (brown, green, spider and velvet), lobsters and prawns, with many of the velvet and green crab catches destined for the Spanish market.

Commercial trawling and scalloping activity is generally limited to outside the estuary as much of the area is within the SAC and these activities are either banned (e.g. scallop dredging) and proposed to be banned (e.g. demersal trawling) .

Oyster Fisheries

The Fal Estuary has a traditional and unique native oyster fishery. The Port of Truro Oyster Fishery has been operational since Roman times and is the largest natural oyster fishery in Europe whereby only traditional forms of dredging are allowed. It is also the last oyster fishery in the world still fished under sail and the last commercial sailing fleet left in Europe. There are approximately 12 sailing boats working the Fal Estuary, and the main beds lie north of Pennarrow Point (see Figure 11.1). The fishing season starts on 1 October and lasts through to the end of March. It is estimated approximately 50-60 tonnes of oysters are taken from the fishery annually (Bate C. pers. comm., 2008).

The oyster fishery is of great importance to the local community through sustaining business (e.g. the Falmouth Bay Oysters which purifies and grade oysters and mussels, and has export markets nationally as well as in Europe and the Far East), and providing cultural and economic input to the town through the annual Falmouth Oyster Festival (held during four days in October).

It is understood that fishing activity during the winter oyster fishing season may occur within the new navigation channel that is proposed under the Falmouth Cruise Project (Toms S. pers. comm., 2007).

Historically there was commercial activity on the Percuil and Penryn Rivers, although a decrease in water quality in the Penryn has meant this is no longer the case. The beds at Percuil are also no longer used commercially.

Private oyster fisheries exist in the Helford Estuary which is leased from the Duchy of Cornwall. The Helford fishery is mainly Pacific oysters, with seed oysters brought in from France, grown on and exported.

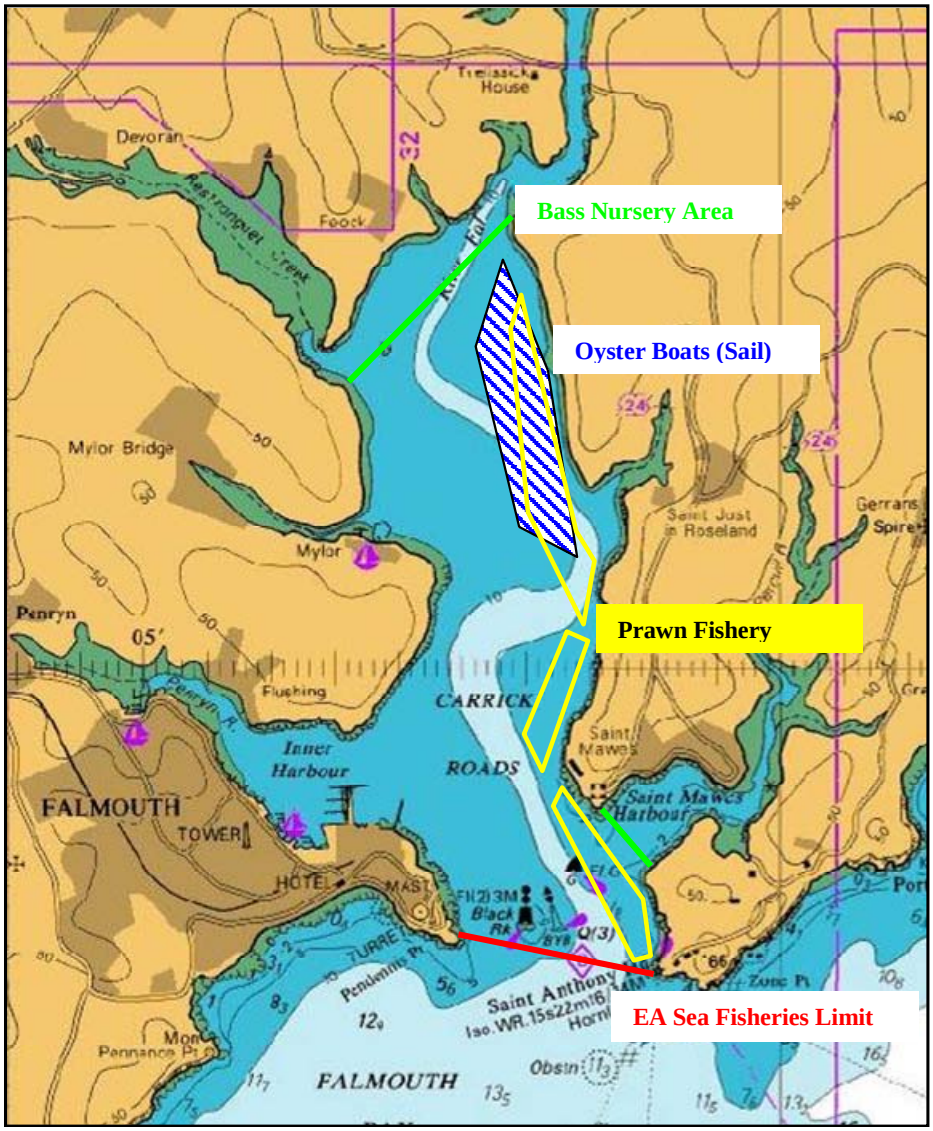
Potting

Within the Fal Estuary, potting is the main fishing in addition to the oysters. Potters target prawns, velvet swimming crab, lobster and brown crab. The main grounds for potting are in the Carrick Roads and in the winter months this takes place in the deeper channel (Environment Agency, 2004). However, it is understood from dialogue with local fishermen's associations that activity for such species occurs year round and includes the

new navigation channel under the proposed Falmouth Cruise Project (Tomlinson, T. pers. comm., 2007).

The prawn industry in the Fal Estuary over the past five years has thrived and has an estimated turnover of £50,000 per year (Environment Agency, 2004). The majority of the prawn grounds are within the Carrick Roads on the eastern side between St Anthony's Head and Turnaware Point (see Figure 12-1), although these areas are approximate and prawn and oyster fishing also occur in other parts of Carrick Roads (Pilcher, 2007). The season runs from August to December with approximately 1500-1700 pots set annually in strings of 20-30 pots.

Figure 12-1 Prawn and Oyster Fishing Areas and Bass Nursery Areas in Carrick Roads (source: adapted from Pilcher, 2007)



Mussel Culture

Mussel culture takes place immediately below King Harry Ferry, with crosses between Feock and Philliegh in the northern extents of Carrick Roads (Toms, S. pers comm.,

2007), approximately four miles upstream of Falmouth. The water quality in the King Harry Reach has recently dropped, leading to concerns and one company seeking a new site in the Carrick Roads so that mussels may be located in clean water for a period of two months before harvesting (Brigden, 2007).

Scallop Dredging

Scallop dredging has taken place within the Fal Estuary and around its mouth for the past 30 years. Historically, the effort has been low and restricted to winter months when severe weather has stopped vessels fishing offshore in more exposed waters. Bad weather resulting in more vessels fishing inshore combined with good catches within the area brought about an increase in dredging effort in 2006. In 2006 the value of this sheltered fishery to the local fleet may have been as high as £100,000 (i.e. assuming all landings recorded by the local vessels as having been taken in ICES statistical rectangle 29E4 (an area ’30 min latitude and 1° longitude by which fisheries data is collected). The landings data shows 158 days fishing in 29E4 and a high proportion of this will have taken place within the boundary of the SAC (Defra, 2008).

Collection by Hand

Shellfish including whelk and winkles are collected by hand with green crabs often collected for fishing bait. Within the Fal Estuary, fishermen deploy weighted scrape to provide habitat for shore crabs, making them easy to catch for use as fishing bait (Jensen, 1997). Diving for scallops has taken place within the Fal and Helford Estuaries for 20 years, although the main commercial scallop diving occurs in the mouth of the Helford River.

12.3.4 Commercial Fishing Activity within Falmouth Bay

With its proximity to the fishing ports of Newlyn and Plymouth the areas around the Lizard peninsula and Falmouth Bay are important areas for demersal and shellfish fisheries. The sea area off the south Cornwall coast has historically supported some of the highest fishing effort in the UK’s waters.

Within Falmouth Bay there are a number of significant fishing grounds, particularly for shellfish, sole and monkfish (see Figure 12-2). The shellfish catch forms a significant part of the regional fishing industry, with landings representing almost half (44%) of the total landings, which is far greater than the national average.

Table 12-1 summarises the total landings into Falmouth by UK vessels from 2001 to 2005. The data show the importance of the shellfish fisheries which from 2003 onwards increased in value over demersal fish landings.

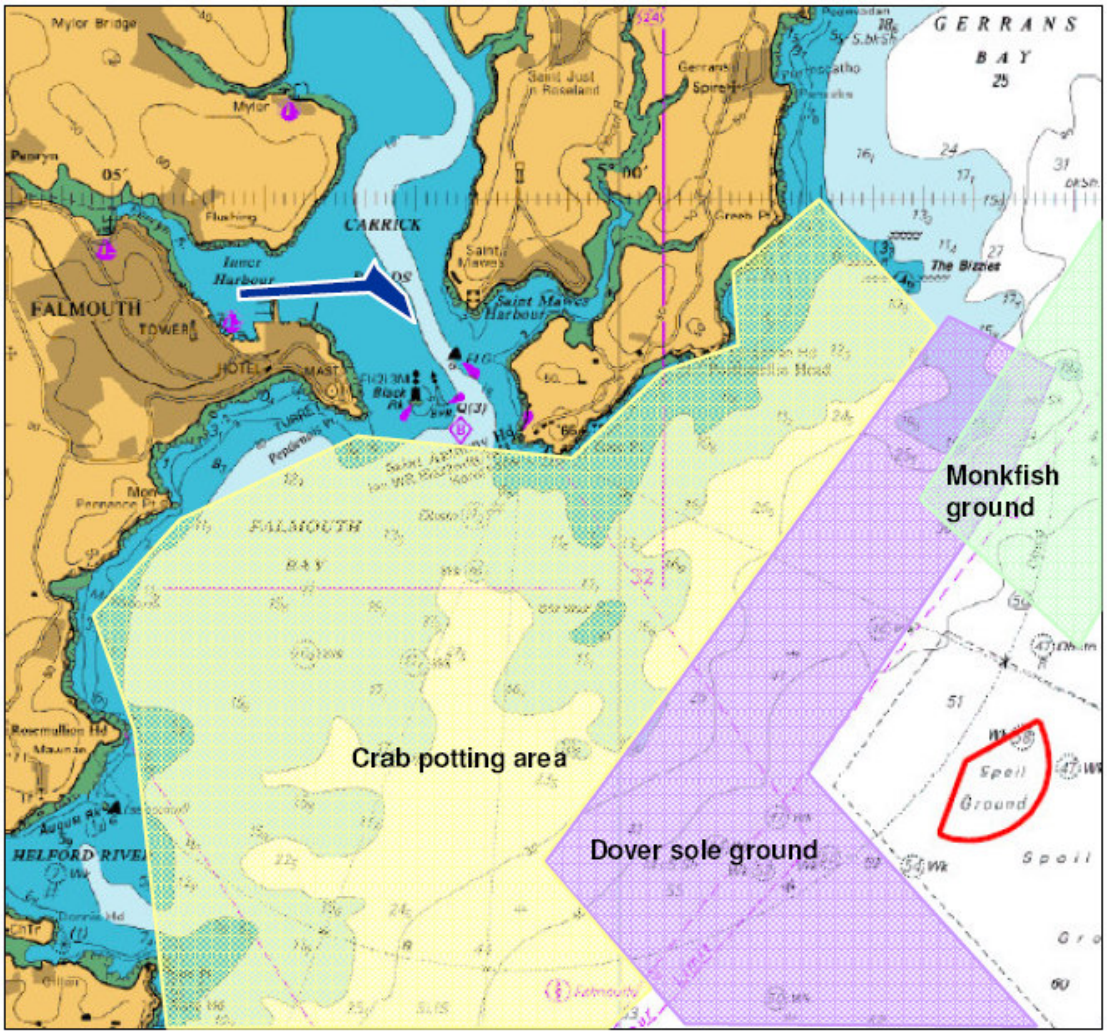
Table 12-1 Total Landings into Falmouth by UK vessels 2001 to 2005 (source: Defra, 2008)

	Quantity ('000 tonnes)					Value (£ million)				
	2001	**2002**	**2003**	**2004**	**2005**	**2001**	**2002**	**2003**	**2004**	**2005**
Shellfish	0.2	0.3	1.3	1.1	1.4	0.6	0.8	1.9	1.3	2.0
Demersal	1.5	1.5	0.6	0.3	0.3	1.6	1.5	0.9	0.6	0.6
Total	1.7	1.9	1.9	1.4	1.7	2.2	2.3	2.8	2.0	2.6

Whilst the exact fishing grounds are slightly unclear due to a lack of substantial information and some conflicting information from local sources, it is understood to receive a wide variety of fishing effort from trawling, scalloping, potting and netting (Tomlinson, T. pers. comm., 2007).

Figure 12-2 has been compiled from the information provided by CHAD on the fishing grounds within the vicinity of the disposal ground. The main sole grounds run just inside of the designated offshore disposal site between the 35 and 55m contours and are fished seven days a week (weather permitting) between May and December by around four boats. Dover sole provides up to half of the income for three of the inshore fishing vessels working out of the Helford Estuary. The crab potting grounds are fished year round by a minimum of four vessels with crab catches accounting for between 50 and 70% of several vessels' income (CHAD, 2007).

Figure 12-2 Fishing Activity in Falmouth Bay Relative to the Dredged Material Disposal Site (source: Pers. Comm. CHAD, 2007)



Although some scallop dredging has occurred in Carrick Roads and the Fal Estuary in the past, the majority of the scallop fishing grounds lie outside the estuary (Environment

Agency, 2004) and the area between The Lizard peninsula and Start Point is known to be an important scallop ground (Pawson, 1995).

12.3.5 Bait Digging

Both commercial and recreational bait digging and collection also take place in the Fal and Helford Estuaries mainly for ragworm and peeler crab. Bait diggers are encouraged to follow the code of conduct produced by the Cornish Federation of Sea Anglers.

12.4 POTENTIAL IMPACTS DURING THE CONSTRUCTION PHASE

Impacts on fish and shellfish resources are discussed in Section 11.4. It is recommended that Section 12.4 is read in conjunction with Section 11.4, because many of the impacts on resources indirectly influence impacts on commercial interests by potentially reducing populations and the productivity of the fisheries.

12.4.1 Impact on Fishing Gear and Fishing Activity due to Capital Dredging and the Disposal of Dredged Material

As with any marine based construction works and changes to navigation requirements, there is the potential to cause damage or loss of static fishing gear and/or change fishing activity if the proposed construction activities take place within a fishing area. Damage or loss of fishing gear affects fishermen both financially and logistically since they must repair and/or replace the gear and may have to stop or reduce their fishing effort until the gear has been replaced. Restricted access to fishing grounds affects fishermen both financially and logistically since they must use different grounds than normal, which may interfere with other fishing activities, reduce catches, increase fuel costs, etc.

Capital Dredging

Capital dredging plant could directly damage lain gear due to physical impact and excavation, or cause burial due to sediment deposition. It could damage buoy-lines between the gear and the dhan buoy at the surface if a line is cut and the gear becomes lost or unrecoverable. Capital dredging could restrict access to fishing grounds if the two activities coincide.

In the case of the proposed Falmouth Cruise Project, capital dredging for the new navigation channel will largely avoid areas used for fishing. However, dredging at the eastern end of the new navigation channel may take place within an area of Carrick Roads where potting occurs, although this activity is restricted by existing navigation requirements. Capital dredging will take place outside the Truro oyster beds (see Figure 11.1) and outside the prawn fishery on the eastern side of Carrick Roads between St Anthony's Head and Turnaware Point, and therefore there should be no coincidence of dredging plant and fishing gear.

As described in Section 5.4.2, Table 5.4 and Figures 5.10, 5.12, 5.14 and 5.15, numerical modelling indicates that, in total, capital dredging will cause very small average deposition rates between 0.5mm and 1.7mm across the lower Fal Estuary. These deposition rates are unlikely to change the nature of the bed in the areas studied, although the presence of finer factions of sediment may be detectable in particular areas. Deposition will take place largely outside the Truro oyster beds (see Figure 11.1) and

outside the prawn fishery on the eastern side of Carrick Roads between St Anthony's Head and Turnaware Point, and therefore there is low potential for burial and smothering of fishing grounds.

Barge Movements

Barge movements are unlikely to damage fishing gear unless poor navigation or poor marking causes a vessel to damage buoys and buoy-lines thereby losing the gear or making it unrecoverable. Barge movements are unlikely to restrict access to fishing grounds even if the two activities coincide since appropriate navigation measures are available to facilitate the undertaking of both activities.

Some 600 round trips between the new navigation channel and the offshore disposal site will be required to dispose of 600,000m^3 of dredged material assuming the use barges with a capacity of 1000m^3. This equates to approximately three to four round trips per day assuming a six month continuous working period. Given that are between 300 and 500 commercial vessel movements per quarter over the past three years (see Section 13.3.8), barge movements associated with the Falmouth Cruise Project have the potential to double the number of commercial vessel movements through the lower part of Carrick Roads and offshore to the disposal site.

For reasons of safe navigation, the FHC advise fishermen to not lay their gear in such a way as it causes an obstruction in the main buoyed channel in the Carrick Roads (or in other approaches or sailing routes), although short term deployment of gear may be acceptable subject to the FHC's permission and provisions for removal in time to prevent any obstruction to the passage of a commercial vessel. In Falmouth Bay, the sailing route for the barges will cross the crab potting area and grounds for monkfish and Dover sole (see Figure 12.2). Accordingly, there is low potential in Carrick Roads and medium potential in Falmouth Bay for the increased barge movements to coincide with deployed fishing gear and fishing activities, particularly if fishermen are not aware of the navigation requirements during construction of the proposed Falmouth Cruise Project.

Disposal of Dredged Material

Disposal of dredged material could affect fishing gear and grounds due to burial and smothering of lain gear and resources on the seabed.

Disposal of dredged material will take place at the offshore disposal site, which is situated in an area of Falmouth Bay. As described in Section 11.4.8, numerical modelling by HR Wallingford (2008; see Appendix A) predicts the magnitude of disposal of dredged material to be at depths from 0.1m to 0.5m within the disposal site's boundary, 0.01m to 0.05m (i.e. 10 to 50mm) within 800m of the disposal site's boundary, and below 0.005m (i.e. 5mm) beyond 1km of the disposal site's boundary.

Deposition due to dredged material disposal will be focussed on and be deepest at the disposal site, rather than the fishing grounds outside it (see Figure 12.2). The nearest fishing gear would be deployed within the crab potting area (see Figure 12.2), and will be sufficiently distant from the predicted sediment deposition to damage or loss due to sediment deposition. The nearest fishing grounds are for Dover sole and monkfish (see Figure 12.2), and will be, at their nearest points, close enough to be affected by sediment deposition. Based on the predicted deposition depths, the maximum depth of localised

deposition outside the disposal site is predicted to be 10 to 50mm within 800m of the disposal site's boundary, and below 5mm beyond 1km of the disposal site's boundary.

At these deposition rates, the potential impact on fishing gear and fishing grounds appears to be limited to a localised area around the disposal site. However, CHAD have voiced concern over the disposal of dredged material in Falmouth Bay at high levels for a lengthy period, and have commented that previous disposal activities have caused crab mortality adjacent to the disposal site, and noted that the undersides of the crabs' carapaces became black and silted up with oily organic sediment and that some crustaceans died within pots and nets. CHAD have advised that Dover sole provides up to half the incomes for three of the inshore fishing vessels that work out of Helford Estuary, and that crabs account for between 50 and 70% of several members' incomes. CHAD have also commented that their members have systematically cleared up the disposal site over the last six years by removing debris (e.g. electrical cables, concrete chunks with reinforcing irons and other industrial waste) and taking it ashore for landfill.

Navigation Procedures relative to Fishing Activities

As with all activities potentially affecting navigation and safety within the harbour, FHC will issue a Notice to Mariners to inform harbour users about the location and duration of the construction works associated with the proposed Falmouth Cruise Project. In addition, to maintain safe navigation the FHC have powers to regulate fishing gear deployment under the Falmouth Harbour (General) Bye-laws. The bye-laws require fishermen not to place any "drift, trawl or other net or pot in such a position as to be likely to become an obstruction or danger to any property". These provisions should mean that fishermen will be aware of the construction activities and will plan their fishing activities to avoid damages or losses to their gear.

Furthermore, the FHC have in place their Policy on the Deployment of Fishing Equipment within Falmouth Harbour Area. Under this policy, the FHC try to accommodate fishing activities "without imposing unreasonable restrictions whilst regulating activities appropriately to ensure that the Harbour remains safe and free from hazards". The policy addresses of inappropriate deployment or insufficient marking of fishing gear that "is a cause of a significant number of complaints within the harbour". Therefore, the FHC have put in place a policy that "aims to provide a framework to allow those who fish for their livelihood or for recreation to undertake their activities in a way that does not affect the safe use of the Harbour by other users." The policy states "in general fisherman should avoid laying gear in such a way as it causes an obstruction in the main (buoyed) channel in the Carrick Roads or the approaches and in the immediate vicinity of charted ferry routes, small craft moorings and approaches to marinas or similar facilities. Short term deployment of gear in the main channel may be acceptable with permission provided that the intended vessel movements are monitored and gear removed in time to prevent any obstruction to the passage of a commercial vessel."

In theory, therefore, sufficient procedures are in place, or can be put in place, such that the damage or loss of fishing gear should be avoided. These procedures should be adequate for capital dredging and barge movements, but may need some review to cover the disposal of dredged material.

Impact Assessment

Given the location of the proposed new navigation channel relative to the distribution of the oyster beds and the prawn fishery to the east of Carrick Roads, and the existing navigation procedures that are in place (e.g. permission, marking), it is anticipated that the construction works due to capital dredging will have a negligible impact on fishing gear and access to fishing grounds in the lower Fal Estuary.

Given the low magnitude and spatial extent of the levels of deposition predicted by numerical modelling relative to distribution of the oyster beds and the prawn fishery to the east of Carrick Roads, it is anticipated that the predicted sediment deposition increases due to capital dredging will have a negligible impact on fishing gear and the shellfish resource in fishing grounds in the lower Fal Estuary.

Given the predicted increase of barge movements through the lower part of Carrick Roads and in Falmouth Bay relative to the distribution of the oyster beds and the prawn fishery in Carrick Roads and the crab potting, monkfish and sole grounds in Falmouth Bay, and the existing navigation procedures that are in place (e.g. permission, marking), it is anticipated that barge movements will have a negligible impact on fishing gear and access to fishing grounds in the lower Fal Estuary and Falmouth Bay.

In summary, there will be a moderate magnitude and limited spatial extent of deposition predicted by numerical modelling relative to distribution of fishing gear and fishing grounds in Falmouth Bay. Therefore, it is anticipated that the predicted sediment deposition increases due to dredged material disposal will have a localised minor adverse impact on the fishing grounds in the immediate vicinity of the disposal site (i.e. within one kilometre) and a negligible impact on the fishing grounds and fishing gear further away from the disposal site.

Mitigation and Residual Impact

In theory, the FHC's existing procedures, bye-laws and policy put in place measures to minimise the risk to of damage and loss of fishing gear. Nevertheless, given the predicted magnitude of increased vessel movements and disposal activities, it is recommended that FHC put in place additional measures for the duration of these activities, and that these measures and their delivery are devised through liaison with the fishermen and their representatives. The FHC's Marine Safety Committee has an appropriate advisory member to represent fishing industry interests and it is recommended that this person be made responsible for liaison with fishermen and other relevant stakeholders.

Firstly, prior to construction, all construction activities, vessel movements and disposal activities should be publicised to fishermen and representative organisations through the appropriate means such as Notices to Mariners and the FHC's website.

Secondly, during construction, all construction activities, vessel movements and disposal activities should be publicised through routine broadcasts on appropriate VHF channels. Fishermen should check for any known shipping movements and be aware of all shipping movements by maintaining a listening watch on relevant VHF channels because not all vessels require a pilot. To facilitate fishing safety and activities, the dredging contractor should be required to advise FHC, the Dock Master and other relevant parties of an

anticipated schedule of barge movements. This advice should be updated on a daily basis.

Thirdly, the dredging contractor should be allocated a sailing route through Carrick Roads and offshore to the disposal site to define the geographical extent of the vessel movements, and a deposition zone should be defined for the geographical extent of the sediment plume. The latter definition should consider the depth of sediment deposition relative to burial and smothering of fishing gear and fishing grounds. Based on Figures 13.6, 5.16 and 5.17, it appears that a direct sailing route and a deposition zone can be defined in Falmouth Bay. The limits of the sailing route and deposition zone should be discussed, agreed with the local fishermen as far as practicable, and communicated widely. For the period of the dredging and disposal activity, the dredging contractor will not be able to sail outside the sailing route.

Fourthly, to support the implementation of the above measures, it is recommended that FHC revises its Policy on the Deployment of Fishing Equipment within Falmouth Harbour Area with an addendum that is put into effect during the period when the dredging, barge movements and disposal activities will be taking place. The addendum will advise that no fishing and/or gear deployment takes place in the new navigation channel, in and near to the sailing route, and in and around the disposal site where significant sediment may deposit.

Given the successful implantation of the above measures, there will be a negligible residual adverse impact on fishing in terms of fishing gear and fishing grounds.

12.4.2 Impact on Commercial Fisheries from Increased Chemical Contaminant Concentrations due to Capital Dredging

As described in Sections 11.4.5 and 11.4.6, capital dredging in the western part of the new navigation channel will release sediment and the associated contaminants into the water column within the lower Fal Estuary, which may affect the wellbeing of shellfish and finfish resources exposed to this effect in terms of toxic responses, which in turn may affect commercial fisheries interests. The Falmouth and Truro Port Health Authority has expressed concerns about the implications of increased levels of TBT in the water as a result of capital dredging.

Shellfish Beds

As described in Sections 7.4.1 and 11.4.5, the scale of the impact on TBT concentrations will be limited in space (i.e. largely around Falmouth Docks and the harbour area) and time (i.e. over the duration of the capital dredge for contaminated sediment – 50 per cent of the dredging programme of c.26 weeks). Numerical modelling predicts that the extent of increased TBT concentrations occur over a wider area on spring tides compared to neap tides, and do not disperse as far as the Truro oyster fishery (see Figures 7-5 and 7-6).

In combination, the baseline TBT concentrations and the increased TBT concentrations due to capital dredging could reduce the growth of new spat, when considered against the criteria derived from Jackson (2007) (see Table 11-5). However, given the background levels already present in the lower Fal Estuary and the limited extent of TBT

dispersion, the TBT concentration increases arising as a result of capital dredging are predicted to have a low potential to impact on the Truro oyster fishery.

Mitigation and Residual Impact

As described in Section 11.4.5, the impact is temporary and reversible (i.e. baseline conditions will return following the cessation of capital dredging). Like the baseline conditions for water quality, the conditions after dredging will remain above the EQS for TBT, at least in the short-term. No mitigation measures are proposed given that the best dredging option (i.e. backhoe dredging) has been proposed to minimise impacts on water quality, and that it is recommended that the adverse nature of this impact be considered against the long-term, permanent benefits to water quality and, indirectly to shellfish resources, that are predicted to occur due to the removal of TBT from the estuarine system.

Without mitigation, there will remain a temporary minor adverse impact on shellfish resources with regard to TBT concentrations.

12.4.3 Impact on Oyster Depuration Activities from Increased Chemical Contaminant Concentrations due to Capital Dredging

As described in Sections 11.4.5 and 11.4.6, capital dredging in the western part of the new navigation channel will release sediment and the associated contaminants into the water column within the lower Fal Estuary, which may affect quality of the water extracted for oyster depuration. Falmouth Bay Oysters has expressed concerns about the implications of increased levels of TBT in the water as a result of capital dredging.

As described in Sections 7.4.1 and 11.4.5, the scale of the impact on TBT concentrations will be limited in space (i.e. largely around Falmouth Docks and the harbour area) and time (i.e. over the duration of the capital dredge for contaminated sediment – 50 per cent of the dredging programme of c.26 weeks). Numerical modelling predicts that the extent of increased total TBT concentrations occur over a wider area on spring tides compared to neap tides (see Figure 7-5), but neither tidal condition increases total TBT concentrations by 0.001µg/l at the intake. Accordingly, there will be a small magnitude of change in TBT concentrations at the intake from capital dredging: numerical modelling predicts that TBT concentrations will increase baseline water quality conditions (mean TBT concentration of 0.033µg/l around Falmouth Docks; see Table 7-4) by less than 0.001µg/l.

Shellfish Depuration

Falmouth Bay Oysters are based in the eastern part of the estate in Falmouth Docks. The business sources native oysters from the Fal Estuary and pacific oysters from other areas outside the county, depurates them, and sells them to local and overseas markets for human consumption. Water is extracted from the harbour at a point within the Docks Basin close to the Eastern Breakwater, and is pumped into storage tanks where it is passed through UV and other filters and into tanks to be used for oyster depuration. Accordingly, changes in water quality could affect the extracted water that is processed and used for depuration.

It is understood that Falmouth Bay Oysters' lease on the land they use within the docks estate is due to end and that this may require that they move from this site. If this were to occur, then there will be no impact because there will be no water extraction taking place.

If the lease is renewed and water extraction continues, then there will be a temporary minor adverse impact on oyster depuration because total TBT concentrations will increase slightly in the water in the Docks Basin. It is unlikely that this increase alone would be sufficient to change water quality conditions to the extent that water extraction would be affected. On the basis of the above assumptions and an extension to Falmouth Bay Oysters' lease, there will be a minor adverse impact on oyster depuration activities.

Mitigation and Residual Impact

If the lease is withdrawn and Falmouth Bay Oysters no longer operate at this site, then no migiation measures are required and there will be no residual impact.

If the lease is maintained and Falmouth Bay Oysters continue to operate at this site, then it is anticipated that the Falmouth and Truro Port Health Authority will monitor water quality and, if necessary, put restrictions on water intake and ensure clean water is brought in by tanker for oyster depuration. The authority's action typically applies to bacteriological water quality requirements and therefore it may be necessary for the authority's monitoring programme to be extended to cover TBT concentrations and, if so, FHC and FDEC should provide some form of support.

With monitoring and mitigation in place, a minor adverse residual impact will remain.

12.5 POTENTIAL IMPACTS DURING THE OPERATIONAL PHASE

No impacts on commercial fishing activity are anticipated as part of the operational phase.

13 MARINE MAMMALS

13.1 INTRODUCTION

This section describes the existing environment with regard to populations of marine mammals, which includes pinnipeds (seals) and cetaceans (whales, dolphins and porpoise) within the Fal Estuary and wider area of the south west coast of Great Britain (the study area). A brief description of the behaviour, distribution and estimated local population size is provided for each species which is known to occur, or which has been observed, even occasionally within the study area.

This section also details the potential impacts of the proposed schemes construction and operational phases on these populations and suggests, where appropriate mitigation or monitoring measures.

13.2 ASSESSMENT METHODOLOGY

13.2.1 Study Area

The broad-scale study area includes the south-west approaches to the English Channel. Specific reference is made to data concerning Falmouth Bay and the Fal Estuary.

13.2.2 Data Collection

Marine mammal baseline data was collected from a number of key sources including:

- Small Cetaceans in the European Atlantic and the North Seas (SCANS II);
- Atlas of Cetacean Distribution in Northwest European Waters (Reid ***et al.,*** 2003);
- JNCC Coasts and Seas of the United Kingdom, Region 11 The Western Approaches: Falmouth Bay to Kenfig (Duck, 1996; Evans,1996); and
- Sea Watch Foundation.

13.2.3 Survey

No specialist marine mammal surveys have been undertaken to inform the EIA process for the proposed Falmouth Cruise Project.

13.2.4 Assessment Techniques

The impact assessment has been undertaken on the basis of the data collected and through the findings of an extensive literature review, which includes recent studies into seal and cetacean behaviour associated with the effects of human disturbance: notably, COWRIE (Collaborative Offshore Wind Research Into the Environment) funded studies in relation to underwater noise and vibration and its effects on marine mammals (e.g. Nedwell et al, 2003; Nedwell and Howell, 2004; Thomsen et al, 2006; Nedwell et al, 2007).

The impact assessment focuses mainly on the potential effects of the proposed development on harbour porpoise and grey seal, as these are two of the most commonly occurring species within the study area. Additionally, harbour porpoise is one of the most sensitive marine mammals species to most aspects of construction related underwater

noise (Nedwell et al, 2003), therefore, any predicted impacts will be formed on a conservative scenario.

13.2.5 Assessment Criteria

The impacts have been assessed in accordance with the assessment criteria described in a number of guidance documents concerning the impacts of construction related noise on marine mammals (i.e. JNCC, 2004; JNCC, 2008).

13.2.6 Assessment of Impact Significance

The significance of predicted impacts was assessed using the classification criteria and terminology outlined in Table 1-1 in Section 1.4.3 on the EIA process.

13.3 BASELINE ENVIRONMENTAL CONDITIONS

13.3.1 Cetaceans

The south-west approaches to the English Channel are richer in cetaceans than the waters of any other part of southern Britain. Seventeen species of cetacean have been recorded along the coasts or in nearshore waters (within 60 km of the coast) of the region since 1980 (Table 13-1, Evans, 1996).

Table 13-1 Cetacean species regularly recorded in the south-west region (from Evans 1996)

Species	Status, distribution and seasonal occurrence
Fin whale ***Balaenoptera physalus***	Rare visitor to offshore waters, where it is recorded mainly along continental shelf edge at depths of 500-3,000 m between June and December
Sperm whale ***Physeter macrocephalus***	Rare visitor to offshore waters, where it is recorded mainly along the continental shelf edge at depths of 1,000-3,000 m between October and December
Harbour porpoise ***Phocoena phocoena***	Uncommon, occurring in small numbers in nearshore waters, mainly between December and March
Bottlenose dolphin ***Tursiops truncatus***	Recorded regularly only since 1990, but now the most frequently observed dolphin in nearshore waters, though generally in groups numbering 5-20 individuals. Recorded in every month of the year, but since 1990 mainly between January and April
Common dolphin ***Delphinus delphis***	The commonest dolphin in the region, but occurring mainly offshore. Peak numbers and frequency of sightings between August and January
Striped dolphin ***Stenella coeruleoalba***	Rare, but recorded annually in the western English Channel in very small numbers, mainly between September and February
Risso's dolphin ***Grampus griseus***	Uncommon, occurring in nearshore waters mainly in the months of March-April and August-September
Long-finned pilot whale ***Globicephala melas***	Present throughout the year mainly offshore, sometimes in large numbers, particularly in November and December
Killer whale ***Orcinus orca***	Rare, occurring mainly between August and November

The most common near shore species in the region are bottlenose dolphin, ***Tursiops truncatus,*** harbour porpoise ***Phocoena phocoena,*** and Risso's dolphin ***Grampus griseus.*** Offshore, the species most frequently seen are the common dolphin ***Delphinus delphis*** and the long-finned pilot whale ***Globicephala melas*** (Evans, 1996). These tend to be most commonly observed in areas of prominent headlands and bays, such as at the Lands End peninsula, Penzance Bay and St Ives Bay.

Cetacean species are protected under Annex IV of the Habitats Directive because they are either endangered, vulnerable or rare. Harbour porpoise and bottlenose dolphin are also listed under Annex II of the Habitats Directive, which requires Member States to designate areas (e.g. SACs) essential to their life and reproduction to ensure their conservation. Both harbour porpoise and bottlenose dolphin are found within the Fal and Helford SAC and form interest features of the site, however, the site is of limited importance to both species and consequently they have been assessed as a D grade interest features.

Amendments to the Conservation (Natural Habitats &c.) Regulations 1994 came into force on the 21st of August 2007. The amendments provide a much more strict interpretation of the term "disturbance" and, under Regulation 39 makes it an offence to:

"***(b) deliberately disturb wild animals of any such species in such a way as to be likely significant to affect:***

(i) the ability of any significant group of animals of that species to survive, breed, or rear or nurture their young; or

(ii) the local distribution or abundance of that species."

The significance of Regulation 39(b) to coastal development lies in (b)(ii). Central to the effectiveness of the currently accepted approach to marine mammal mitigation is the use of acoustic deterrents and soft start pile driving to encourage the movement of marine mammals outside of an area in which they would otherwise be disturbed in line with (b)(i). Therefore, mitigation that encourages marine mammals to leave an area is, in effect, deliberate disturbance that will cause a change in the local distribution and abundance of the species and should be considered an offence under Regulation 39(b) (ii).

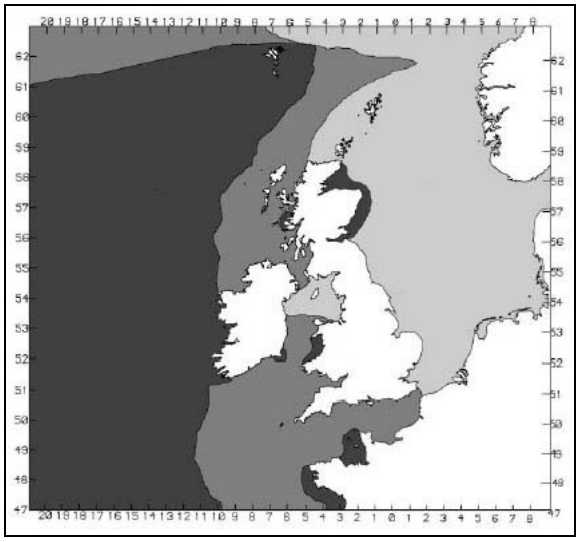
JNCC (2008) have produced draft guidance (with the final version currently being considered) on the new regulations on the deliberate disturbance of marine European Protected Species (cetaceans, turtles and Atlantic sturgeon) and provides its interpretation of what constitutes a "significant" group and explains the "disturbance offence" in greater detail. In summary, significant disturbance is defined as an event that causes an ecological impact. The Commission's guidance further states that "any disturbing activity that affects the survival chances, the breeding success or the reproductive ability of a protected species or leads to a reduction in the occupied area should be regarded as a disturbance in terms of Article 12".

Given the potential implications of the Regulations, impacts have been assessed under the assumption that any marine mammal species that could be present within the study area are present within the study area, and mitigation will be identified accordingly.

Bottlenose Dolphin

Bottlenose dolphin, ***Tursiops truncatus*** are the most commonly occurring species of the inshore cetaceans in the study area. The dolphin commonly forms groups of 2-25 animals, usually occurring within 10km of land, although they do also occur in offshore waters. The greatest numbers recorded in the south-west tend to be between January and April, although some animals are present near the shore year round (Reid ***et al***., 2003, Evans 1996, Figure 13-1).

Figure 13-1 Bottlenose dolphin distribution around the UK and adjacent northern European waters from Sea Watch Foundation data (www.seawatchfoundation.org.uk)



Status: Regular, common or fairly common (dark shading); Occasional (intermediate shading); Casual/Absent (light shading)

Since 1990, bottlenose dolphin have been reported nearshore in the southwest in every month, with most sightings records coming from prominent headlands and bays such as Penzance Bay, the Land's End peninsula and St. Ives Bay (Evans, 1996). The dolphin feed on a wide variety on bottom dwelling and mid-water fish, as well as cephalopods and shellfish.

Bottlenose dolphin are also occasionally observed within Falmouth Bay, with a group of nine individuals recently sighted (13th October 2008) (Sea Watch recent sightings data, 2008). Surveys undertaken by Marine Research in October 2007, recorded 13 bottlenose dolphins along a transect from Fowey to Falmouth on 4 October (www.marineresearch.co.uk).

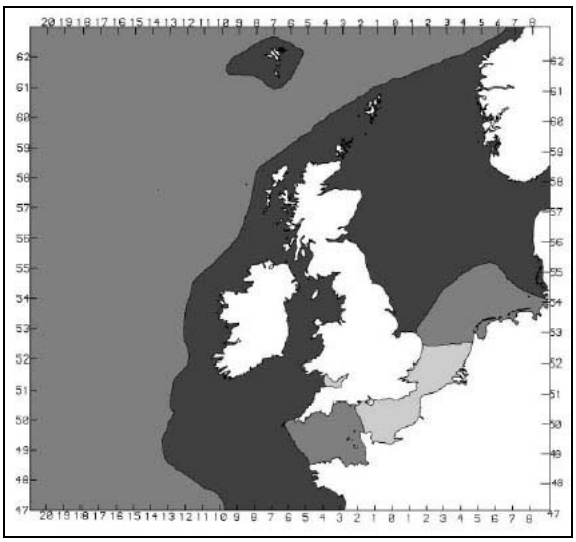
Harbour Porpoise

Harbour porpoise ***Phocoena phocoena*** are the smallest of the cetacean species found along the south west coast (Reid ***et al***., 2003). Typically, they occur in small groups of one to three animals and are mainly confined to shelf waters, although sightings have occurred in deep water (Reid ***et al***., 2003).

The diet of harbour porpoise comprises of a wide variety of small fish, such as small gadoids, whiting, poor cod, sprat, sandeel, herring, saithe, pollack, dab, flounder and sole, dependant on the time of year and location.

Although breeding can commence as early as March, the main season occurs between May and August, with a peak in June. The south-west and in particular the west Cornish coast, represents an important area for the species, particularly during the summer months of May and June (Evans, 1996, Goodwin and Speedie, 2008) (Figure 13-2). The south-west was estimated to have a population of 163 during these peak months. This estimate is however likely to be an underestimate for the region, as it is likely that the small population is either widely spread or distributed offshore (Goodwin and Speedie, 2008).

Figure 13-2 Harbour porpoise distribution around the UK and adjacent northern European waters from Sea Watch Foundation data (www.seawatchfoundation.org.uk)



Status: Regular, common or fairly common (dark shading); Occasional (intermediate shading); Casual/Absent (light shading).

Small Cetaceans in the European Atlantic and the North Seas (SCANS) II project was a major international collaborative programme, conducted in the European Atlantic and the North Sea, designed to generate precise and unbiased abundance estimates of small cetaceans by boat and aircraft based surveys in 2005. The study area falls under area B, which covers the channel and the majority of the south coast of England. West of The Lizard peninsula falls under area P, which covers the southern Irish Sea and the Bristol Channel and is likely to give a better indication of cetacean numbers in the study area. Shipboard surveys of area P, recorded 79,468 harbour porpoise individuals in 2005, the highest of any area surveyed, aerial surveys of area B recorded 40,927 (Macleod 2006).

Acoustic monitoring of Falmouth Bay and the Fal Estuary undertaken between June 2004 and March 2006, recorded regular use of the bay and very low level use of the estuary by harbour porpoise (Cornish Wildlife Trust, 2006). T-PODs (now called C-PODs) were deployed at twelve different sites in the Tamar and Fal Estuaries and within Falmouth Bay. Porpoise were regularly detected in Falmouth Bay (on 80% of days), but only on two occasions within the Fal Estuary. Large levels of boat sonar were recorded within

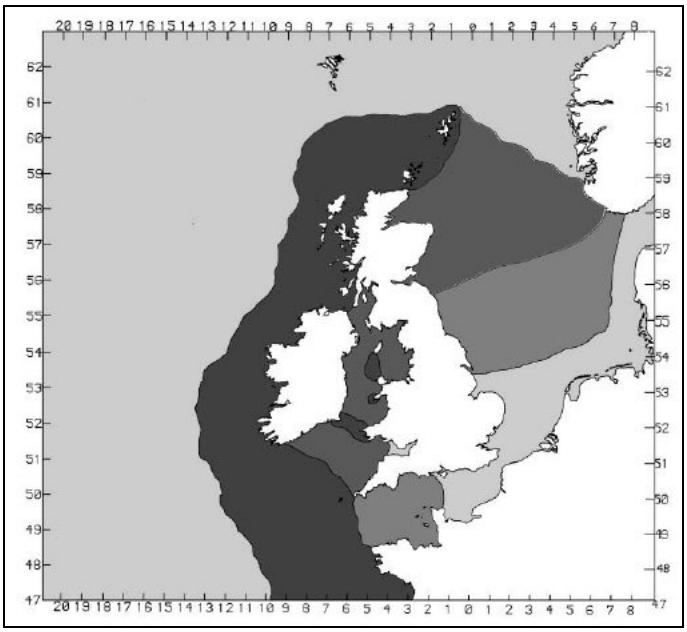
the estuary during the day and within the audible range of porpoise, this pattern of anthropogenic noise may serve to explain the low numbers of porpoise recorded within the estuary during the study (Cornish Wildlife Trust, 2006).

Risso's Dolphin

Primarily a warm water species, Risso's dolphin, ***Grampus griseus*** is a relatively large dolphin (around 3.5m in length), that typically forms groups of 6-12 individuals, off the coast of the UK (Reid ***et al***., 2003). The dolphins are sighted fairly regularly in the south west, with most sightings occurring in near shore waters between March and April and August to September (Evans, 1996, Figure 13-3).

Risso's dolphin are pelagic, mostly occurring seaward of the continental slope, where they feed mainly on a diet of cephalopods, although small fish are also taken.

Figure 13-3 Risso's dolphin distribution around the UK and adjacent northern European waters from Sea Watch Foundation data (www.seawatchfoundation.org.uk)



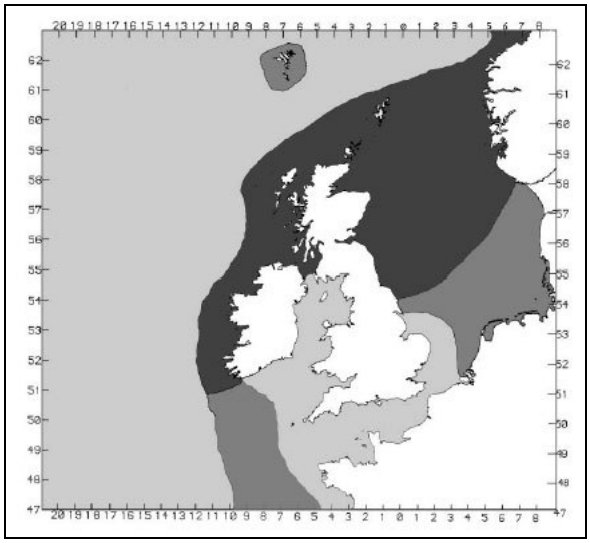
Status: Regular, common or fairly common (dark shading); Regular, uncommon (fairly dark shading); Occasional (intermediate shading); Casual/Absent (light shading).

White-beaked Dolphin

White-beaked dolphin ***Lagenorhynchus albirostris*** are a large, robust dolphin growing up to 3 metres in length. The dolphin is a species of the continental shelf and favours the cool, temperate and sub-arctic waters of the north Atlantic, rarely visiting the waters around the south west coast (Figure 13-4).

White-beaked dolphin feed on a variety of prey including cod, whiting, hake, haddock, cephalopods and sometimes crustaceans.

Figure 13-4 White-beaked dolphin distribution around the UK and adjacent northern European waters from Sea Watch Foundation data (www.seawatchfoundation.org.uk)

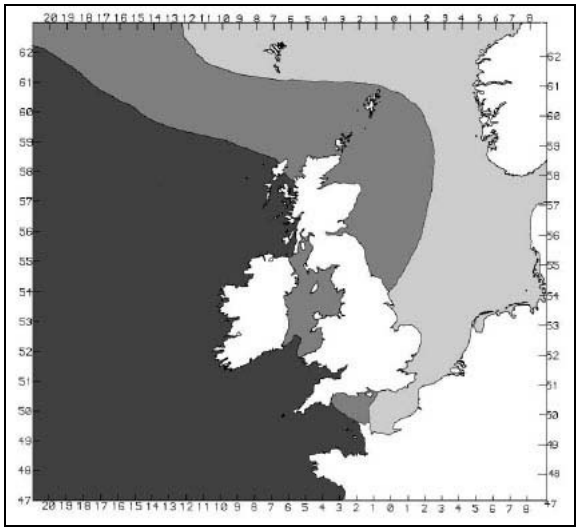


Status: Regular, common or fairly common (dark shading); Occasional (intermediate shading); Casual/Absent (light shading).

Common Dolphin

Common dolphin ***Delphinus delphis*** are the commonest dolphin to occur in the offshore waters of the south west, where they typically form groups of 6 to 10. Their numbers are typically concentrated in the Celtic Sea and western approaches to the Channel and off southern and western Ireland (Figure 13-5, Reid ***et al***., 2003). Their diet comprises a wide range of small fish and squid.

Figure 13-5 Common dolphin distribution around the UK and adjacent northern European waters from Sea Watch Foundation data (www.seawatchfoundation.org.uk)



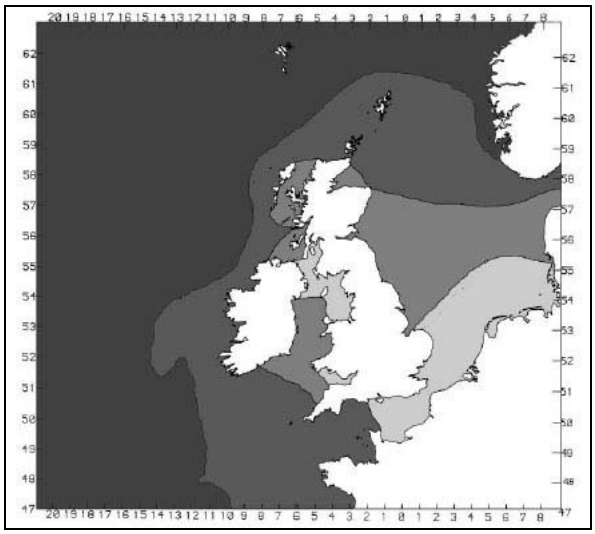
Status: Regular, common or fairly common (dark shading); Occasional (intermediate shading); Casual/Absent (light shading).

Peak numbers and frequency of sightings occur in the region between August and January (Evans, 1996). SCANS II surveys of area P (the southern Irish Sea and Brittany coast) recorded 19,650 individuals in 2005 (Macleod 2006).

Long-finned pilot whale

The long-finned pilot whale ***Globicephala melas*** occurs mainly offshore, in deep waters (200-3,000m), although it is present in the south west for most of the year. Pilot whales appear to be wide-ranging, with no specific location favoured nearshore, as they are more concentrated along the continental shelf edge, although most sightings occur in November and December (Evans, 1996, Figure 13-6).

Figure 13-6 Pilot whale around the UK and adjacent northern European waters from Sea Watch Foundation data (www.seawatchfoundation.org.uk)



Status: Regular, common or fairly common (dark shading); Regular, uncommon (fairly dark shading); Occasional (intermediate shading); Casual/Absent (light shading).

Pilot whale feed mainly on squid, although some fish such as mackerel and shrimps are also taken.

13.3.2 Seals

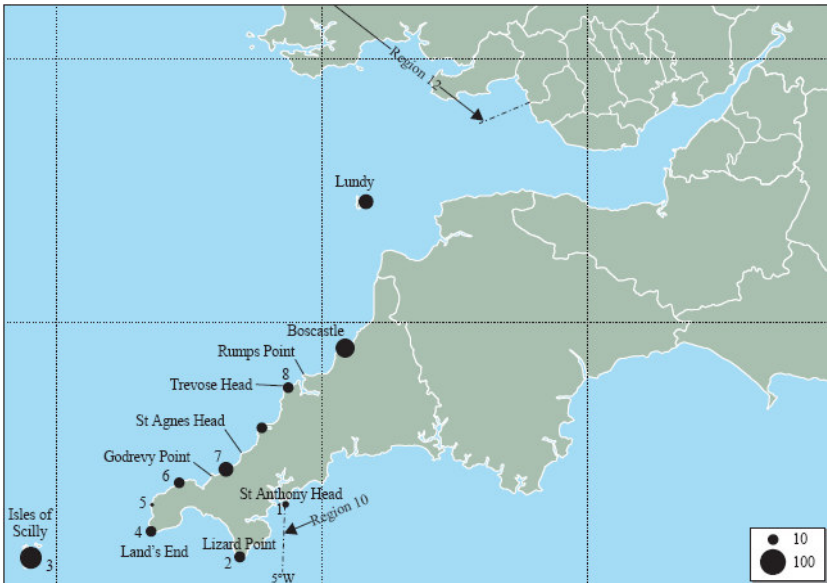
Two species of seal are known to breed around the UK, common or harbour seals ***Phoca vitulina*** and grey seals ***Halichoerus grypus***. There have been no recent, confirmed sightings of common seals in the Cornish region, or in the south west of England in general. Grey seals, although not abundant along the Cornish coast, do form important features at a number of sites in the south west, such as at the Isles of Scilly Complex SAC.

The grey seal is the larger of the two species and is found across the North Atlantic Ocean and the Baltic Sea. In Europe, grey seals come ashore on remote islands and coastlines to give birth to their pups in the autumn (July to November in the south-west), to moult in spring, and at other times of the year to haul out and rest between foraging trips to sea.

Grey seals feed mostly on fish that live on or close to the seabed. In the UK their diet comprises primarily of sandeels, whitefish (cod, haddock, whiting, ling), and flatfish (plaice, sole, flounder, dab) but varies according to availability. Tracking of individual seals has shown that they can feed up to several hundred kilometres offshore during foraging trips lasting several days. Individual grey seals based at a specific haulout site often make repeated trips to the same region offshore, but will occasionally move to a new haulout and begin foraging in a new region.

The southwest region produces approximately 0.5% of the grey seal pups born in Great Britain. The main grey seal breeding sites in the region are on the Eastern Isles, the Norrard and Western Rocks in the Isles of Scilly (41% of pups born in the region), around Boscastle (20%) and on Lundy (10%). Smaller sites are located around Lizard Point, Land's End and along the north Cornwall coast (Clark 1977; Willcox 1986, 1987, cited from Duck, 1996). These and important non-breeding haul-out sites are shown on Figure 13-7 below.

Figure 13-7 Grey seal pup production. Circles represent the number of pups born along sections of the coast from Duck, 1996.



Both grey and common seal are protected under Annex II of the Habitats Directive, which requires Members States to designate SACs for their conservation. Grey seal are found within the Fal and Helford Estuaries SAC and form an interest feature of the site, however, the site is of limited importance to the seals and consequently they have been assessed as a D grade interest feature.

Grey and common seals are also listed on Annex V of the Habitats Directive, which requires their exploitation or removal from the wild to be subject to management measures. These measures are provided for within national legislation.

Both grey and common seal are listed under Appendix III of the Bern Convention. This appendix requires appropriate and necessary legislative and administrative measures to ensure the protection of the listed species. Any exploitation of wild fauna must also be regulated in order to keep the populations out of danger.

The Conservation of Seals Act 1970 provides for closed seasons, during which it is an offence to take or kill any seal except under licence or in certain particular circumstances. For grey seals, the closed season is from 1 September to 31 December, and for common seals it is from 1 June to 31 August.

13.4 POTENTIAL IMPACTS DURING THE CONSTRUCTION PHASE

13.4.1 Impact of Noise Disturbance to Marine Mammals

Marine mammals and in particular cetaceans, are sensitive to underwater noise. Cetaceans utilise the perception of sound as their primary sense for communication, navigation and orientation. Intraspecific variation in sound perception is high and, accordingly, so is the response of individual species to sound stimuli. Audiogram data indicates that harbour porpoise are responsive at frequencies from 100Hz to 170kHz (Parvin ***et al***. 2006). Peak hearing sensitivity occurs over the frequency range from 20kHz to150kHz (Parvin ***et al***., 2006, from studies by Kastelein, 2002). Seals, such as the grey seal, hear better at low and mid-frequency ranges (frequency range from 100Hz to approximately 5kHz), however their hearing is not as sensitive as harbour porpoise at a very high frequency (Kastak and Schusterman 1998, cited from Parvin ***et al***., 2006).

Underwater noise can have a severe effect on marine mammals in the immediate vicinity of high-level sources (Nedwell, Langworthy and Howell, 2003). As the distance from the source increases the noise will decrease and its effects will diminish. The effects of noise on marine mammals can be classed into three groups and include:

- primary effects; such as immediate or delayed fatal injury of marine mammals near powerful sources, such as explosive blasts underwater (above 130dB$_{ht}$);
- secondary effects; such as injury (including temporary hearing threshold shift), or deafness, which may have long-term implications for survival (90-130dB$_{ht}$); and
- tertiary (behavioural) effects; such as avoidance of the area or masking of sounds, which may have significant effects where the man made source is in the vicinity of breeding grounds, migratory routes or feeding areas (above 90dB$_{ht}$).

Commonly observed cetacean behavioural responses to underwater noise include the cessation of all vocalisation, deviation from course and temporary abandonment of an area. Whilst behavioural responses that cause deviation away from a source of noise impact are advantageous in terms of avoidance of potential injury, movement out of a zone of auditory damage may not always be possible, especially if the source of noise is sudden, loud and unpredictable. In addition, forced behavioural responses may have an adverse impact upon particularly vulnerable individuals (e.g. pregnant females) or if an area is important for breeding or feeding.

During the construction phase of the proposed scheme there are likely to be a number of sources of underwater noise and vibration, principally during piling, drilling and dredging operations.

Section 2.3 provides a description of the proposed construction phase. This is likely to include the placement into the seabed of a number of tubular 750mm steel piles (over 60) and grouted raking piles. The grouted raking piles will be installed with a specialist drilling rig. The tubular piles will be driven into the underlying rock by an impact hammer,

operating from marine plant (i.e. a jack up barge), with piling operations anticipated to last for 13 weeks in total. Construction in all is anticipated to last for a total of 13 months. Dredging operations will utilise two backhoe dredgers over a period of approximately 26 weeks.

In terms of noise disturbance, pile-driving activities are of particular concern as they generate very high sound pressure levels and are relatively broad-band (20Hz to >20kHz). Consequently, noise associated with piling is loud, travels a great distance and is heard by a number of species including marine mammals. Studies investigating noise levels associated with pile (approximately 4m diameter) driving operations in offshore wind farm construction have measured noise levels that are capable of causing injury in marine mammals within hundreds of metres of the source. Significant avoidance reactions have been recorded within 10km, and audible levels up to hundreds of kilometres from the source (Thomsen ***et al***., 2006, Nedwell ***et al.,*** 2007). A similar scale of impact would not be anticipated with the proposed Falmouth Cruise Project due to the smaller diameter piles (750mm) proposed for piling operations.

Studies suggest that a number of factors affect piling generated noise and consequently the zone of impact, including pile diameter, local geology and bathymetry (Nedwell and Howell, 2004). Monitoring undertaken for marine works at Southampton Docks recorded a Source Level of approximately 194 dB re 1 µPa, with a Transmission Loss rate N_a of about 0.15 dB per metre (Nedwell ***et al.,*** 2003) associated with pile driving operations. To species such as marine mammals that hear within the noise ranges produced by pile driving, this would represent a total attenuation to 0 dB at 1,293 metres, or over one kilometre, and at a sound level that is aversive (90 dB) at a distance of 600 metres from the source.

Few studies have focussed directly on the noise levels associated with dredging operations. The data that does exist suggests that noise from suction and hopper dredgers is audible to cetacea several kilometres from the source (Nedwell and Howell, 2004). Behavioural reactions such as avoidance would be expected at close range to the source, where the sound level would be above background levels.

As discussed in Section 13.3, Falmouth Harbour and the Fal Estuary are of limited importance for marine mammals, although harbour porpoise, bottlenose dolphin and grey seal are occasionally recorded within the study area. Given the developed nature of Falmouth Harbour and the number of large commercial vessels using the water, existing underwater noise levels are anticipated to be high compared to further offshore and within the adjacent Falmouth Bay. Pile driving operations are anticipated to last for approximately 13 weeks and during this time it is likely that any marine mammals using the harbour and the immediate areas of the surrounding Fal Estuary would be excluded at least 600 metres from the source. However, if any marine mammals are within the immediate vicinity of pile driving operations they could be injured.

It is not anticipated that any marine mammals within the surrounding areas of Falmouth Bay would be impacted by the construction activities in Falmouth Harbour, as construction related noise would attenuate to levels below levels that are likely to illicit behavioural reactions (such as avoidance) over this distance. Also, given the existing noise levels within Falmouth Harbour, it is not anticipated that dredging operations will significantly impact marine mammals, although any within the immediate vicinity of dredging operations are likely to be disturbed.

Overall, significant noise disturbance and associated injury to marine mammals is only likely to occur if marine mammals are present in the vicinity of Falmouth Docks while pile driving is taking place to construct the cruise quay. While existing marine mammal distribution data indicates that their presence is unlikely, given the environmental sensitivity of these species there is the risk that noise disturbance and associated injury could lead to a moderate adverse impact.

Mitigation and residual impact

Two mitigation measures are typically employed to reduce the risk of piling related noise impacts on marine mammals. These are:

- soft start of piling works; and
- use of a Marine Mammal Observer (MMO).

Soft start is a commonly applied mitigation measure for a range of piling activities and is recommended by JNCC (2008). Soft start involves commencement of piling at a level well below full power, in order to avoid introducing sudden high peak pressure noise. This can be achieved by 'dry firing' the hammer, which involves raising and dropping the hammer without compression. Such measures can reduce noise levels by around 50%. Following the initial 'soft start', the power and frequency of blows can be progressively increased over a period of not less than 20 minutes. This allows any sensitive species to leave the area before noise levels reach a peak.

MMOs undertake a search for marine mammals 30 minutes prior to the start of pile driving, as recommended by JNCC (2008). A safety zone around piling activity would be implemented by the MMO, with the distance based on consultation with Natural England. In this zone, injury/mortality can still occur even when soft start methods are employed. Therefore, the MMO must be confident that no marine mammals are present within the safety zone before the initial piling works commence. If a marine mammal is sighted within the safety zone, then pile driving activities should be delayed by at least 30 minutes, until it has left the safety zone.

Consultation with the relevant bodies (notably Natural England) will establish if it may also be necessary to employ soft start and/or a MMO to ensure that marine mammals are not present in the near vicinity of the piling operations associated with the proposed Falmouth Cruise Project.

Given the limited use of the estuary and the harbour by marine mammals, it may not be necessary to employ a MMO and therefore it is proposed that the use of soft-start will be used to reduce the risk of an impact on marine mammals during piling operations. However, if further consultation with Natural England establishes that further mitigation is required, the use of a trained MMO with the establishment of a safety zone may also be put into place during piling operations. With mitigation measures agreed with Natural England and put in place during piling, there is predicted to be a localised, temporary minor residual impact associated with the proposed project.

13.4.2 *Impact on Marine Mammals from Increased Contaminant Concentrations in the Water due to Capital Dredging*

As described in Sections 7.4.1 and 7.4.2, capital dredging in the western part of the new navigation channel will release sediment and the associated contaminants into the water column within the lower Fal Estuary, which may affect the wellbeing of marine mammals exposed to this effect in terms of toxic responses.

Elevated concentrations of contaminants such as TBT, metals and organic substances (i.e. PCBs, PAHs) can be of concern because of their toxicity, environmental persistence and tendency to bioaccumulate in living organisms, particularly in apex predators such as marine mammals. TBT is known to damage the immune and hormonal systems of marine mammals (Nakata ***et al.,*** 2002, Strand ***et al.,*** 2005, Frouin ***et al.,*** 2008). Studies on terrestrial mammals also suggest that TBT and other butyltin compounds may also affect hearing capabilities in mammals, including marine mammals, which may result in causing strandings and vessel collisions, particularly in cetaceans, which rely on sound to navigate (Song ***et al.,*** 2005).

Contaminant increases are described in Section 7.4.1. Only TBT increases are of a magnitude that affects water quality conditions with respect to the requirements of the DSD, and these increases are only experienced in the lower Fal Estuary (see Figure 7-5). The scale of the impact on increased TBT concentrations will be limited in space (i.e. largely around Falmouth Docks and the harbour area) and time (i.e. over the duration of the capital dredge for contaminated sediment – 50 per cent of the dredging programme of c.26 weeks). In addition, the impact of increased TBT concentrations needs to be put into the context of the baseline conditions (see Section 7.3.1) where TBT is already present at concentrations exceeding the EQS and, accordingly, capital dredging will make a bad situation worse (rather than making a good situation bad).

It is not anticipated that the wider area of the Fal Estuary or Falmouth Bay will be affected by the mobilisation of contaminants associated with dredging operations and as the majority of marine mammals forage offshore and not within the confines of the harbour area where levels are likely to be most elevated during dredging operations, and given the area's limited importance for marine mammals, the impact associated with contaminants mobilised during dredging is considered a localised, short term minor adverse.

Mitigation and residual impact

The impact is temporary and reversible (i.e. baseline conditions will return following the cessation of capital dredging). Like the baseline conditions for water quality, the conditions after dredging will remain above the EQS for TBT, at least in the short-term. No mitigation measures are proposed given that the best dredging option (i.e. backhoe dredging) has been proposed to minimise impacts on water quality, and that it is recommended that adverse nature of this impact be considered against the long-term, permanent benefits to water quality and, indirectly on marine mammals, that are predicted to occur due to the removal of TBT from the estuarine system (see Section 7.5.1).

Without mitigation, there will remain a temporary minor adverse impact on marine mammals with regard to TBT concentrations.

13.4.3 Potential Collision Risk due to Increased Construction Vessel Numbers

Vessel movements and marine mammal activity in shared waters can lead to collisions. In the case of the Falmouth Cruise Project, construction activities will lead to an increase in vessel movements within Falmouth Harbour and Falmouth Bay, and this could increase the risk of collision with marine mammals (over the existing level of risk).

Collisions (i.e. ship strikes) are a known cause of mortality and injury for marine mammals. Many species of whales and dolphins may be vulnerable to collisions. While most reported incidents concern large whales and in particular fin whales (29.2% of recorded collisions), collisions with smaller species also occur (van Waerebaek ***et al***., 2007; Waerebeek and Leaper, 2008). Resultant injuries tend to fall into two categories, lacerations from propellers and blunt traumas from impact with the hull. Blunt traumas can result in fractured skulls, jaws or vertebrae, in conjunction with large haematomas (IWC, 2006). It is possible that if these injuries do not cause the immediate death of the animal they will leave it vulnerable to death from secondary infections, complications or predation. From the UK, reports have been received of direct observation of collisions with minke whale, sperm whale and long-finned pilot whale and evidence of non-fatal propeller cuts observed in killer whale, bottlenose dolphin, short-beaked common dolphin, white-beaked dolphin and harbour porpoise (Evans, 2003).

Factors influencing collision risk

The main drivers that are thought to influence the number and severity of ship strikes are reviewed in Wilson ***et al***. (2007):

- vessel type and navigation speed;
- underwater noise – high levels of ambient noise can result in difficulty in detection of approaching vessels;
- weather conditions and time of navigation – this can affect the ability of crew to locate whales and add to ambient noise; and
- marine mammal behaviour – which is species specific; juvenile and sick individuals appear to be more vulnerable; and
- marine mammal activity – an individual may be distracted by feeding or social interactions.

In terms of vessel characteristics, Laist ***et al*** (2001) concluded that vessels over 80 metres in length cause the most severe or lethal injuries and that serious injuries rarely occur to marine mammals if struck by vessels travelling at speeds below ten knots while most lethal and severe injuries occur to marine mammals if struck by vessels travelling at more than 14 knots. A summary of the IWC global database of collision incidents reported that serious injury and death in a range of cetaceans was most commonly recorded associated with vessels travelling at speeds between 15 to 45 knots and between 100 and 250 metres in length (Waerebeek and Leaper, 2008). The probability of lethal injury to whales drops below 0.5 at 11.8 knots and 0.17 at 8 knots (Vanderlaan and Taggart, 2007). Seasonal speed limits of ten knots have been placed along various areas along the eastern coast of the US to reduce ship strikes to endangered right whales between 2008 and 2013 (NOAA, 2008).

Vessel noise is dominated by propeller noise, except when operating at very low speeds, where hull radiated noise dominates. Documented source levels range from 152dB re 1µPa @ 1m for a small vessel with an outboard engine, to 170 dB re 1 µPa @ 1 m for a

25 m tug pulling an empty barge, to 192dB re 1µPa @ 1m for a large container ship (Nedwell and Howell, 2004), between a range of 2kHz and 20kHz (Evans, 2008). In addition to engine generated noise, vessels may also employ active sonar, which may range from high (>10kHz) to low intensity (<1kHz).

Behavioural reactions to boat noise from marine mammals can include both avoidance (e.g. diving to deeper water) and attraction (e.g. turning into the path of a vessel) and depend upon a number of unpredictable factors; including species, age class, behavioural state at the time of the encounter, the sound properties of the approaching vessels, and other factors (ACCOBAMS, 2005).

In summary, research into collision risk between commercial shipping and marine mammals (whales) in the Mediterranean Sea indicates that collision risk is highest where:

- marine mammals (particularly large whale species) are abundant; and
- movements of large and fast moving vessels (e.g. ferries) are high (ACCOBAMS, 2005).

Risk assessment

A number of marine vessels and plant are likely to be necessary during construction of the proposed Falmouth Cruise Project, including stationary pontoons for backhoe dredgers and piling equipment, self-propelled barges for clean dredged material, a tug and dumb barges for contaminated dredged material, and other vessels for delivering construction plant and materials to site.

The majority of additional vessels arising from the proposed Falmouth Cruise Project are likely to be self-propelled hopper barges. These vessels may be purpose built equipment or former dredgers. For example, Van Oord's trailing suction split hopper dredger, ***Pelican***, is used as a self-propelled barge and has a similar hopper volume to the self-propelled barge identified in the description of the construction phase (i.e. 1000m^3; see Section 2.3.4). The ***Pelican*** has a hopper volume of 965m^3, is 63m in length, and is capable of travelling up to speeds of nine knots when fully loaded (although this speed will be restricted within the harbour to eight knots and will be lower on approach to and within the disposal site). For comparison, Van Oord has a dedicated self-propelled barge on order. This vessel will have a larger hopper volume than identified in the description of the construction phase (i.e. 2,850m^3 rather than 1000m^3), will be 96m in length and will travel at a speed of up to 10.5 knots when fully loaded.

In terms of vessel numbers, Falmouth Harbour is a busy port with around 300-500 commercial vessel movements per quarter (see Figure 14-3). Vessel movements will be increased during construction primarily due to some 600 barge movements between the new navigation channel and the offshore disposal site which will be required to dispose of 600,000m^3 of dredged material (assuming the use of barges with a hopper capacity of 1000m^3). This equates to approximately three to four round trips per day assuming a six month continuous working period. Given that there have been between 300 and 500 commercial vessel movements per quarter over the past three years, barge movements associated with the Falmouth Cruise Project, have the potential to double the number of commercial vessel movements. Given the findings presented in Wilson et al (2007), the collision risk associated with increased vessel numbers is predicted to be moderate.

In terms of vessel speed, Falmouth Harbour Byelaws restrict speed within the harbour limits to eight knots. As shown in Figure 2-5, the harbour limits extend into Falmouth Bay and potentially cover most of the sailing route to the disposal site. However, assuming the most direct sailing route is used, some of it there would be beyond the speed restricted area and so vessel speeds could exceed eight knots. However, speed restrictions and the published speeds of the barges described above suggest that speeds greater than 10 knots are unlikely. Given the findings of Laist et al (2001), Vanderlaan and Taggart (2007) and management practices of NOAA (2008), the collision risk associated with vessel speed is predicted to be low.

In terms of vessel size, the lengths of the barges described above suggest that a self-propelled barge with a hopper capacity of c. 1,000m^3 would be less than 80m in length. Accordingly, the collision risk associated with vessel speed is predicted to be low.

In terms of vessel noise, each additional vessel will add to the anthropogenic underwater noise created by propeller noise from vessels underway and hull radiated noise from stationary vessels conducting works and the use of any active sonar, such as echo sounders. Accordingly, the collision risk associated with vessel noise is predicted to be moderate.

In terms of the marine mammal number and species, a variety of marine mammal species are known to occur within the study area (Section 13.3), but predominantly species of dolphin. Harbour porpoise and grey seal are regularly recorded within Falmouth Bay and bottlenose dolphin are recorded occasionally, however their use of the harbour and estuary is limited, as is other species of marine mammal use of Falmouth Bay. Consequently, the species that are likely to be encountered are likely to be less vulnerable species of seals, porpoise and dolphin rather than more vulnerable species of whales. Accordingly, the collision risk associated with marine mammal number and species is predicted to be low.

Overall, there is an overall low to moderate risk associated with the proposed Falmouth Cruise Project. The risk is considered low in Falmouth Harbour and moderate in Falmouth Bay. Risk is assessed in terms of the key factors identified in ACCOBAMS (2005): vessel movements and marine mammals. In summary:

- there will be a low to moderate risk associated with vessel movements - the risk is considered moderate where it is associated with the predicted increase in the number of vessel movements (an increase of 600 vessel movements over 6 months), but is considered low where it is associated with the expected size (<80m) and speed (<10 knots) of the additional vessels; and
- there will be a low to moderate risk associated with marine mammals – the risk is considered low / moderate where it is associated with infrequent / regular recording of marine mammals in Falmouth Harbour / Falmouth Bay, and is considered low where it is associated with porpoise, dolphin and seal species rather than whale species.

Risk management and residual collision risk

Risk management measures have been identified in ACCOBAMS (2005) to include measures associated with vessel operations (i.e. dedicated MMOs aboard or trained crew, and detection instrumentation) and measures associated with vessel navigation (i.e. speed restrictions and shipping lanes). Of these measures:

- speed restrictions of 10 knots have been applied in certain circumstances where particularly endangered whales are at risk (e.g. NOAA, 2008) and are believed to be effective at reducing risk if properly implemented (ACCOBAMS, 2005);
- dedicated MMOs and trained staff have been effective at reducing collisions off the US coast (ACCOBAMS, 2005); and
- remote detection has not been shown to give satisfactory results (ACCOBAMS, 2005).

Therefore, and subject to agreement with Natural England, it is recommended that speed restrictions of 10 knots be applied to the barges used to dispose of dredged material in Falmouth Bay. This measure should reduce the probability of a collision causing a lethal injury in line with the findings of Vanderlaan and Taggart (2007), and should be relatively straightforward to achieve since some of the sailing area will be within an area subject to a speed restriction of 8 knots and vessel speed can be monitored by the FHC.

In addition, procedures will be established to ensure that any accidental collision is reported to the relevant authorities, such as to the IWC Ship Strikes Working Group (SSWG), Natural England and the JNCC.

With the speed restriction in place along the entire sailing route to and from the offshore disposal site in Falmouth Bay, the residual collision risk is considered to be low.

13.5 POTENTIAL IMPACTS DURING THE OPERATION PHASE

13.5.1 Potential Collision Risk due to Increased Cruise Vessel Numbers

As described in Section 13.4.3, vessel movements and marine mammal activity in shared waters can lead to collisions. In the case of the Falmouth Cruise Project, more cruise calls will lead to an increase in vessel movements within Falmouth Harbour and Falmouth Bay, and this could increase the risk of collision with marine mammals (over the existing level of risk).

Cruise vessel size and number are predicted to increase as a result of the proposed Falmouth Cruise Project. In summary, there is estimated to be a three per cent per annum rise for day calls and a five per cent per annum rise for turnaround calls with the project in place, increasing from 57 to up to 98 by 2023 (see Section 2.4.4). This is an increase of up to 76 vessel movements per annum (based on an increase of 38 cruise calls per annum) against a baseline of c. 1,500 commercial vessel movements per annum (i.e. a low magnitude of increase equating to 2.5 per cent). Accordingly, the collision risk associated with vessel numbers is predicted to be low.

Maximum cruise vessel size is currently limited to 230m, but will be increased to 340m as a result of the longer cruise quay. The existing and future maximum vessel are above the length identified by Laist et al (2001) to pose a higher risk to marine mammals (i.e. 80m). Accordingly, the collision risk associated with the change in vessel size is predicted to be low.

Existing and future cruise vessel speed will be restricted to 8 knots within the Falmouth Harbour Limit and cruise vessels will usually be subject to piloting by FHC, so the speed restriction will be observed. This speed restriction is lower than the speed identified by Laist et al (2001) to pose a low risk to marine mammals (i.e. 10 knots) and much lower

than the speed identified by Laist et al (2001) and ACCOBAMS (2005) to risk a high risk to marine mammals (i.e. >14 knots). Accordingly, the collision risk associated with the change in vessel speed is predicted to be low.

Overall, there is predicted to be an overall low risk associated with the proposed Falmouth Cruise Project. The risk is considered low in Falmouth Harbour and in Falmouth Bay. Risk is assessed in terms of the key factors identified in ACCOBAMS (2005): vessel movements and marine mammals. In summary:

- there will be a low risk associated with vessel movements - the risk is considered low where it is associated with the predicted increase in the number of vessel movements (increases by c.2.5%), the expected size (remains >80m) and speed (remains <10 knots) of the vessels; and
- there will be a low to moderate risk associated with marine mammals – the risk is considered low / moderate where it is associated with infrequent / regular recording of marine mammals in Falmouth Harbour / Falmouth Bay, and is considered low where it is associated with porpoise, dolphin and seal species rather than whale species.

Risk management and residual collision risk

Risk management measures have been identified in ACCOBAMS (2005) to include measures associated with vessel operations (i.e. dedicated MMOs aboard or trained crew, and detection instrumentation) and measures associated with vessel navigation (i.e. speed restrictions and shipping lanes). Of these measures:

- speed restrictions of 10 knots have been applied in certain circumstances where particularly endangered whales are at risk (e.g. NOAA, 2008) and are believed to be effective at reducing risk if properly implemented (ACCOBAMS, 2005);
- dedicated MMOs and trained staff have been effective at reducing collisions off the US coast (ACCOBAMS, 2005); and
- remote detection has not been shown to give satisfactory results (ACCOBAMS, 2005).

Therefore, and subject to agreement with Natural England, no risk mitigation measures are recommended on the basis that cruise vessels will be subject to a speed restriction of 8 knots within Falmouth Harbour Limits, pilotage by FHC, and vessel speed can be monitored by the FHC.

In addition, procedures will be established to ensure that any accidental collision is reported to the relevant authorities, such as to the IWC Ship Strikes Working Group (SSWG), Natural England and the JNCC.

With the low numbers of additional cruise vessels and the existing speed restriction remaining in place, the residual collision risk is considered to be low.

14 NAVIGATION AND RECREATION

14.1 INTRODUCTION

This section considers navigation and recreation activities within Falmouth Harbour, the Fal Estuary and Falmouth Bay, and builds upon the scoping work and consultation with relevant stakeholders including the FHC, FDEC, St Mawes Pier & Harbour Company, and recreational clubs such as Falmouth Diving Club. Activities occurring within the vicinity of the works activities associated with the proposed Falmouth Cruise Project are described and the potential impacts of the project's construction and operation are assessed.

14.2 ASSESSMENT METHODOLOGY

14.2.1 Study Area

The study area includes Falmouth Harbour and Docks, the Fal Estuary including all the main port and marina locations, and Falmouth Bay.

14.2.2 Baseline Data Collection

Information relating to both commercial and recreational navigation within the study area was collected through by a desk review and consultation with FHC and FDEC.

14.2.3 Survey

No survey for navigation or recreation was undertaken to inform the EIA process.

14.2.4 Assessment Criteria / Technique

Assessments have been made with reference to ongoing navigation and recreational activities and the statutory and voluntary procedures that are in place to manage them.

14.2.5 Assessment of Impact Significance

The significance of predicted impacts was assessed using the classification criteria and terminology outlined in Table 1-1 in Section 1.4.3 on the EIA process.

14.3 BASELINE ENVIRONMENTAL CONDITIONS

14.3.1 Ports and Harbours

The ports within the Fal Estuary are very different.

Falmouth Docks is essentially a port that services passing vessels, including cruise vessels, and provides specialist ship repair in its dry docks. At Falmouth Docks, FDEC currently operate the County, Duchy and Queens Wharves for alongside mooring for vessels up to 230 metres in length and requiring -8mCD of water depth, and three dry docks for ship repair. Cargo handling facilities are provided and parcels of cargo in the order of 2000 tonnes are regularly handled.

Vessels can be moored at the sheltered deepwater lay-up moorings in the Carrick Roads for vessels up to 220 metres in length. These are the largest moorings offered in a single location in the UK. Vessels of any size are able to anchor in Falmouth Bay. In the eastern part of the docks, Falmouth Oil Services (FOS) operates a jetty along the eastern breakwater. Falmouth also offers the UK's largest offshore bunker station, providing a fuel bunkering service round the clock.

The Port of Truro includes Town Quay, Worths Quay / Gerras Wharf upstream near the city and Lighterage Quay downstream. It is close to the main road network of Cornwall and provides facilities for the distribution of bulk commodities albeit usually in parcels of less than 2000 tonnes. Penryn and St Mawes provide small harbour areas with little commercial trade apart from passengers.

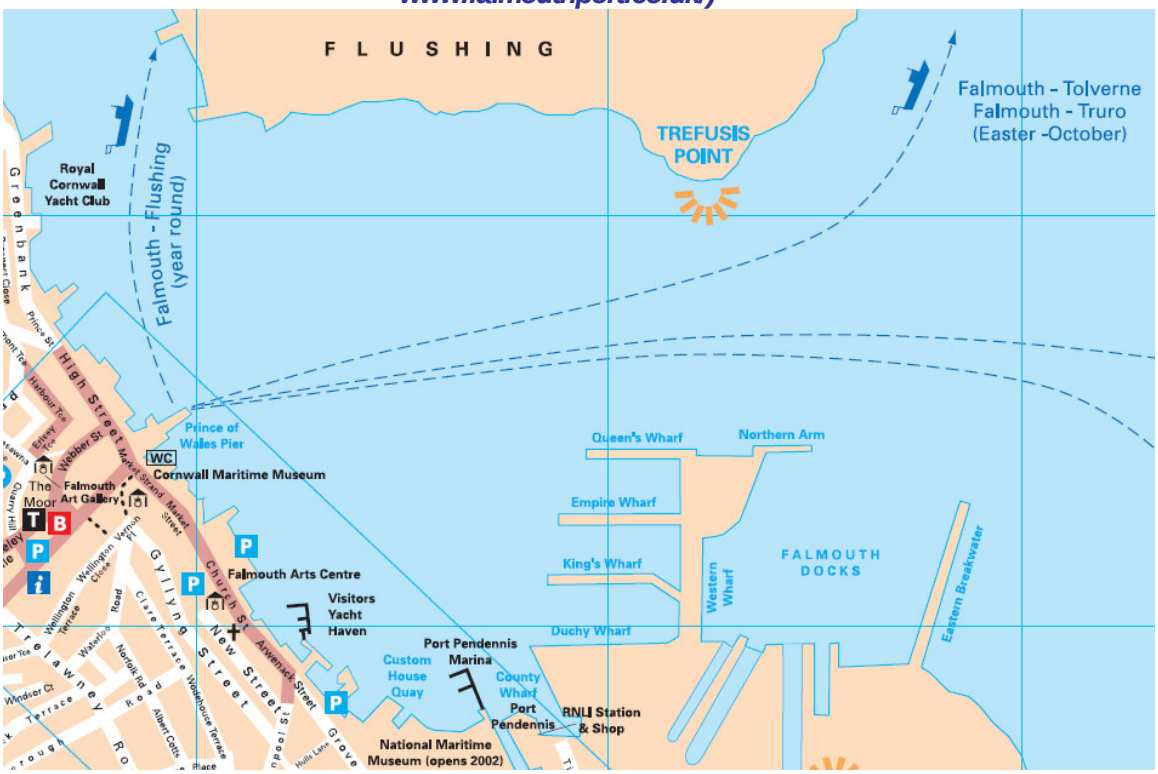
14.3.2 Passenger Services

Passenger craft operate from the various harbours. There are passenger services linking Falmouth to Tolverne and Truro (seasonal from April to October), and to Flushing and St Mawes (year round) (see Figure 14-1).

In recent years a park and float facility has started operating from Falmouth, linking Ponsharden with the town and links to St Mawes.

Various tripping vessels operate from Falmouth, principally from the Prince of Wales Pier. The Prince of Wales Pier currently has 14 pleasure craft operating from the pier ranging from small RIBs offering environmental cruises to large pleasure craft taking up to 128 people on pleasure cruises around the Fal and Helford estuaries.

Figure 14-1 Passenger Ferry Routes and Other Sites around Falmouth Harbour (source: www.falmouthport.co.uk/)



14.3.3 Marinas and Moorings

The demand for leisure moorings in the Fal Estuary outstrips supply. Currently the Fal Estuary holds approximately 4,700 leisure craft moorings; 1,500 of which are located within the Port of Truro and about 350 in Penryn.

There are a further 800 moorings and pontoon berths at Mylor Yacht Harbour and at Falmouth Marina, and a number of privately operated marinas (e.g. Port Pendennis Marina).

Falmouth Harbour

For local residents, Falmouth Harbour provides 588 deep water swinging moorings for vessels between 5m and 30m. The moorings are located within three areas (see Figure 14-2). Around Falmouth, these are situated between Custom House Quay and the Prince of Wales Pier, and between Greenbank Quay and Prince of Wales Pier. On the Flushing side, these are situated between Flushing New Quay and Kiln Quay. In addition, there are dinghy berths and a slipway at Grove Place Boat Park, and outhaul facilities for vessels up to 4.88m in length on Custom House Quay, King Charles Quay and North Quay.

For visiting vessels, Falmouth Harbour provides a boat park and slipway and a Visitors Yacht Haven for up to 100 vessels (see Figure 14-1). There are also 19 deep water moorings for single vessels, five of which can take vessels up to 80ft long.

An anchorage is available between Custom House Quay and Falmouth Docks, although vessels are required to move to facilitate shipping movements.

Falmouth Harbour also provides a fuel barge which is situated at the south end of the Visitors Yacht Haven. In 2006, the barge dispensed over 217,000 litres of diesel and 59,000 litres of petrol.

14.3.4 Sailing Clubs and Events

There are approximately 30 recreational sailing clubs in and around Falmouth Harbour. The main sailing clubs include Royal Cornwall Yacht Club, Falmouth Town Regatta, Flushing Sailing Club, St Mawes Sailing Club, Mylor Yacht Club and Restroguet Sailing Club.

There are numerous sailing events throughout the year, including the Falmouth Regatta Week, which is the largest sailing regatta in the southwest. Events take place almost every day between April and October and include village regattas, championship races, special club races, club series and offshore races. Sailing races generally take place on the weekend and during some weekday evenings in the summer. Full itineraries are published by the Port of Falmouth Sailing Association (POFSA).

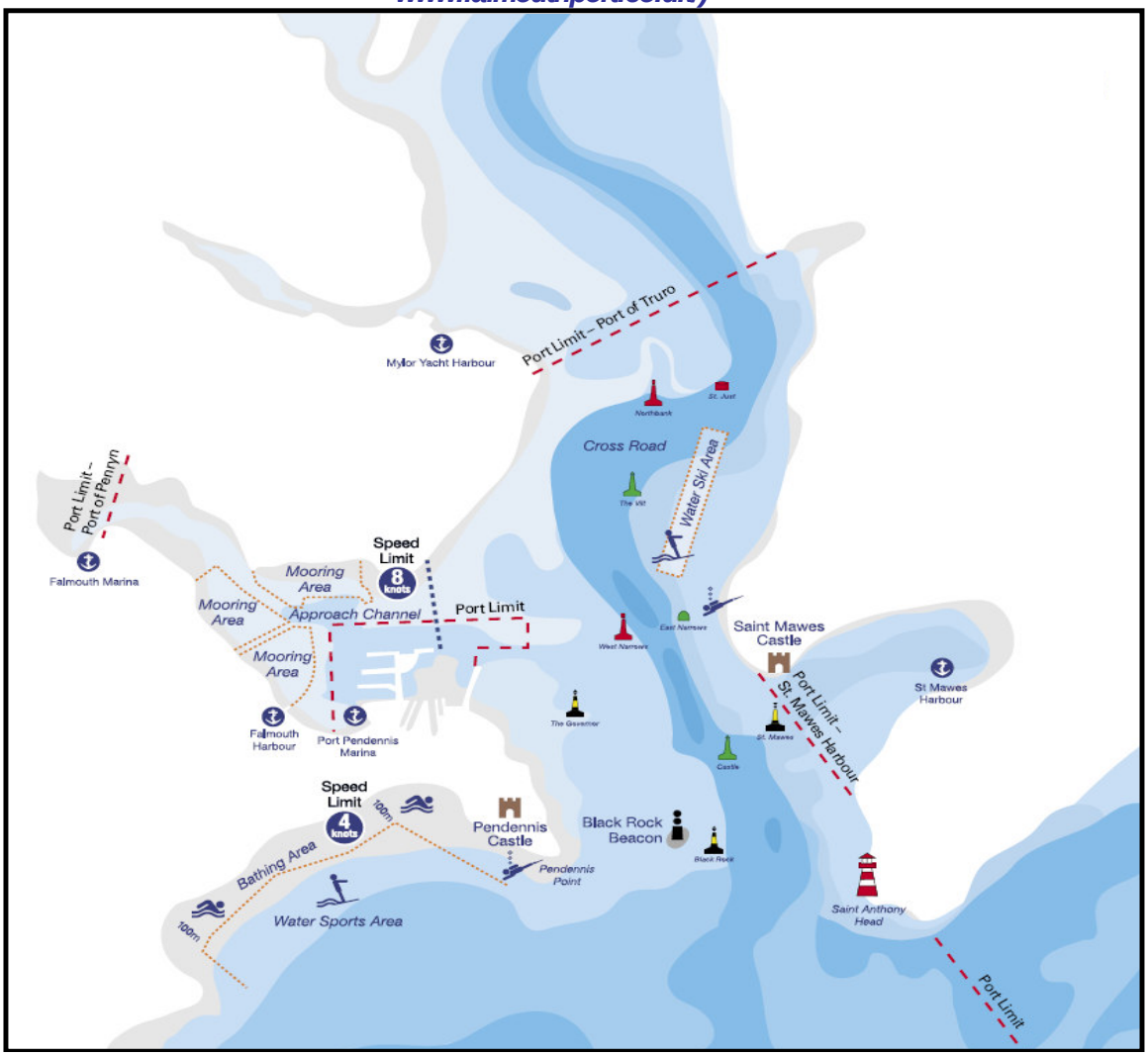
Falmouth Harbour (General) Bye-laws ensure the Harbour Master is provided with fourteen day written notice prior to a regatta, championship races or other occasions when small vessels are expected to assemble on the waters of the harbour. All events or races are conducted on courses and times approved in advance by the Harbour Master.

14.3.5 Water Sports

Water-Skiing, Aquaplaning, Kiting, Parachute Towing

Figure 14-2 shows the designated zones for a number of water sport activities in the Fal Estuary, including a marked water-ski area to the east of Carrick Roads. Vessels are advised to keep well clear of water-skiers and avoid anchoring in the designated water ski area. The Falmouth Harbour (General) Byelaws include a specific byelaw concerning waterskiing, aquaplaning, kiting and parachute towing which establishes that such activities can only be undertaken with the written permission of the Harbour Master, and only in such areas as may be designated by the Commissioners and in accordance with such conditions as may be imposed by the Harbour Master.

Figure 14-2 Port Limits and Recreational Areas in the Fal Estuary (source: www.falmouthport.co.uk/)



Diving

Diving is popular in Falmouth Bay and Carrick roads and a number of dive shops operate in the area including Cornish Divers (Falmouth), Seaways Diving (Penryn), Bay Marine (Falmouth Marina) and Falmouth Underwater Centre (Maenporth). Popular diving areas are indicated in Figure 14-2 although divers may be encountered anywhere within the harbour area. Shore dives take place from Swanpool beach, Gyllyngvase beach, castle beach, Silversteps and Pendennis Point. Dives in Falmouth Bay include the Old Walls Reef and the wrecks of the Epsilon, NG Peterson (Danish steam ship at c.25m) and Coroni River (oil tanker at c. 25m).

FHC have published a detailed protocol for recreational diving in the Falmouth Harbour and Bay area (FHC, 2004). The protocol requires that "diving activities must be planned, and carried out, in such a way that divers keep well clear of these shipping movements, and so as not to obstruct or impede any commercial activity in the Harbour Area." The protocol states that "No recreational diving is permitted in the vicinity of Falmouth Docks Wharves or Jetties or within the Docks Basin."

The protocol requires, inter alia, that divers have prepared a risk assessment taking into account the byelaws and speed limits that apply to diving activities and potential commercial shipping movements (in particular cruise ships). In Carrick Roads, divers must not surface on the east bank, and not in the main shipping channel, when diving in the East Narrow (Carrick Roads) and must plan dives so that no decompression diving occurs inside Black Rock Beacon.

The protocol requires, inter alia, that diving activities have the following level of equipment as a minimum:

- each dive boat must carry a large "A" flag capable of being seen by surface traffic in all wind conditions during diving activities;
- each diver must carry a delayed surface marker buoy (and be trained in its use); and
- each dive boat must have diver recall signals (which the divers must recognise).

Other Water Sports

Other allocated areas include the buoy-marked bathing water areas off Gyllyngvase and Swanpool beaches. These areas extend 100m off the beaches. There is a water sports area beyond this zone.

14.3.6 Angling

Recreational angling for a number of species is extremely popular in the Fal Estuary. Angling takes place all over the Fal Estuary and the Carrick Roads from shore marks and also from kayaks, which has recently increased in popularity.

Recreational boat angling generally takes place in the summer from April to October and also occurs in Falmouth Bay and offshore, including around the disposal site, with lots of offshore wreck marks and reefs providing fishing grounds.

The Fal and Helford Estuaries are notable for their localised populations of thornback rays which are an important species for recreational angling. At one time the Fal Estuary

also supported large localised populations of spotted ray and greater spotted dogfish (Environment Agency, 2004). Species such as bass, pollack, wrasse thornback ray and bull huss are all targeted. Numbers of gilthead bream have also increased and are targeted in the creeks. Flounder move inshore during the winter months and are targeted between October to January, with thornbacks and bull huss generally targeted in spring and autumn. Cod are not generally caught in the estuary and the numbers of plaice are also scarce.

14.3.7 Navigation Authorities

A number of port and harbour authorities are responsible for navigation around the Fal Estuary. Figure 14-2 shows the port limits under FHC's jurisdiction, which extend over the lower part of the Fal Estuary and out into Falmouth Bay, relative to the limits of:

- Falmouth Docks, which include the area around the wharves and the approach channel;
- Port of Penryn, which include the area of the Penryn River upstream of Falmouth;
- St Mawes Harbour, which include the area of the Percuil River upstream of the river's confluence with Carrick Roads;
- Port of Truro, which include the area of the upper part of the Fal Estuary.

14.3.8 Navigational Procedures

General Provisions

The port and harbour authorities have a duty to regulate navigation within the estuary to ensure efficient and safe operation of the port. They have the power to make bye-laws which provide general rules for navigation and the conduct of a vessel within the jurisdiction of a harbour authority. In addition to these powers, the harbour masters are able to give directions to vessels within their areas of authority in respect of when and how they may enter the harbour.

Falmouth Harbour

The approach to Falmouth Harbour is straightforward for small shallow drafted vessels with Black Rock (the main hazard) situated in the middle of the entrance to the estuary well marked by a lit beacon and a lit East Cardinal Buoy. Vessels inbound for Falmouth Harbour round the docks' wharves and can use the old observatory tower as a conspicuous skyline mark for the Yacht Haven approach. The approach to the visitors Yacht Haven is dredged to -2mCD and is very well marked using large orange triangular leading marks.

There is no Vessel Traffic Service (VTS) as such within the harbour but Falmouth Pilots operate on a 24 hour basis. Commercial vessels are requested to report arrival and departure details to Falmouth Pilot Radio via VHF.

FHC are responsible for the maintenance of all navigational aids, the sounding of channels and removal of wrecks within their harbour area. Their activities provide for the safety of all craft within Falmouth Harbour and the route to the Port of Truro or Falmouth Docks.

Speed Limits

Bye-laws state vessels are not permitted to travel at speed greater than eight knots in specified parts of Falmouth Harbour and the Penryn River (i.e. “west of an imaginary straight line drawn from the light on the Northern Arm of Falmouth Docks Basin to Trefusis Point”). In addition, there is a five knot speed limit in the Percuil River and St Mawes Harbour, St Just Creek, Restronguet Creek and Mylor Creek.

Pilotage

The Falmouth Pilotage Area is defined as the area below the level of high water that exists to landward of an imaginary line drawn between Black Head and Dodman Point. FHC provide pilotage services for the Ports of Falmouth, Falmouth Docks, Truro, Penryn and St Mawes as well as the Helford river, the Quarries on the East side of the Lizard Peninsula and the Falmouth, Gerrans and Veryan Bays.

According to FHC’s Pilotage Information (FHC, 2008), pilotage is required for the following vessels:

- all vessels in excess of 180m LOA when navigating to the north of a line drawn between Black Head and Dodman Point;
- all vessels in commercial use in excess of 30m LOA when navigating to the west of a line drawn between Rosemullion Head and position Lat 50 03.35N Long 5 01.60W (WGS 84);
- all vessels in excess of 75m when navigating to the north of a line drawn between Zone Point and Rosemullion Head and to the south of a line drawn between Messack Point and Penarrow Point or elsewhere in the Pilotage Area if navigating within 1.0 mile of the shore;
- all vessels in excess of 60m navigating to the North of a line drawn between Messack Point and Penarrow Point, or in the Penryn River to the west of a line drawn between Prince of Wales Pier and Flushing New Quay;
- all vessels navigating within the designated Pilotage Area carrying dangerous or polluting goods;
- all vessels in commercial use navigating within the Pilotage Area not equipped with corrected Admiralty Charts (or equivalent) as required to cover the entire passage;
- all vessels in excess of 50m entering or leaving a dry dock;
- all manned vessels in excess of 50m using the services of a harbour tug; and
- vessels of any size when directed by the harbour master or dock master in the interests of safety of the vessel, other vessels, persons, the port or its infrastructure.

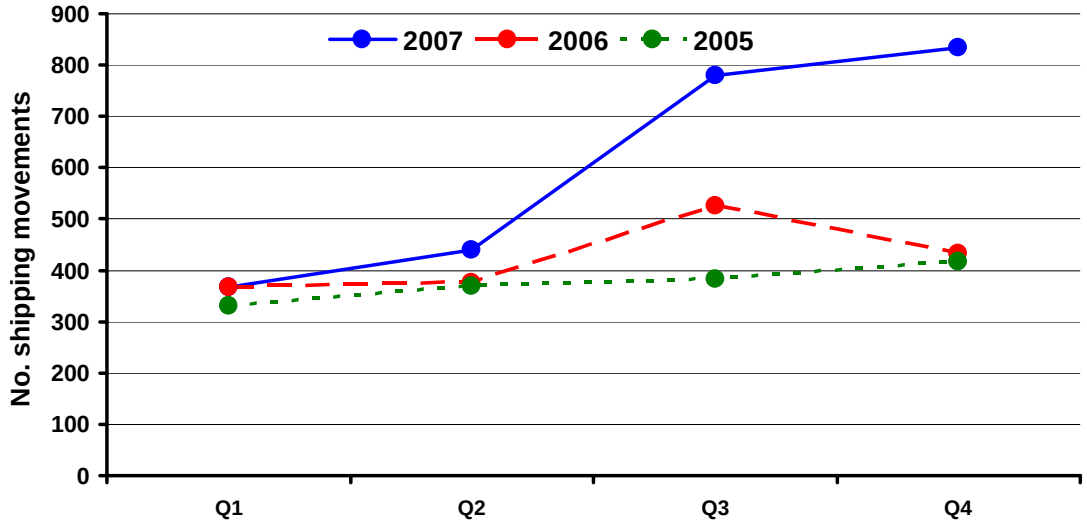
Pilotage requirements do not apply to naval vessels or to vessels of less than 20m in length or registered fishing vessels of less than 47.5m.

Piloted movements increased from 1518 in 2005 to 1665 in 2006, with 1511 pilot boat operations undertaken (FHC, 2006).

14.3.9 Commercial Vessel Movements

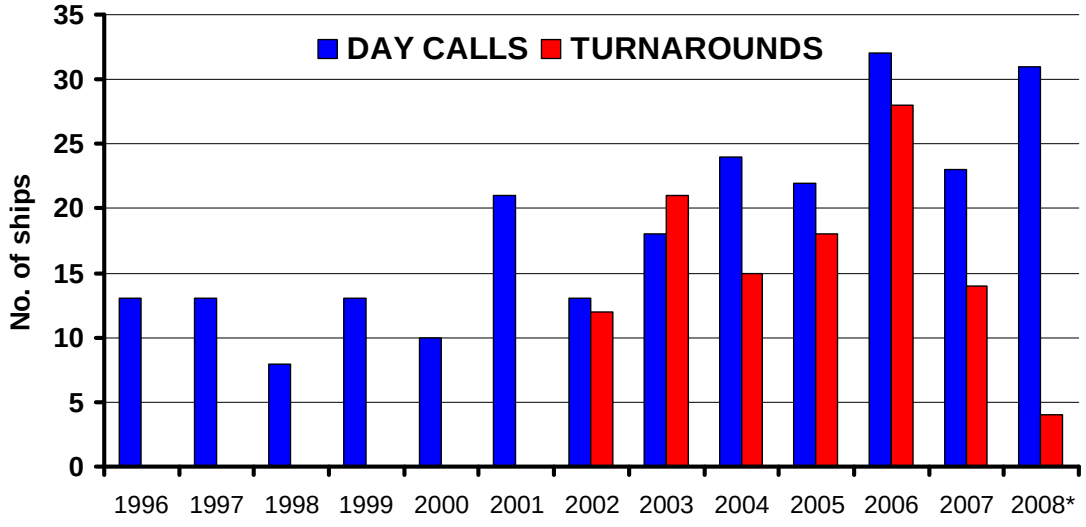
Quarterly data provided by FHC (see Figure 14-3) shows that typically there have been between 300 and 500 commercial vessel movements per quarter from 2005 to 2007, except in the latter half of 2007 when movements increased to around 800 per quarter.

Figure 14-3 Falmouth Vessel Movements by 2005-2007



Data from FDEC shows that the cruise business operating from Falmouth Docks has contributed up to 60 vessels (120 movements) per annum in the years since 1996. Cruise call and turnarounds for this period are shown in Figure 14-4

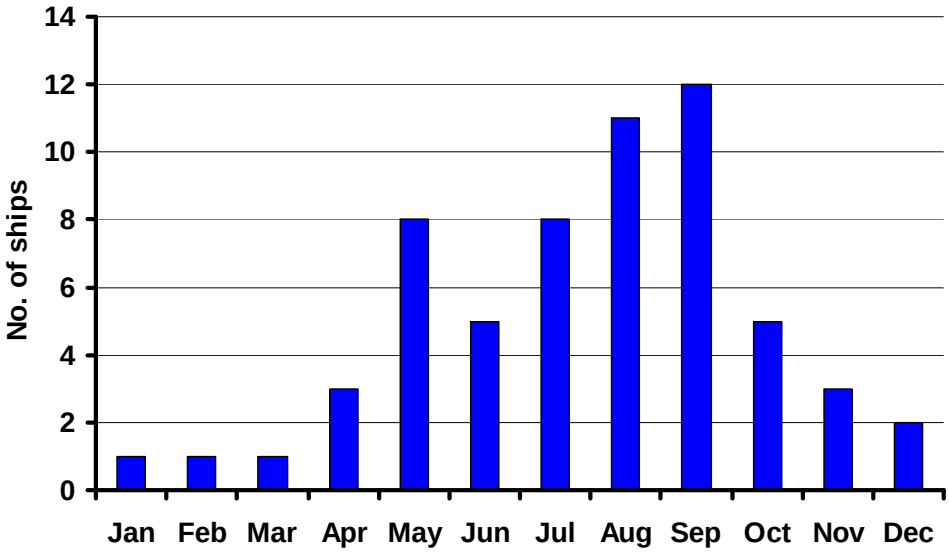
Figure 14-4 Cruise calls and turnarounds 1996 to 2008



*Projection on current bookings

Day calls tend to occur between May and September, while turnaround calls occur throughout the year. Figure 14-5 shows the monthly distribution of cruise calls during 2006.

Figure 14-5 Monthly Distribution of Cruise Calls at Falmouth in 2006



14.4 IMPACTS DURING THE CONSTRUCTION PHASE

Potential impacts on navigation associated with the proposed scheme were identified during the scoping phase and are presented below.

14.4.1 Impact on Commercial and Recreational Navigation due to Construction in the Water

Construction of the proposed wharf improvements and dredging of the new navigation channel will require the presence of vessels and equipment in and/or near the main navigation channel to Falmouth Docks and Harbour, in and/or near the berths at Falmouth Docks, and in lower part of Carrick Roads. Accordingly, there is potential for the construction vessels and equipment to interfere with the navigation of commercial and recreational vessels and there is an increased risk of collision particularly at night.

During the construction phase, backhoe dredgers and barges will be present within the new navigation channel and off the Queens and Northern Wharves for a period of approximately six months. Backhoe dredgers are stationary, fixed in position by anchors or spud-poles, and normally accompanied by barges moored alongside them to receive the dredged material. In addition, jack-up pontoons may be present off the Queens and Northern Wharves. It is from these pontoons that piling and other marine works equipment may be operated to install the proposed new open-piled quay sections that are necessary to combine the Queens and Northern Wharves. Like backhoe dredgers, jack-up barges are fixed in position. Barges will be present in Carrick Roads and in Falmouth Bay as they sail from the dredging area to the offshore disposal site some seven kilometres offshore. Disposal of clean dredged material offshore will require c.600 barge sailings.

In addition to all the day-to-day navigational procedures in place (see Section 14.3.8), all construction vessels and equipment will be subject to a range of measures that are necessary to maintain safe navigation. Construction vessels and equipment operating

within the harbour will be required to operate to certain standards. In order to minimise the risk of collision, the dredgers, barges and other equipment will display appropriate lights and day signals (as required by the International Regulations for the Prevention of Collisions at Sea 1972 (as amended)). All construction works (working areas) would also be appropriately marked. For example, if required, additional buoys would be deployed to mark construction works and inform other users of the activities taking place.

The dredger, barges and other equipment will be subject to standard operational requirements and will be under the control of the harbour authority. Large commercial vessel movements are subject to compulsory pilotage. Notices to Mariners will be issued regarding the construction works and radio broadcasts may be made to advise the operational movements of dredgers and construction traffic.

Notices to Mariners will be issued to yacht clubs and other organisations for distribution to recreational sailors. Ferry operators will also receive copies. The FHC's web site will be regularly updated with information relating to the movement of craft involved with dredging operations.

FHC have advised that no navigational conflict has been experienced during previous dredging and disposal activities that have been carried out in the harbour. Given the standard navigational procedures and the additional measures that will be put in place, a negligible impact on navigation is predicted.

Mitigation and Residual Impact

No mitigation measures are recommended in addition to the measures described above and, accordingly, a negligible residual impact is predicted.

14.4.2 Impact on Recreation due to Construction in the Water

Construction of the proposed wharf improvements and dredging of the new navigation channel will require the presence of vessels and equipment in and/or near the main navigation channel to Falmouth Docks and Harbour, in and/or near the berths at Falmouth Docks, and in lower part of Carrick Roads. Accordingly, the potential exists for the construction vessels and equipment to interfere with recreation to the extent that the new activities could pose a risk to safety and a change to activities. [Note: diving is covered separately in Section 14.4.3]

However, construction activities will not take place in the marinas leisure mooring areas and designated zones for water-skiing, bathing and water sports (see Figure 14-2) and, accordingly, should not pose any risk to recreational safety or provide a need to change activities in these locations. Accordingly, there will be no impact on these recreational activities.

Mitigation and Residual Impact

No mitigation measures are required and there will be no residual impact on these recreational activities.

14.4.3 Impact on Diving due to Construction in the Water

Construction of the proposed wharf improvements and capital dredging of the new navigation channel will require the presence of vessels and equipment in and/or near the main navigation channel to Falmouth Docks and the inner harbour, in and/or near the berths at Falmouth Docks, and in lower part of Carrick Roads. The disposal of dredged material to the offshore disposal site in Falmouth Bay will require barge movements and regular deposits of sediment into the water and onto the seabed. Accordingly, there is potential for an increased risk of collision with vessels and divers in these areas. [Note: recreational sailing is covered by Section 14.4.1]

Figure 14-6 shows the location of key dives sites in Carrick Roads and Falmouth Bay. The diving protocol (FHC, 2004) prohibits diving around Falmouth Docks and therefore there should be no risk associated with the wharf improvements and capital dredging activities in this area. However, the unconfined nature of diving within Carrick Roads and Falmouth Bay potentially puts divers and dive boat operators at risk from construction vessels and their activities. In particular, there may be a risk associated with barge movements and the offshore disposal of dredged material.

Barge Movements

Some 600 round trips between the new navigation channel and the offshore disposal site will be required to dispose of 600,000m^3 of dredged material assuming the use of barges with a capacity of 1000m^3. This equates to approximately three to four round trips per day assuming a six month continuous working period. Given that there has been between 300 and 500 commercial vessel movements per quarter between 2005 and 2007 (see Section 14.3.9), barge movements associated with the Falmouth Cruise Project have the potential to double the number of commercial vessel movements.

Figure 14-6 shows the location of key dives sites relative to Falmouth Docks and the offshore disposal site. A couple of dive sites (Old Walls and Epsilon) are in the vicinity of an anticipated sailing route between the capital dredging area and the offshore disposal site, which suggests that there is a medium potential for barge movements to affect the safety and planning of recreational diving in this part of Falmouth Bay.

Offshore Disposal of Dredged Material

The disposal of clean dredged material at the offshore disposal site in Falmouth Bay will require the deposition of sediment from barges onto the seabed. Divers are at risk from disposal activities if they are affected by the sediment as it falls through the water column to the seabed and as it subsequently disperses.

The offshore disposal site is designated for receiving dredged material and receives up to c. 25,000m^3 per annum and no measures in addition to the diving protocol are put in place when this activity occurs.

However, the proposed project requires the disposal of 600,000m3 of dredged material, and this requires three or four 1000m3 deposits per day over approximately six months, so there will be a substantial increase over the existing situation.

Figure 14-6 shows the locations of key dives sites relative to the offshore disposal site. The dive sites are not in the vicinity of the disposal area and the predicted extent of the sediment plume dispersion, as predicted by numerical modelling (see Figures 5-16 and 5-17), because the deposited sediment will remain beyond -40mCD and the dive sites are located in shallower water. This suggests that there is a low potential for deposition activities to affect the safety and planning of recreational diving of the key dive sites in this part of Falmouth Bay. However, diving is generally unconstrained and there could be a number of other dive sites that could be within the area affected by the sediment deposition.

Figure 14-6 Locations of Key Diving Sites and the Offshore Disposal Site



Impact Assessment

Given the magnitude of increased shipping movements due to barge activities, the proposed project will potentially double the number of shipping movements and affect the safety and planning of recreational diving in Carrick Roads and Falmouth Bay,

particularly at the Old Walls and Epsilon dive sites. Although there is a diving protocol in place that will manage this risk, there will be a temporary moderate adverse impact (in the form of a risk) on diver safety and recreational diving activities.

Given the magnitude of increased dredged material disposal activity, the proposed project will potentially increase the number of depositions by approximately 25 times, thereby increasing the potential to affect the safety and planning of recreational diving in Falmouth Bay. It appears that deposition should not affect the key dive sites in Falmouth bay, but the unconstrained nature of diving means that deposition and diving could coincide. Again, although there is a diving protocol in place that will manage this risk, there will be a temporary moderate adverse impact (in the form of a risk) to diver safety and to recreational diving activities.

Mitigation and Residual Impact

In theory, the diving protocol puts in place measures to minimise the risk to diving activities associated with vessel movements, and consultation with Falmouth Diving Club revealed that interference with recreational scuba diving in Falmouth Bay could be accommodated by simply moving to another area until the dredging has been completed.

Nevertheless, given the predicted magnitude of increased vessel movements and deposits of dredged material, it is recommended that FHC put in place additional measures for the duration of these activities, and that these measures and their delivery are devised through liaison with the local dive operators.

Firstly, prior to construction, all vessel movements and disposal activities should be publicised to dive operators and divers through the appropriate means such as Notices to Mariners, FHC's website, dive shop websites, etc.

Secondly, during construction, all vessel movements and disposal activities should be publicised through routine broadcasts on appropriate VHF channels. In accordance with the diving protocol, dive planners should check for any known shipping movements and the dive marshals should be aware of all shipping movements by maintaining a listening watch on relevant VHF channels because not all vessels require a pilot. To facilitate diving safety and activities, the dredging contractor should be required to advise FHC, the Dock Master and other relevant parties of an anticipated schedule of barge movements and deposits. This advice should be updated on a daily basis.

Thirdly, the dredging contractor should be allocated a sailing route through Carrick Roads and offshore to the disposal site to define the geographical extent of the vessel movements, and a deposition zone to define the geographical extent of the sediment plume. Based on Figures 14-6, 5-16 and 5-17, it appears that a direct sailing route and a deposition zone can be defined that does not pass over or affect the key dive sites in Falmouth Bay. The limits of the sailing route and deposition zone should be discussed, agreed with all local dive operators, and communicated widely. For the period of the dredging and disposal activity, the dredging contractor will not be able to sail outside the sailing route.

Fourthly, to support the implementation of the above measures, it is recommended that FHC revises its diving protocol with an addendum that is put into effect during the period when the vessel movements and disposal activities will be taking place. The addendum

will advise that no diving takes place near to the sailing route and in and around the disposal site, and will add requirements for dive planning and risk assessing to consider vessel movements and disposal activities.

Given the successful implementation of the above measures, there will be a minor residual adverse impact on diving in terms of safety risk and recreation.

14.4.4 Impact on Angling due to Construction in the Water

Construction of the proposed wharf improvements and capital dredging of the new navigation channel will require the presence of vessels and equipment in and/or near the main navigation channel to Falmouth Docks and the inner harbour, in and/or near the berths at Falmouth Docks, and in lower part of Carrick Roads. The disposal of dredged material to the offshore disposal site in Falmouth Bay will require barge movements and regular deposits of sediment into the water and onto the seabed. Accordingly, there is potential for an increased risk of collision with vessels and anglers in these areas.

Recreational angling takes place all over the Fal Estuary and in Carrick Roads from shore marks and also from kayaks, and takes place in Falmouth Bay at locations around the offshore disposal site, including offshore wreck marks and reefs (corresponding with the sites shown on Figure 14-6). Accordingly, the unconfined nature of angling within the estuary (notably Carrick Roads) and Falmouth Bay potentially puts anglers and boat operators at risk from construction vessels, particularly barge movements to the offshore disposal site.

Barge Movements

The predicted magnitude of barge movements is described in Section 11.4.3. As shown in Figure 14-6, a reef site (Old Walls) and a wreck mark (Epsilon) are in the vicinity of an anticipated sailing route between the capital dredging area and the offshore disposal site, which suggests that there is a low potential for barge movements to affect the safety and planning of angling in this part of Falmouth Bay.

Impact Assessment

Given the magnitude of increased shipping movements due to barge activities, the proposed project will potentially double the number of shipping movements and affect the safety and planning of angling in Carrick Roads and Falmouth Bay, particularly from kayaks within the lower estuary and Carrick Roads and from boats offshore at the Old Walls and Epsilon sites.

As described in Section 12.4.1, as with all activities potentially affecting navigation and safety within the harbour, FHC will issue a Notice to Mariners to inform harbour users about the location and duration of dredging works and barge movements. In addition, to maintain safe navigation the FHC have powers under the Falmouth Harbour (General) Bye-laws to restrict the presence of small vessels in navigation fairways (e.g. Carrick Roads) to avoid obstruction to other vessels. Furthermore, the FHC have in place their Policy on the Deployment of Fishing Equipment within Falmouth Harbour Area. This policy applies to recreational angling and “aims to provide a framework to allow those who fish for their livelihood or for recreation to undertake their activities in a way that does not affect the safe use of the Harbour by other users.”

In theory, therefore, sufficient procedures are in place, or can be put in place, such that the risk to anglers and angling activities can be managed such that there will be a temporary minor adverse impact (in the form of a risk) to angler safety and to angling activities.

Mitigation and Residual Impact

In theory, existing byelaws put in place measures to minimise the risk to angling activities associated with vessel movements. Nevertheless, given the predicted magnitude of increased vessel movements, it is recommended that FHC put in place additional measures for the duration of these activities, and that these measures and their delivery are devised through liaison with the local angling clubs and fishing boat operators. The FHC's Marine Safety Committee has an appropriate advisory member to represent fishing industry interests and it is recommended that this person be made responsible for liaison with recreational angling stakeholders.

Firstly, prior to construction, all vessel movements should be publicised to fishing boat operators and anglers through the appropriate means such as Notices to Mariners, FHC's website, etc.

Secondly, during construction, all vessel movements should be publicised through routine broadcasts on appropriate VHF channels. Fishing boat masters should check for any known shipping movements and be aware of all shipping movements by maintaining a listening watch on relevant VHF channels because not all vessels require a pilot. To facilitate angling safety and activities, the dredging contractor should be required to advise FHC, the Dock Master and other relevant parties of an anticipated schedule of barge movements. This advice should be updated on a daily basis.

Thirdly, the dredging contractor should be allocated a sailing route through Carrick Roads and offshore to the disposal site to define the geographical extent of the vessel movements, and a deposition zone to define the geographical extent of the sediment plume. Based on Figures 14-6, 5-16 and 5-17, it appears that a direct sailing route and a deposition zone can be defined that does not pass over or affect the key reefs and wreck marks in Falmouth Bay. The limits of the sailing route and deposition zone should be discussed, agreed with all local fishing boat operators, and communicated widely. For the period of the dredging and disposal activity, the dredging contractor will not be able to sail outside the sailing route.

Fourthly, to support the implementation of the above measures, it is recommended that FHC revises its policy with an addendum that is put into effect during the period when the dredging, barge movements and disposal activities will be taking place. The addendum will advise that no angling takes place in the new navigation channel, near to the sailing route and in and around the disposal site.

Given the successful implantation of the above measures, there will be a negligible residual adverse impact on angling in terms of safety risk and recreation.

14.5 IMPACTS DURING THE OPERATIONAL PHASE

14.5.1 Impact on Commercial and Recreational Navigation due to the Cruise Vessel Movements

Currently the sizes of cruise vessels that can berth alongside the wharves at Falmouth Docks are restricted by the depth of the existing navigation channel and berths, and the length of the quay available. While cruise vessels of the size of the design vessel (see Section 2.4.1) already visit Falmouth Harbour (albeit infrequently), they can only navigate to and moor in the deep water anchorage, and not to Falmouth Docks. As described in Section 2.4.2, it is predicted that the number of cruise vessels visiting Falmouth Docks will increase from 40 in 2005 to between 68 in 2020 (Arup, 2008) and 98 in 2023 (FDEC predictions). With the proposed Falmouth Cruise Project in place and the size of cruise vessels increasing across the cruise industry, it is likely that the proportion of larger cruise vessels visiting Falmouth will increase too. Accordingly, there will be an increasing number and size of cruise vessels navigating to and from Falmouth Docks with the potential to affect the navigation of commercial and recreational vessels.

The preferred option for the new navigation channel will improve navigation to the Queens and Northern Wharves. The existing navigation channel is designed to provide vessels with safe access to FDEC's dry docks but not to the Northern and Queens Wharves, and hence the tight S-bend in the existing channel. At present, accessing the wharves requires vessels to be lined up for the dry docks approach and then manoeuvred northwards around the wharves and any vessels moored against them. The realigning of the vessels' tracks to northwards requires course alterations and a period of settling onto the new track, adding unwelcome complexity to the manoeuvre and reducing the margins of safety for larger vessels. This is operationally difficult. S-bends are theoretically possible to navigate safely but require long straight sections between the bends for the vessel to safely transition from one turn to the next. The preferred channel design has been made in accordance with the International Navigation Association's (PIANC) guidance and accommodates the safe handling of large vessels with minimum margins for diverging from the intended track by providing a track as straight as possible, so that the vessel can be lined up on the intended track and maintained and effectively monitored in safe water throughout the passage.

As described in Section 2.2.1, the preferred option for the new navigation channel is proven using computational modelling. The proposed straightening and deepening of the navigation channel to Falmouth Docks will be sufficient for the design vessel to be well capable to pass safely from sea to its berth when using its thrusters. Furthermore, if the design vessel were disabled and without any of its own controls, three 30 ton bollard pull ASD tugs can safely bring the vessel from sea to the berth (Royal Haskoning, 2008.

In accordance with Section 7 of the Pilotage Act 1987, and as directed by FHC since 1st September 2003, pilotage is compulsory for certain vessels (see Section 14.3.8), which means that virtually all cruise vessels, and certainly all large cruise vessels, will be subject to pilotage requirements to aid safe navigation.

Given the existing cruise vessel movements, the outline design of the preferred channel option, the results of the simulation modelling and the pilotage requirements, there will be a negligible impact on navigation. In summary, the increased number and larger

dimensions of cruise vessels will be offset by the improved navigation afforded by the new navigation channel.

Mitigation and Residual Impact

No mitigation measures are required and a negligible residual impact will remain.

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15 ARCHAEOLOGY AND HERITAGE

15.1 INTRODUCTION

This section concerns the historic environment characteristics and baseline within the area of and surrounding the proposed development. It largely summarises the detailed investigation for the Falmouth Cruise Project carried out by Cornwall Historic Environment Service (CHES).

The work carried out by CHES is presented in Appendix E and comprised the following staged approach:

- desk-based assessment (April 2007);
- inspection and interpretation of vibrocores (September – November 2007);
- geophysical surveys (August– September 2007);
- investigation of geophysical anomalies, as appropriate (October 2007);
- final report (December 2007).

15.2 ASSESSMENT METHODOLOGY

15.2.1 Study Area

The study area includes the Fal Estuary and Falmouth Bay, as shown on Figures 15-1 and 15-2 respectively.

15.2.2 Baseline Data Collection

To collate baseline data for the study areas shown in Figure 15-1 and Figure 15-2, the following sources were examined during the desk-based assessment:

- Cornwall Historic Environment Record (HER);
- Cornwall Record Office, Truro;
- Royal Institution of Cornwall, Truro;
- Cornish Studies Library, Redruth;
- National Maritime Museum, Falmouth;
- Royal Cornwall Polytechnic Society, Falmouth;
- Falmouth Library;
- UK Hydrographic Office, Taunton;
- National Monuments Record, Swindon;
- Early maps and photographs (see Appendix E);
- Published sources (see Appendix E).

Further information was obtained from historic boreholes, 12 of which were located in and immediately adjacent to the area of the proposed dredge. Vibrocoring was also undertaken specifically for this proposed EIA, and of the 26 cores taken, examination was undertaken, and two cores were subjected to further detailed analysis and radio-carbon dating. The details and results of the vibrocore and borehole examination are presented in Appendix E.

Figure 15-1 Development Study Area (excluding Disposal Site)

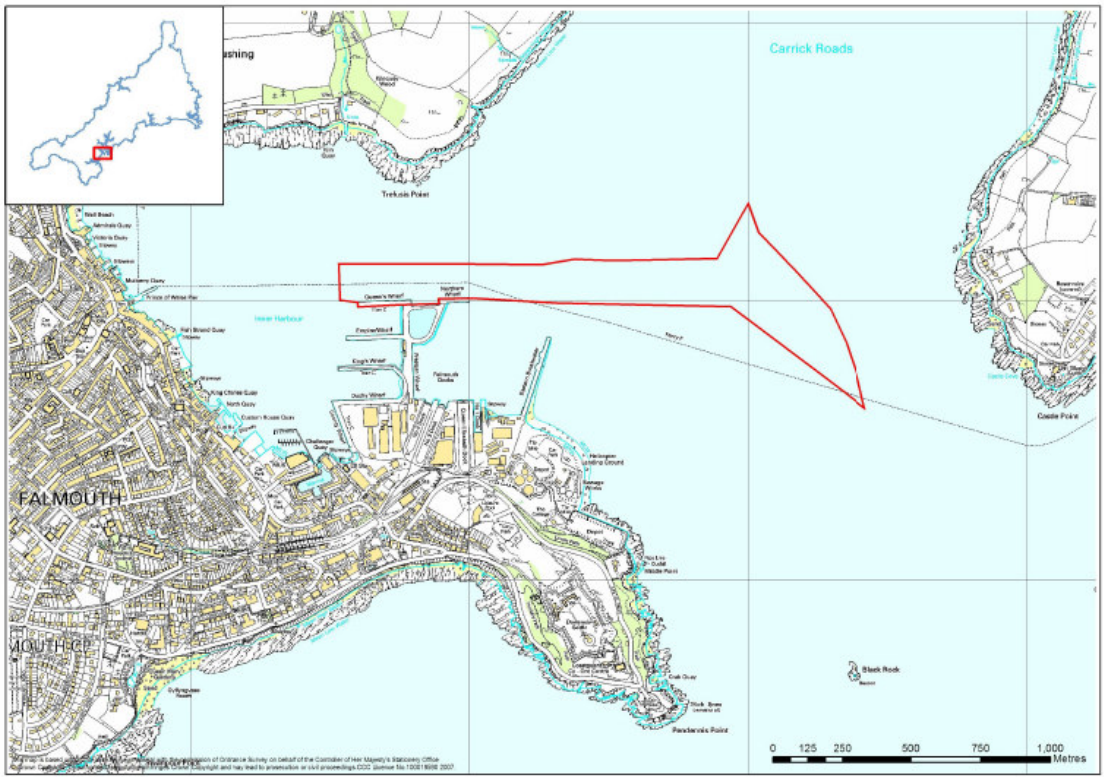
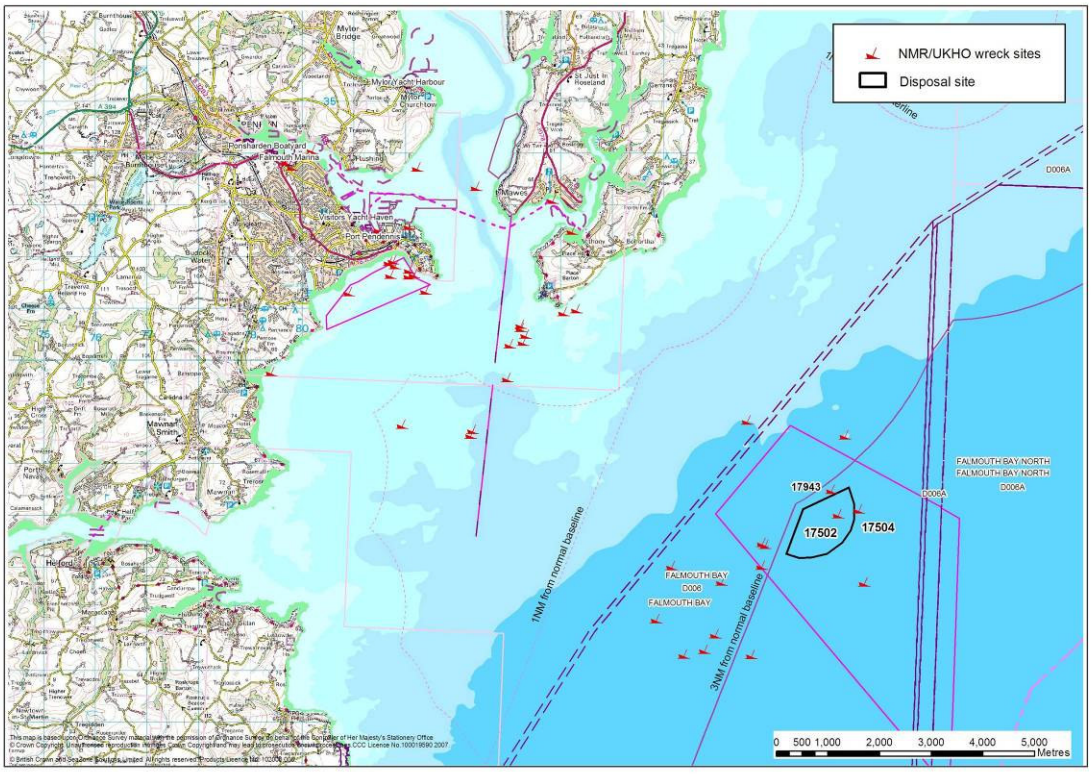


Figure 15-2 Disposal Site Study Area



In addition, a site visit was carried out to:

- visually examine the study area for possible sites relating to the historic environment that are not listed in existing records; and
- appraise the potential visual impact of the scheme on the proposed development on Falmouth Harbour and the setting of Scheduled Monuments (Pendennis Castle, Pendennis Headland, St Mawes Castle).

15.2.3 Survey

Geophysical Survey

A geophysical survey was undertaken in early August and September 2007. The techniques used were bathymetry, magnetometry, sidescan sonar, and sub-bottom profiling. The line spacing for the acquisition of the sidescan sonar and sub-bottom profiling data was set at 20m, while the line spacing for the acquisition of the magnetometer and single-beam echosounder data was set at 10m, with cross lines set at 100m. The resulting data was then assessed for archaeological potential. The detailed methodology and results are presented in Appendix E.

Ground-truthing of Anomalies

Two hundred and thirty-three anomalies were detected from the first tranche of sidescan sonar survey, of which 90 were classified as of possible archaeological interest. A representative sample of 24 anomalies was selected for inspection by Remotely Operated Vehicle (ROV), which filmed each anomaly on video during the first week of October 2007. Sixty-four magnetic anomalies and 35 sidescan anomalies were identified from the additional geophysical survey, of these 11 were selected for ROV inspection, which was undertaken in April 2008. The details of the anomalies identified and surveyed, along with the results of the survey are presented in Appendix E.

15.2.4 Assessment Criteria

As described in Appendix E, the assessment criteria are the study area's:

- visual setting and historic context; and
- archaeological sites.

15.2.5 Assessment Technique

The desk-based assessment was carried out following best practice as set out in the Institute of Field Archaeologists (IFA) Standard and Guidance for Archaeological Desk-based assessments (IFA 2001). The survey methodology is described in Appendix E.

15.2.6 Assessment of Impact Significance

The significance of predicted impacts was assessed using the classification criteria and terminology outlined in Table 1-1 in Section 1.4.3 on the EIA process.

15.3 BASELINE ENVIRONMENTAL CONDITIONS

15.3.1 The Historic Development of the Study Area

The Fal Estuary and the wider landscape around it have seen human activity over several thousand years. From at least the Mesolithic (c9000-4000 BC), the estuary and its network of rivers provided a means of communication. From the Neolithic (c4000-2500 BC) the land around the estuary was settled and farmed, exploited for its resources of timber and stone and used for industry and religious and ceremonial activity. A few early artefacts are known from the immediate vicinity of Falmouth, including an exotic polished Neolithic jadeite axe was found 'near Falmouth', fragments of a Bronze Age urn (c2500-700 BC) derived from a mid-19th century excavation on the coast around Pendennis, a later Bronze Age palstave and axe found in the Falmouth area (Kirkham, 2005), and a bronze sword from Falmouth harbour (Jeffries and McDonald, 1966).

The Cornish place-name element dynas 'fort' (Padel, 1985) suggests that Pendennis headland may have been an Iron Age cliff castle (c700 BC – AD 43). There are many examples of later Iron Age and Roman (AD 43-410) defended farmsteads known as 'rounds' around the Fal estuary suggesting a well-settled landscape at this time. Hoards of Roman coins have been found at Pennance Point, south of Falmouth and at Turnaware, upstream on the eastern shores of the estuary, as well as a number of stray coin finds from the Falmouth area (Kirkham, 2005).

Place-names incorporating the Cornish place-name element tre 'estate, farmstead' (Padel, 1985) are likely to date to the Early Medieval period 6th to 9th centuries AD, and the frequency of such names in the vicinity of the Fal estuary again suggest a well-settled and farmed landscape in Falmouth's wider hinterland (Kirkham, 2005).

Later medieval urban settlement focussed on a small number of centres – Truro, Penryn, Grampound – sited at bridging points and the upper limits of the various tidal waterways. The only coastal settlement of any note was St Mawes, which was described by Leland as 'poor fisher village' in the mid-16th century.

Other settlement in the area south and west of the Penryn River centred on a scatter of manorial and farm estates, including Arwenack first recorded in 1260 and acquired by the Killigrew family, probably by marriage in the later 14th century (Gover, 1948; Kirkham, 2005).

In 1812 a large tin ingot was dredged up in deep water of St Mawes by some bargemen taking up sand for manure. "Together with the Rillaton gold cup the St Mawes ingot is the most famous of all objects in the county". It measures 913mm long and weighs c.72kg and is now in the Royal Cornwall Museum, Truro. Its weight suggests it dates to the period of Edward 1 (1272-1307) for later ingots were heavier (Penhallurick, 1986).

The town of Falmouth developed after Pendennis and St Mawes Castles were built to defend the entrance to the Carrick Roads in the early 1540s. The town grew around Arwenack House, the seat of the Killigrews, who were the captains of Pendennis during the 16th and much of the early 17th century (Ratcliffe, 1997).

At the end of the 16th century Sir Walter Raleigh suggested that Falmouth Haven would benefit from victualling facilities and from about 1613, when the building of four inns was

sanctioned by James I, the Killigrews began to establish the village of Smithick, also known as Pennycomequick.

Influenced by the rising importance of Pendennis Castle and despite opposition from Penryn, which had been the main port on the lower Fal Estuary since the early 13th century, the population of the village grew to over 300 inhabitants by 1627, and in 1661 a charter of incorporation was obtained for the new town of Falmouth. The charter and subsequent legislation limited the town to a strip of land along the harbour shore. Fishing and the provision of services to ships and sailors using the haven were initially the town's main functions. By the end of the 17th century shipbuilding was important, large scale trade followed the establishment of customs collection, the town had a sizeable fleet of trading vessels and it had developed greatly as a commercial centre. By the beginning of the 19th century it was the largest town in Cornwall, with “about 600 houses and about 4,900 inhabitants besides sailors” (Ratcliffe, 1997).

During the 18th century incessant warfare and the expansion of the Packet Service ensured that Falmouth became the biggest naval and trading port in Cornwall. Conversely, by the mid-19th century, the loss of war-time business as a result of peace with France, and the abandonment of the local Packet Station brought about a severe decline in the amount of trade handled by the port. However, by the end of the century the town was thriving again, with the expansion of shipbuilding and repairing and the construction (from 1863) of Falmouth Docks. Though shipbuilding ended in 1930, ship repairing at the docks has continued throughout the 20th century. Tourism, the town's other thriving 20th century industry, developed after the arrival of the railway (1863), with the construction of several large hotels and numerous lodging houses. The railway also opened up new markets and helped to increase Falmouth's importance as a local commercial centre (Ratcliffe, 1997).

Numerous archaeological sites and historic structures of post-medieval date have been recorded along Falmouth's waterfront, although many post-medieval sites (limekilns, shipyards, timber yards, gasworks, coal yards, smithies and a tide mill) have been destroyed, particularly at the southern end of the town where land reclamation, the expansion of the docks and a modern housing development (Port Pendennis) have radically altered the waterfront and removed virtually all traces of the earlier industries which dominated the area (Ratcliffe, 1997).

Today, Falmouth is still Cornwall's principal port, with fishing, recreation and commercial facilities. As well as the shipyard which carries out major repairs and refits and offers cargo and passenger handling facilities, there are heavy moorings for receiving ship casualties, oil-rig lay-up facilities, oil bunkering operations and several hundred leisure moorings (Ratcliffe, 1997).

15.3.2 Known Terrestrial Sites

Table 15-1 presents the known terrestrial sites within the development area. The only terrestrial sites within the study area are Falmouth Docks (site 1 in Table 15-1), the Northern Wharf (site 2 in Table 15-1), first completed in 1866 and updated c.1928, and Queen’s Wharf (site 3 in Table 15-1), built c1935, destroyed by fire and rebuilt in 2004.

Table 15-1 Recorded and Identified Terrestrial Sites

Site No	PRN	Name	Site type	Condition	Period	NGR (SW)
1	41643	Falmouth Docks	Harbour	Extant	Modern	82000 32830
2	-	Northern Wharf	Wharf	Extant	Modern	
3	-	Queen's Wharf	Wharf	Extant	Modern	
4	38436	Falmouth to St Mawes	Ferry Crossing	Extant	PM, Modern	8085 3305 – 8082 3375
5	-	Examination Anchorage	Anchorage		PM, Modern	

15.3.3 Known Wreck Sites

Although there are many wreck sites in Falmouth Bay there are no recorded sites of maritime wreck sites within the proposed dredge area for the development. The distribution of recorded wreck sites around the study area, derived from UKHO and NMR data, are listed in Table 15-2 and presented on Figure 15-3.

Figure 15-3 Known Wrecks within the Study Area

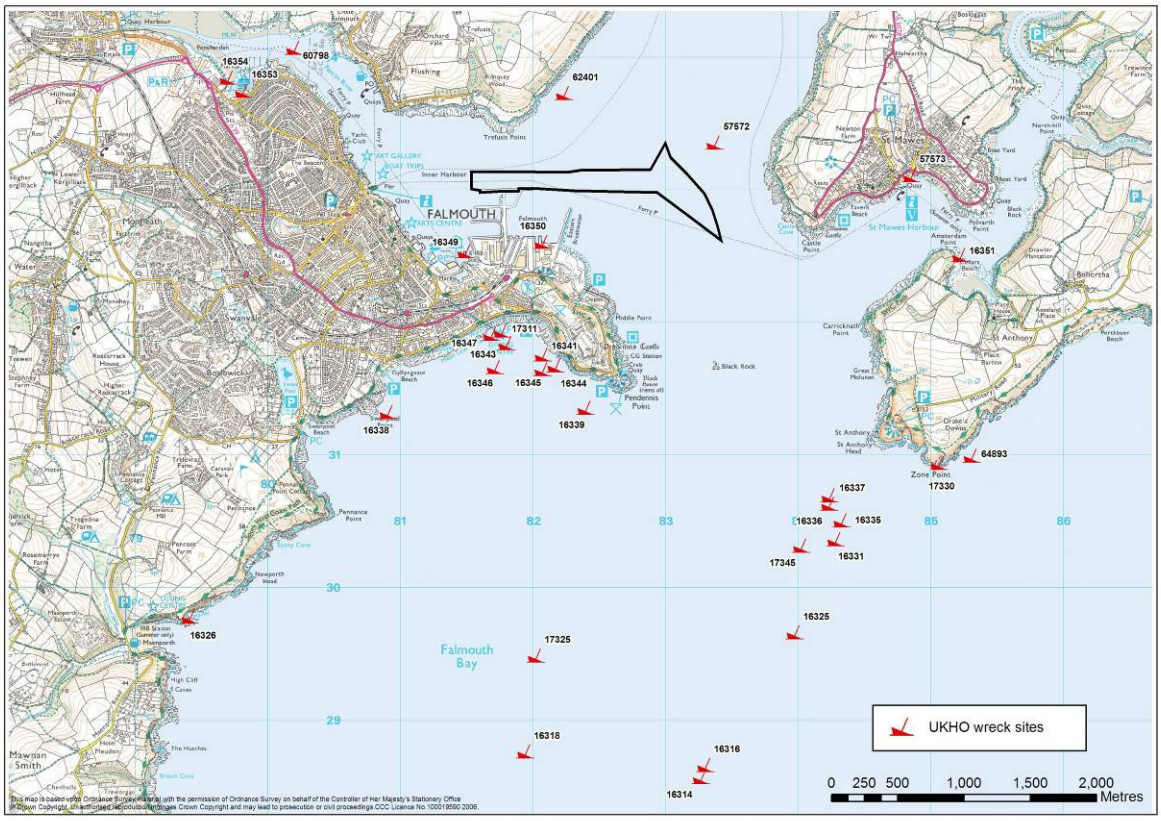


Table 15-2 Recorded Wreck Casualties from RCHME

Date of loss	Name of vessel	Loss/wreck location	Vessel type	Propulsion	Construction	Cargo
1667		Falmouth Harbour	cargo	sail	wood	Coal
1669		Falmouth Harbour		sail	wood	
1670		Falmouth Harbour		sail	wood	
1670	Bear	Falmouth Harbour	cargo	Sail	wood	Wine
1691		Falmouth Harbour	schooner	sail	wood	
1693		Falmouth Harbour		sail	wood	
1740		Falmouth Harbour	cargo	sail	wood	Candles, tallow
1740	Two Brothers	Falmouth Harbour		sail	wood	
1758	Katherine	Falmouth Harbour	cargo	sail	wood	
1773		Falmouth Harbour	cargo	sail	wood	Silk
1773	Duke of Gloucester	Falmouth Harbour		sail	wood	
1781	Firebrand (Annapolis, Porpoise)	Carrick Roads	fireship	sail	wood	
1795	Charlotte	Falmouth Harbour		sail	wood	
1795	Martinico Packet	Falmouth Harbour	packet	sail	wood	
1796	Hercules	Falmouth Harbour		sail	wood	
1797	Westmoreland Packet	Falmouth Harbour	packet	sail	wood	
1797	Indian Chief	Falmouth Harbour		sail	wood	
1797	Carolina Wilhemina	Falmouth Harbour		sail	wood	
1797	Phoenix	Falmouth Harbour	frigate	sail	wood	
1798	Elizabeth	Falmouth Harbour		sail	wood	Coal
1800	Union	Falmouth Harbour	cargo (collier)	sail	wood	Coal
1802	Newham	Falmouth Harbour	cargo (brig)	sail	wood	Hemp, gunpowder
1804	Eclipse	Falmouth Harbour	cargo (brig)	sail	wood	Rum
1804	Pelican	Falmouth Harbour	cargo (schooner)	sail	wood	Sail cloth, textile
1808	Hyana	Falmouth Harbour		sail	wood	
1809	Carteret	Falmouth Harbour	packet	sail	wood	
1809	Minerva	Falmouth Harbour		sail	wood	
1809	Charlotte	Falmouth Harbour	cargo (sloop)	sail	wood	Limestone
1809	Harriet	Falmouth Harbour	sloop	sail	wood	
		Falmouth Harbour		sail	wood	
1812	Endeavour	Falmouth Harbour		sail	wood	
1813	Unanimity	Falmouth Harbour		sail	wood	
1830	Nicholas	Falmouth Harbour	cargo (brig)	sail	wood	Government stores
1833	Catherine	Falmouth Harbour	cargo	sail	wood	Coal
1838	Richard and Elizabeth	Falmouth Harbour	fishing	sail	wood	Ballast
1858	Dandy	Falmouth Harbour		steam	wood	Ballast
1867	Miguel Angelo	Eastern Breakwater	cargo (brig)	sail	wood	Sugar
1869	Charles Emma	Falmouth Harbour	cargo (brig)	sail	wood	General
1880	Otter	Falmouth Harbour	cruise boat	sail	wood	Ballast

Date of loss	Name of vessel	Loss/wreck location	Vessel type	Propulsion	Construction	Cargo
			(cutter)			
1885	Gazelle	Falmouth Harbour	cargo	sail	wood	Ballast
1892	Faithful	Falmouth Harbour	leisure (yacht)	sail	wood	Ballast
1893	Freemantle	Falmouth Harbour	Revenue cutter	steam	wood	Ballast
1911	Brother	Carrick Roads?	cargo (schooner)	sail	woos	Water
1922	Curvos	Falmouth Harbour	cargo (schooner)	sail	wood	
1935	Bruce	Falmouth Harbour	cargo	steam	steel	
1939	Stanwood	Carrick Roads	cargo	steam	steel	Coal
1940	Resparko	Falmouth Docks	trawler, minesweeper	engine	steel	
1941	Fisher Girl	Falmouth Harbour	drifter, degaussing ship	engine	steel	

A request was made to the UKHO and NMR for wreck data within the licensed disposal area and digital data from the UKHO showed that one wreck is recorded as being within the area (UKHO wreck number 17502) and two as being on the boundary of it (UKHO wreck numbers 17943 and 17504) (see Figure 13-2).

No details of wreck 17502 are given on the UKHO record except that it lies at a depth of 57m at latitude 50° 06´.300 N and longitude 004° 55´.833 W (position quality unreliable). The NMR does not have any matching records for this wreck.

Wreck 17943 is that of Julie Anne II a motor fishing vessel (PZ 648) 7.6m long at latitude 50° 06´.600 N and longitude 004° 56´.300 W. The vessel sank whilst on a fishing trip on 31 July 1994 and 10 crew and passengers were rescued. The wreck is recorded as being intact and lying in an area of rocks at a depth of 60m. The NMR does not have any matching records for this wreck.

Wreck 17504 is recorded as a probable WWII steamship, 300ft in length by 42ft high, possibly a liberty ship of unknown name, at latitude 50° 06´.406 N and longitude 004° 55´.537 W (position precisely known). On 16 July 2005 the wreck was recorded as being upright and generally intact with a slight list to port, lying at a depth of 60m. The bows stand some 7-8m high, the decks are upright but collapsed giving access to three large boilers and several large cargo holds. The NMR does not have any matching records for this wreck.

Sites of maritime interest identified in the study area are the Examination Anchorage (site 4) and the Falmouth to St Mawes ferry crossing (site 5). More detailed information is provided in Appendix E.

15.3.4 Magnetic Anomalies

Of the 233 magnetic anomalies identified through the geophysical survey only 31 unique targets were positively identified on the sidescan sonar images. The list of anomalies to

be inspected included 24 targets, and the results of the inspection are presented in Table 15-3.

Table 15-3 Geophysical Anomalies Surveyed and Result

GT	Identification	Est date
1	Part of the bows of an iron vessel. Consisting of bulwark plating, stanchions and hawse-hole. Possibly the result of a collision?	20th C
2	Pile of nine lobster pots and rope	20th C
3	Rock	-
4	Collection of debris: timber or iron object, pipe, iron object, timber box, pipe or steel hawser, tyre, glass bottle, iron plate	19 – 20th C
5	Debris: tyre, timber piles	20th C
6	Large iron object – machinery with electrical wires and spin-wheel	20th C
7	Collection of debris: iron and timber, timber pile, iron stanchion?, metal keg	20th C
8	Debris: tyre and timber piles, timber pile, yellow wellington boot	20th C
9	Iron object – possibly an anchor	18 – 20th C
10	Debris: stoneware jar, sounding lead?, pipe, tractor tyre, fishing gear	18 - 20th C
11	Round-crown anchor	19th C
12	Collection of debris: fishing pot, hawser, wharf wall, coils of pipe, ladder, flange, gas bottle, cylinder?, fender, fender	20th C
13	Fishing gear: 1m cube formed from steel mesh – keep pot?	20th C
15	Collection of debris: fishing gear – pot?, lobster pot, hawser, iron object, ceramic, hawser, metal object, timber pile & pipe	20th C
16	Iron anchor & chain	19th C
20	Debris: tyre, steel keep pot, close-up of keep pot, iron object, iron object	18 – 20th C
22	Iron object – open ended cylinder – heavily concreted	19 – 20th C
24	Iron chain and part of a stockless anchor	19 – 20th C
31	Wreckage: iron object – bollard?, iron – machinery, rock, rock and leather object?, iron grating, iron object, rock, iron concretion & rock, complex metal object, firebrick?, copper object, wood, bottle base, wood with iron, iron rope thimble, rock, iron object, ceramic tile?	19 - 20th C
32	Iron poppet valve & fragment of ceramic, rock	20th C
33	Debris: iron concretion (approx. 0.45m long x 0.15m high), iron object (c.0.4m), ceramic mug	19 - 20th C
34	Rubber tyre	20th C
35	Debris: rock, iron concretion, rock	?
36	Ceramic tile?, searching	17 – 20th C
37	Rocks, rock (c. 0.4 x 0.25m), rock (c. 0.3 x 0.15m), rock or iron concretion (c. 0.25 x 0.20m)	
38	Debris: iron rod (c. 1 x 0.02m), wood (c. 0.3m long), iron bar traces of paint (c. 1 x 0.04 x 0.005m), iron concretion (c.0.2m), substantial iron object, partly buried in the seabed – possibly part of a folding anchor stock?	19 - 20th C
39	Not investigated	
40	Debris: four similar rectangular objects, (c. 1.6 x 0.4 x 0.4m) composed of wood with iron attachments - these are in a line on the seabed – evenly spaced	19 - 20th C
41	Single rectangular block composed of wood and iron	19 - 20th C

15.3.5 *Archaeological Potential*

It should be understood that the ROV inspections only looked at a small sample of the targets identified by the geophysical survey. This was useful in allowing a characterisation of the material. However, any of the un-investigated targets listed in Appendix E could potentially represent important archaeological material. The key importance of the geophysical anomalies within the study area is presented in the following descriptions.

Of the targets investigated by ROV, five are probably of no archaeological importance; these are GT32, GT34, GT35, GT36 and GT37. They all consist of natural objects such as rocks or of modern debris to be expected on the seabed in a busy harbour. Two of the targets were of low archaeological interest, these being GT33 consisting of two small pieces of iron concretion, and GT38, which is probably a partially buried 19th or early 20th century anchor.

In the immediate vicinity of GT31 fifteen separate small artefacts of wood and metal were identified. This may indicate an area of partially buried wreckage – possibly 19th century in date.

GT40 consisted of four similar rectangular wood and iron objects in a line on the seabed (approximately 3-5m apart). These were approximately 1.6m long x 0.4 x 0.4m. GT41 was a single example of a similar object, lying some 35m from GT40 and probably part of the same assemblage. It was not possible to make an identification of these objects from the ROV images.

Of relevance to the archaeological (prehistoric landsurface) potential of the study area, based on the borehole and vibrocore data examined, the information provides evidence that at least in places a major buried early Holocene landsurface exists beneath the seabed. Details are presented in Appendix E.

15.4 POTENTIAL IMPACTS DURING THE CONSTRUCTION PHASE

The following impact assessments summarise the findings of CHES (2008) (see Appendix E).

15.4.1 *Impact on the Northern Wharf and Queens Wharf due to Wharf Improvements*

The Northern Wharf was built in 1866, modified in 1928 and is now decrepit and unsafe. The Queens Wharf dates to the 1930s and was rebuilt in 2004 following a fire.

These features are not designated in relation to their archaeological value, and consequently, their loss would result in a minor adverse impact, as they are not of historical significance or architectural interest.

Mitigation and Residual Impact

However, it is recommended that a photographic record is undertaken of the Northern Wharf prior to its demolition to ensure that the structure is preserved by record, and thus reduce the significance to a negligible residual impact.

15.4.2 Impact on Wrecks and Wreckage due to Capital Dredging

Dredging will disturb and/or destroy any archaeological material of maritime interest lying on the seabed or below the seabed surface to the declared depth of dredging. Many of the targets identified by the geophysical survey and inspection of anomalies are likely to be rocks and modern debris of no archaeological importance and many more are of low archaeological interest, such as iron concretions or modern anchors. However some - such as GT31 the area of partially buried possibly 19th century wreckage or GT40/41 arrangement of wood and iron objects - are possibly of greater archaeological interest. It should be noted that the ROV inspections only looked at a small sample of the targets identified by the geophysical survey, which was useful in allowing a characterisation of the material, but any of the un-investigated targets listed in the main geophysical report could represent important archaeological material.

Consequently, a potential negligible to major adverse impact could arise due to the number of features and potential wreckage that could be disturbed.

Mitigation and Residual Impact

Mitigation should be undertaken according to an Archaeological Protocol and Written Scheme of Investigation (WSI) that should be agreed with the Local Authority and English Heritage. The Archaeological Protocol will specify the actions to be taken to deliver mitigation and the action to be taken should material of archaeological interest be encountered during dredging. The WSI will set out a methodology of how this will be achieved and by whom.

The Archaeological Protocol should include an archaeological watching brief during dredging with provision for intervention if archaeological material of maritime interest is identified during this process. It would not be practicable or productive for an archaeologist to be on site constantly during the dredging and a pragmatic approach to the watching brief should be adopted. For example, the project archaeologist could visit the site on the first day of dredging to inspect the method of working and the potential for archaeological screening and to liaise with the appointed contractor's staff with regard to the identification of artefactual material. Subsequently, the watching brief would operate on a call out basis, with the appointed contractor contacting the project archaeologist in the event of anything out of the ordinary being dredged up and the archaeologist making a weekly visit to inspect the work in progress.

A system for reporting finds of archaeological interest could be adopted, closely following the British Marine Aggregate Producers Association and English Heritage Protocol (Wessex Archaeology, 2005). The appointed contractor would nominate one of their staff as a Site Champion for archaeology that would be issued with a flow chart setting out the actions to be taken when they are told about a discovery. The Site Champion would fill in a pro forma Preliminary Record sheet for each find, and would inform the Project Archaeologist. The Project Archaeologist should be present when the areas of selected targets such as GT 31 and GT 40/41 are dredged with a view to recovering at least one of these objects to enable a positive identification to be made.

Provided the dredging protocol is undertaken, no residual impact should arise, as any features or wreckage would be preserved by record, and could potentially add additional

information to our knowledge and understanding of the site and the historical development of Falmouth.

15.4.3 Impact on Prehistoric Landsurfaces due to Capital Dredging

Dredging to a depth of 8.3m below CD along the northern edge of the navigation channel will truncate the Holocene landsurface capping the late Devensian sequence.

The vibrocores taken for this project represent an important resource for future research projects and should be retained in full. However, many of the vibrocores did not fully penetrate the full Holocene sequences and, therefore, a record of the full Holocene sequence within Falmouth Harbour does not exist. The loss of the sequence could potentially result in a minor to major adverse impact, particularly as limited information of this sequence is present.

Mitigation and Residual Impact

Under the WSI identified in Section 14.4.3, a long vibrocore should be taken prior to dredging, and the resultant sediment core should be sent for full archaeological analysis and dating, which should be agreed with the Local Authority and English Heritage. The optimum location is likely to be in the near vicinity of VC-4 (see Figure 6-2). The results should be presented to both the local curators and English Heritage for the local and national records.

Provided the core is collected and analysis is undertaken, a potential minor to moderate beneficial impact could arise due to the additional information available on the Holocene development of Falmouth Harbour.

15.4.4 Impact on Prehistoric Landsurfaces due to Disposal of Dredged Material at Sea

Wreck 17502 is believed to be situated within the disposal site's boundary (see Figure 15-2), although its exact position is unverified. Its archaeological importance is unknown, but it will be subject to possible crushing and burial as dredged material is deposited at the disposal site. Based on Figure 5-19, this wreck will be subject to burial by c.0.5m of disposed material. However, it is noted that the proposed disposal site is a licensed to receive dredged material and has been in used for many years and, therefore, wreck 17502 may have been already impacted by previous disposal events.

In addition, two wrecks are believed to lie on the boundary of the disposal site. These are the fishing vessel Julie Anne II (wreck 17943) and the possible WWII liberty ship (wreck 17504). The fishing vessel (wreck 17943) is of low archaeological importance. The WWII steamship (wreck 17504) is archaeologically important and recorded as intact. Since the wrecks lie on the boundary of the disposal site, they may be less affected by disposal than wreck 17502. Based on Figure 5-19, these wrecks will be subject to burial by c.0.1m of disposed material.

Overall, a potential moderate adverse impact could arise from the damage to wreck 17502 - of which little information exists - and also the potential encroachment of disposed material onto the archaeologically important wreck 17504.

Mitigation and Residual Impact

Under the WSI identified earlier, the condition of wreck 17502 should be verified, and following discussion with English Heritage, a possible exclusion zone for disposal of dredged material may be defined.

Provided the WSI is implemented and following discussion with English Heritage, the importance and condition and state of preservation of wreck 17502 would be determined, and impact avoided on wreck 17504, such that a negligible residual impact arises.

15.5 POTENTIAL IMPACTS DURING THE OPERATIONAL PHASE

The following impact assessments summarise the findings of CHES (2008) (see Appendix E).

15.5.1 Impact on the Visual Setting of Scheduled Monuments due to the Cruise Terminal Building and Wharf Improvements

The development could affect the visual setting of the following Scheduled Monuments:

- Pendennis Peninsula Fortifications (SM 10552) 0.7km to the south-west;
- Pendennis Castle (SM 277), 1.1 km to the south-west; and
- St Mawes Castle (SM 15420), 2.1 km to the ESE.

The site of the proposed cruise terminal building is shielded from Pendennis Castle by the lie of the land. It is overlooked by Upton's Mount Redoubt at the northern end of the Pendennis Peninsula Fortifications and intervisible with St Mawes Castle. Given the sensitivity of the monuments an insensitive design of the cruise terminal building and wharf improvement could adversely affect their visual setting.

Section 2.2.3 describes the cruise terminal building, identifying that its conceptual architectural design and choice of materials is sympathetic to the surrounding maritime environment. The landscape assessment notes that "the cruise terminal building has been designed to be in line with other marine development in the area and also utilises curved shapes and varied heights to break up the mass of the built form. Mitigation is already part of the design assessed in the LVIA (i.e. Appendix G) and no further mitigation is currently considered necessary or feasible. The scheme is in keeping with the visual character and existing uses of the area and is likely to be considered beneficial by many users of the surrounding landscape and urban areas" (see Section 18).

Section 2.3.5 describes the proposed wharf improvements, identifying that they will comprise new structures that are largely similar to the existing Queens Wharf or improve existing structures on the Northern Wharf. The landscape assessment notes that "the quay improvements have to follow stringent engineering criteria and requirements, which limits scope for mitigation. Within the overall scheme, the improvements are causing the least impacts as it is an improvement of an existing structure, which enhances the visual appearance of the currently partially dilapidated wharves. No further mitigation could be identified" (see Section 18 and Appendix G).

Given the design aspects of the cruise terminal building and wharf improvements, a negligible impact is predicted.

Mitigation and Residual Impact

It is recommended that consultation is carried out with English Heritage on the detailed design of the cruise terminal building in terms of the proposed architectural design and its scale, materials, finish, etc. Assuming a sufficient sympathetic design and discussion and agreement with English Heritage, a negligible adverse residual impact will remain.

15.5.2 Impact on the Historic Landscape Character due to the Cruise Terminal Building and Wharf Improvements

The development could affect the visual setting and historical context of Falmouth Harbour and contribute to the erosion of the character and setting of the harbour, the town, listed buildings and structures. Given the sensitivity of the harbour, an insensitive design of the cruise terminal building and wharf improvements could adversely affect its historic landscape character.

The design aspects of the cruise terminal building and wharf improvements are described in Section 14.5.1. Adherence to the conceptual architectural design of the cruise terminal building and the mitigation described in Section 14.5.1, a minor beneficial impact will be expected, as the proposed building and wharf improvements will have a favourable effect on the setting of Falmouth Harbour by improving the environment of Queens Wharf and the Northern Wharf.

Mitigation and Residual Impact

No further mitigation measures are recommended. Assuming a sufficient sympathetic design and discussion and agreement with English Heritage, a minor beneficial residual impact will remain.

16 TRAFFIC AND TRANSPORTATION

16.1 INTRODUCTION

This section of the ES provides a brief overview of issues concerning traffic and transportation.

Consultation with Cornwall County Council has identified the need to conduct a detailed Transportation Assessment (TA) and Travel Plan given the type and volume of vehicular traffic to be associated with the proposed Falmouth Cruise Project. At the time of preparing this section of the ES, a TA was not available to inform the EIA process. Accordingly, this section of the ES does not contain a detailed breakdown of traffic flows per vehicle type and does not contain any assessment of junction capacities.

16.2 METHODOLOGY

16.2.1 Study Area

The study area includes the local primary transport networks in and around Falmouth, and notably the A39.

16.2.2 Baseline Data Collection

The main transport routes in and out of Falmouth Docks have been identified through data collected from maps and timetables. Basic traffic flow information for the A39 was collected from CCC.

16.2.3 Survey

No survey has been undertaken but CCC holds detailed road traffic flow data from automatic and manual traffic counts. There are automatic traffic counters along the A39 at Ponsharden, A39 along Dracaena Avenue, and the C7 at Budock Hospital. In addition, 12 hour manual traffic counts at most of the key junctions on the A39 were carried out in August and October 2006.

16.2.4 Assessment Criteria / Technique

Predicted increases to road traffic wee compared to the baseline data provided by CCC to conduct the impact assessments.

16.2.5 Assessment of Impact Significance

The significance of predicted impacts was assessed using the classification criteria and terminology outlined in Table 1-1 in Section 1.4.3.

16.3 BASELINE ENVIRONMENTAL CONDITIONS

16.3.1 Road Network

The A39 starts (or ends) at Falmouth Docks. It passes through Falmouth where it is known by the street names Melvill Road, Western Terrace and Dracaena Avenue, where it reaches a roundabout junction. From the roundabout, the A39 forms the main road

connecting Falmouth and Truro and has a number of junctions with other 'A' roads (e.g. the A394 to Helston) and passes through villages such as Devoran, Carnon Downs, etc).

The A39 joins the A390 in Truro and the combined road runs around Truro town centre (Tregolis Road) until they split. After the split with the A390, the A39 heads north (known as Newquay Road) through Trispen until it joins the A30. The A30 is the main highway link west to Penzance and Lands End, and east to Exeter where it connects into the M5 and Honiton where it connects into the A303.

16.3.2 Road Traffic Flows

CCC's automatic traffic counters have recorded two-way flows for annual average daily traffic (AADT) including the percentage of HGVs at key locations along the A39, which is the principal road through Falmouth to and from Falmouth Docks. The numbers identified in Table 16-1 are based on hourly data for the whole of 2007.

CCC's automatic traffic counters have also recorded seasonality in the two-way average flows for all vehicles. The numbers identified in Table 16-1 are based on hourly data for 7 August 2007 and highlight the higher traffic flows during the summer holiday season.

Table 16-1 AADT Two-Way Traffic Flows in Falmouth in 2007 and Average Seasonal Peak Two-Way Average Traffic Flows on 7 August 2007 (source: CCC, pers. comm., 2008)

Road Location	AADT 2007	AADT 2007 % HGVs	7 August 2007
A39 Ponsharden	25,400	c.3	28,100
A39 Dracaena Avenue	13,600	c.3	15,500
C7 Budock Hospital	15,200	c.3	15,900

CCC's automatic traffic counters have recorded annual average two-way flows for peak morning (AM) and afternoon (PM) flows of all vehicles. The numbers identified in Table 16-2 are based on hourly data for the period from Monday to Thursday over the whole of 2007.

Table 16-2 Annual Average Peak Hour Two-Way Traffic Flows in Falmouth in 2007 (source: CCC, pers. comm., 2008)

Road Location	Peak AM	Peak PM
A39 Ponsharden	1,950	2,300
A39 Dracaena Avenue	1,000	1,200
C7 Budock Hospital	1,500	1,600

16.3.3 Rail Network

A branch line connects stations at Falmouth Docks and Falmouth with Truro. From Truro there are main line connections west as far as Penzance and east to Plymouth, Exeter and beyond including lines to London's Waterloo and Paddington stations.

16.3.4 Public Transport

Local passenger ferry services connect Falmouth to Tolverne and Truro (seasonal from April to October), and to Flushing and St Mawes (year round).

In recent years a park and float facility has started operating from Falmouth, providing a ferry link from the out of town car parking facility at Ponsharden with the town centre. A normal park and ride also operates between Ponsharden and the town centre.

16.4 POTENTIAL IMPACTS DURING THE CONSTRUCTION PHASE

16.4.1 Changes to Traffic Flows on the Local Road Network during Construction

The presence of construction traffic on the local road network will increase the numbers of vehicles travelling through Falmouth to access Falmouth Docks.

The predicted one-way traffic requirements for construction, excluding traffic movements within the docks, are described in Section 2 and summarised in Table 16-3. In total, there will be approximately 5,040 one-way movements and approximately 10,080 two-way movements.

Table 16-3 Predicted Traffic Movements on the Local Road Network

Construction Element	No. of One-Way Movements	Duration
Mob/demob of treatment plant	15 low-loader HGVs	2 days
Transport of dredged material to landfill	4,575 20t trucks	182 days
Delivery of rock armour to erosion area	225 25t trucks	84 days
Delivery of cruise terminal building materials:		
Concrete for substructure / foundation	25 concrete trucks	21 days
Superstructure and external walls, roof, glazing	120 deliveries	42 days
Internal fixtures and fittings	80 deliveries	56 days

The number of movements is dominated by the transport of treated dredged material off site to landfill and the return of empty trucks to the Docks. These movements will contribute an average of approximately 50 truck movements to/from site per day, or six to eight truck movements per hour. The worse-case scenario based on the transport of treated dredged material will increase the number of vehicles on the local road network by 50 two-way truck movements per day for six months. The magnitude of an additional 50 truck movements in relation to AADTs for 2007 is a small increase of <0.4%, as shown in Table 16-4.

Table 16-4 Predicted % Increase in AADT Two-Way Traffic Flows in Falmouth

Road Location	AADT 2007	AADT 2007 + transport of dredged material	% Change
A39 Ponsharden	25,400	25,450	c.0.2
A39 Dracaena Avenue	13,600	13,650	c.0.37
C7 Budock Hospital	15,200	15,250	c.0.33

The worse-case scenario based on the transport of treated dredged material will increase the number of HGVs on the local road network by 50 two-way movements per day, for six months. Assuming the trucks to be classified as HGVs, the magnitude of an additional 50 two-way movements in relation to AADT % HGVs for 2007 is a minor to moderate increase of between approximately 7% and 12%, as shown in Table 16-5.

Table 16-5 Predicted % Increase in HGVs Two-Way Traffic Flows in Falmouth

Road Location	AADT 2007	No. of HGVs @ 3%	No. of HGVs @ 3% + transport of dredged material	% Change of HGVs
A39 Ponsharden	25,400	762	812	6.6
A39 Dracaena Avenue	13,600	408	458	12.3
C7 Budock Hospital	15,200	456	506	11.0

While the overall change to AADT two-way movements will be very small, the overall change to HGV two-way movements will be much larger. The movements will probably be experienced across the day rather than in peak AM and PM hours. Nevertheless, truck movements associated with the construction phase have the potential to have a temporary and localised moderate adverse impact on the number of HGV movements on Falmouth's local road network.

Mitigation and Residual Impact

It is recommended that a TA is conducted in order to refine the impact assessment on traffic flows and to factor in pressures on road junction capacities, and, if necessary, to derive suitable mitigation measures to reduce the residual impact to acceptable levels.

With the findings of the TA in place and mitigating measures adopted, it is anticipated that there will be a minor adverse residual impact.

16.4.2 Changes to Traffic Flows within Falmouth Docks during Construction

As described in Section 2, it will be necessary to transport various construction materials within the docks estate. Firstly, there will be the transport of treated contaminated dredged material from the Northern Wharf to access the two car parking areas that will undergo ground improvement and the coastline that will undergo erosion protection. These sites are in the eastern part of the docks estate and will require the trucks to pass along the road around the dry docks and past Pendennis Shipyard and the Marine Skills Centre. Secondly, there will be the delivery of concrete from the batching plant to the Northern Wharf that will undergo wharf improvements. The batching plant will be located in the eastern part of the docks estate and will require trucks to pass along the road past the Marine Skills Centre, Pendennis Shipyard and the dry docks.

The predicted traffic requirements for construction related traffic movements within the docks are described in Section 2 and summarised in Table 16-6. In total, there will be approximately 2,034 one-way movements and 4,068 two-way movements on site. Assuming timescale for the traffic movements can be based on an average of the duration of the construction elements identified in Table 16-6, the timescale equates to approximately 41 days. Therefore, there will be an average of approximately 50 one-way movements and approximately 100 two-way movements on site per day.

Table 16-6 Predicted Traffic Movements within the Docks Estate

Construction Element	No. of One-Way Movements	Duration
Transport of dredged material to car park areas	1,030 25t trucks	21 days
Transport of dredged material to erosion area	121 25t trucks	84 days
Concrete delivery to Northern Wharf (Length 2)	450 concrete trucks	56 days
Concrete delivery to Northern Wharf (Length 3)	223 concrete trucks	35 days
Concrete delivery to Northern Wharf (Length 4)	125 concrete trucks	28 days
Concrete delivery to Northern Wharf (Length 5)	85 concrete trucks	21 days

There are no data about the existing number of traffic movements within the docks estate; however, the magnitude of the predicted increase is likely to be high. The road network within the docks estate is not particularly clearly marked and poorly surfaced, and passes by the dry docks, fuel storage tanks, pipelines and car parking areas, and through a gated access. Given the numbers of truck movements and size of the trucks, the construction traffic is predicted to have a temporary and localised moderate adverse impact on the road network within the docks estate.

Mitigation and Residual Impact

As identified in Section 15.1, the need for a TA has been established. Although the impact assessed in this section does not take place on the public road network, it is recommended that the scope of the TA include for an appraisal of the impact of construction traffic on the road network within the docks estate so that a construction traffic management plan can be devised and adopted by the appointed construction contractor(s). It is anticipated that the management plan would consider the most appropriate haul route through the docks estate and measures for minimising disturbance to businesses within the docks estate.

With a management plan in place and utilised, there will be a temporary and localised residual minor adverse impact.

16.5 POTENTIAL IMPACTS DURING OPERATIONAL PHASE

16.5.1 Changes to Traffic Flows due to Day Calls

With the proposed Falmouth Cruise Project in place, the distribution of day visitors between Falmouth and other Cornish destinations (see Figure 2-28) is not expected to change significantly, although the number of coach movements will increase. Assuming an equal distribution of day calls and passenger numbers and concentrating all calls into the main part of the season (i.e. 25 weeks from April to September), there will be an average of two day calls per week.

Allowing for 45 passengers per coach and assuming 50 per cent of passengers visit Cornish attractions by coach, then coach movements during day calls will be:

- an average of 6 coach trips per vessel (i.e. 12 two-way coach movements) per day call in 2005 (assuming an average of 497 passengers per vessel);
- an average of 12 coach trips per vessel (i.e. 24 two-way coach movements) per day call in 2009 (assuming an average of 1,050 passengers per vessel);
- an average of 24 coach trips per vessel (i.e. 48 two-way coach movements) per day call in 2023 (assuming an average of 2,079 passengers per vessel); and

- a maximum of 49 coach trips per design vessel (i.e. 98 two-way coach movements per day in any year the design vessel uses Falmouth Docks for a day call (assuming the maximum number of 4,375 passengers).

The worse-case scenario based on the design vessel will increase the number of vehicles on the local road network by 98 two-way movements per day, for two days per week, for 25 weeks per annum. The magnitude of an additional 98 two-way movements in relation to AADTs for 2007 is a small increase of <1%, as shown in Table 16-7.

Table 16-7 Predicted % Increase in AADT Two-Way Traffic Flows in Falmouth

Road Location	AADT 2007	AADT 2007 + Design Vessel	% Change
A39 Ponsharden	25,400	25,498	c.0.39
A39 Dracaena Avenue	13,600	13,698	c.0.72
C7 Budock Hospital	15,200	15,298	c.0.65

The worse-case scenario based on the design vessel will increase the number of HGVs on the local road network by 98 two-way movements per day, for two days per week, for 25 weeks per annum. Assuming coaches to be classified as HGVs, the magnitude of an additional 98 two-way movements in relation to AADT % HGVs for 2007 is a moderate increase of between 13% and 24%, as shown in Table 16-8.

Table 16-8 Predicted % Increase in HGVs Two-Way Traffic Flows in Falmouth

Road Location	AADT 2007	No. of HGVs @ 3%	No. of HGVs @ 3% + Design Vessel	% Change of HGVs
A39 Ponsharden	25,400	762	860	c.12.9
A39 Dracaena Avenue	13,600	408	506	c.24
C7 Budock Hospital	15,200	456	554	c.21.5

While the overall change to AADT two-way movements will be very small, the overall change to HGV two-way movements will be much larger and will probably be experienced in peak AM and PM hours. However, it is worth noting that the average-case scenario in 2023 will derive changes that are half the magnitude of those predicted for the worse-case scenario because the cruise vessel's passenger numbers will be lower. Nevertheless, coach journeys associated with day calls have the potential to have a moderate adverse impact on the number of HGV movements on Falmouth's local road network.

Mitigation and Residual Impact

It is recommended that a TA is conducted in order to refine the impact assessment on traffic flows and to factor in pressures on road junction capacities, and, if necessary, to derive suitable mitigation measures to reduce the residual impact to acceptable levels.

With the findings of the TA in place and mitigating measures adopted, it is anticipated that there will be a minor adverse residual impact.

16.5.2 Changes to Traffic Flows due to Turnaround Calls

The distribution of turnaround passengers arriving and departing the cruise terminal is not expected to change significantly and will remain a combination of coach (50%); car (45%) and public transport (5%). It should be noted that passengers will require two trips per cruise since they will arrive and depart Falmouth either by coach, car or public transport.

Allowing for 45 passengers per coach, then coach movements for turnaround calls will be:

- 11 coach trips per vessel (i.e. 22 two-way coach movements) per turnaround call in 2005 (assuming an average of 983 passengers per vessel);
- 16 coach trips per vessel (i.e. 32 two-way coach movements) per turnaround call in 2009 (assuming an average of 1,400 passengers per vessel);
- 18 coach trips per vessel (i.e. 36 two-way coach movements) per turnaround call in 2023 (assuming an average of 1,550 passengers per vessel); and
- a maximum of 49 coach trips per design vessel (i.e. 98 two-way coach movements in any year the design vessel uses Falmouth Docks for a turnaround call (assuming the maximum number of 4,375 passengers). [Note: the design vessel is expected to use Falmouth Docks for day calls rather than turnaround calls.]

Allowing for two passengers per car, then car movements for turnaround calls will be:

- 222 car trips per vessel per turnaround call in 2005 (assuming an average of 983 passengers per vessel);
- 315 car trips per vessel per turnaround call in 2009 (assuming an average of 1,400 passengers per vessel);
- 349 car trips per vessel per turnaround call in 2023 (assuming an average of 1,550 passengers per vessel); and
- a maximum of 985 car trips per design vessel in any year the design vessel uses Falmouth Docks for a turnaround call (assuming the maximum number of 4,375 passengers). [Note: the design vessel is expected to use Falmouth Docks for day calls rather than turnaround calls.]

The worse-case scenario based on the design vessel will increase the number of vehicles on the local road network by 49 one-way coach movements and 985 one-way car movements for passengers to arrive at Falmouth for their cruise. These movements will be repeated in the opposite direction as passengers depart Falmouth at the end of their cruise. The magnitude of an additional 49 coach movements and 985 car movements in relation to AADTs for 2007 is a small increase of <8%, as shown in Table 16-9.

Table 16-9 Predicted % Increase in AADT Two-Way Traffic Flows in Falmouth

Road Location	AADT 2007	AADT 2007 + Design Vessel	% Change
A39 Ponsharden	25,400	26,483	c.4.3
A39 Dracaena Avenue	13,600	14,634	c.7.6
C7 Budock Hospital	15,200	16,234	c.6.8

The worse-case scenario based on the design vessel will increase the number of HGVs on the local road network by 49 one-way movements per day. Assuming coaches to be classified as HGVs, the magnitude of an additional 49 movements in relation to AADT %

HGVs for 2007 will be half the increases predicted in Table 16.6 of between c.6.5% and 12%.

The overall change to AADT two-way movements and HGV two-way movements will be small, and will not necessarily be experienced in peak AM and PM hours (unlike for day calls). It is also worth noting that the average-case scenario in 2023 will derive changes that are less than half the magnitude of those predicted for the worse-case scenario because the cruise vessel's passenger numbers will be lower. Nevertheless, the increased numbers of coach and car journeys associated with turnaround calls have the potential to have a minor adverse impact on the number of two-way movements on Falmouth's local road network.

Mitigation and Residual Impact

It is recommended that a TA is conducted in order to refine the impact assessment on traffic flows and to factor in pressures on road junction capacities, and, if necessary, to derive suitable mitigation measures to reduce the residual impact to acceptable levels.

With the findings of the TA in place and mitigating measures adopted, it is anticipated that there will be a minor adverse residual impact.

17 NOISE AND VIBRATION

17.1 INTRODUCTION

This section describes the existing noise environment in the locality of Falmouth Harbour and assesses potential noise impacts associated with the proposed harbour development. Ground borne vibration impacts are not considered for reasons that will be explained subsequently.

The assessment is based on a site visit and noise measurement survey of the existing noise environment, incorporating both qualitative assessment and quantitative measurement, supplemented by a desk-based assessment of potential future noise impacts arising from both the construction and operation of the proposed Falmouth Cruise Project. The assessment of potential impacts includes consideration of off-site aspects associated with movements of construction-related traffic movements and subsequent movements of additional operational traffic on the public road network outside the port area.

A glossary of acoustic terminology is presented at Appendix F.

17.2 ASSESSMENT METHODOLOGY

17.2.1 Study Area

The study area comprises:

- the commercial and residential areas immediately adjacent to the port and extending out approximately 400 metres to encompass the residential areas overlooking, or with a direct view of, the port and which may potentially be subject to noise impacts arising from the construction and operation phases of the wharf development; and
- the residential properties near Trefusis Beach, overlooking the port. These properties are approximately 700 metres from the area of Queens Wharf to be improved and approximately 550 metres from the western-most extent of the proposed dredge boundary.

Noise sensitive receptors in this assessment are principally residential properties and include the recently construction Maritime Apartments close to the docks railway station.

17.2.2 Baseline Data Collection

Baseline noise data was gathered by Royal Haskoning during an attended noise measurement survey in September 2007.

Baseline on-site construction traffic data was derived from Section 2.3 of this report.

Source noise data for items of fixed and mobile construction equipment was obtained from Annex C of BS 5228: Part 1: 1997 and from the ‘Update of noise database for prediction of noise on construction and open sites’ on the web-site of Defra (Defra, 2005).

The location of potentially noise sensitive receptors was derived from examination of Ordnance Survey mapping, aerial imagery and observations during the noise measurement survey.

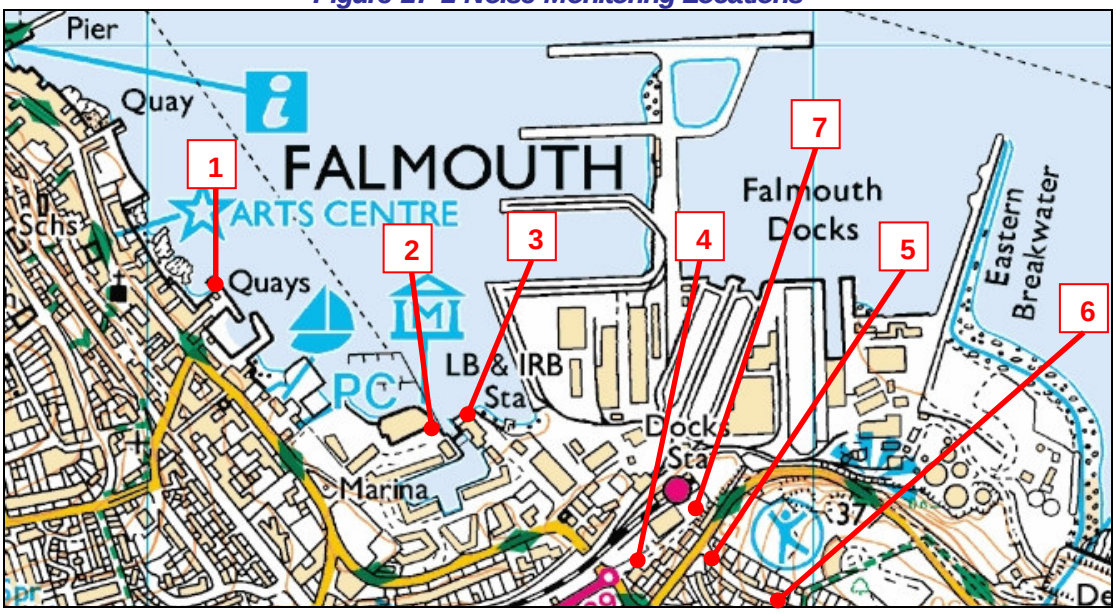
17.2.3 Survey

An attended noise measurement survey was conducted between the 5th and 10th September 2007. The purpose of the survey was to both quantitatively and qualitatively assess and measure the existing baseline noise levels in and adjacent to the port area. The survey included measurements close to potentially noise sensitive receptors around the port area, namely:

1. King Charles Quay;
2. Custom House Quay;
3. Port Pendennis (Tinners Walk near Lifeboat Station);
4. Pendennis Rise;
5. Junction of Tredynas Road and Castle Drive;
6. Top (SE) of Tredynas Road; and
7. Train station car park.

The locations are presented in Figure 17-1.

Figure 17-1 Noise Monitoring Locations



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The noise measurement survey was conducted in accordance with current Best Practice methods using a UKAS calibrated Type 1 sound level meter, mounted on a tripod at a height of between 1.2 and 1.5 metres above the ground and placed at least 3.5 metres from any. The meter was field-calibrated before and after each set of measurements; no variation in calibration level was noted.

The measurements of existing noise levels were made during the weekday and weekend comprising both day and night time periods. Where possible noise measurements were made with and without a cruise liner in port; during the day time survey, measurements included the presence of a cruise liner berthed at County Wharf whilst at night time, measurements included the presence a large vessel berthed at Kings Wharf.

The results are summarised in Table 17-4 and the full results are presented at Appendix F.

17.2.4 Assessment Criteria

The assessment of noise impacts is based on legislation and guidance, and criteria relating to the sensitivity of the human ear, as described in the following paragraphs.

The Control of Pollution Act, 1974 (COPA)

Section 60 of the COPA provides powers to local authority officers to serve an abatement notice in respect of noise nuisance from construction works. Section 61 provides a method by which a contractor can avoid such action by applying for consent to conduct construction activities in advance of their occurrence (a 'prior consent'). The prior consent is drawn up between the local authority and the contractor and may contain a range of agreed working conditions designed to minimise or prevent the occurrence of noise nuisance from construction activities.

Application for a Section 61 'prior consent' is a commonly used mitigation technique in respect of potential noise and vibration impacts from major construction works.

British Standard (BS) 5228: Part 1: 1997 Noise and Vibration Control on Construction and Open Sites

This standard contains a description of the potential noise impacts arising from construction works and provides generic source noise data for typical items of construction plant found on construction sites. However, the source noise data presented is now quite dated and, whilst still valid, more up to date construction equipment noise data is available from the 'Update of noise database for prediction of noise on construction and open sites' (Defra, 2005).

The standard also presents a range of calculation methods for predicting construction noise levels affecting adjacent noise sensitive properties and suggested techniques for mitigating against construction noise including the generic application of the principles of Best Practicable Means (BPM). The calculation techniques take account of various factors that might affect the propagation of noise including the effects of varying types of ground conditions, screening effects by buildings, barriers or topography, and specifically cautions in the use of propagation calculations beyond 300 metres due to the varying effects of local meteorological conditions on noise propagation.

The predicted construction noise levels are given as decibel (dB) L_{Aeq} noise levels, external to a potentially affected receptor building.

The Design Manual for Roads and Bridges, Vol. 11, Section 3, Part 7 Traffic Noise and Vibration (DMRB 11.3.7)

This guidance document is principally intended for use in assessing noise and vibration impacts arising from changes in traffic flows on new or significantly changed trunk roads including motorways. It can, however, be applied to any scheme having impacts on moderate to major roads outside the trunk road network. The guidance indicates that a change in total traffic flows of 25% on a road may give rise to a change in noise level of approximately 1 dB which is a potentially perceptible change in noise levels. DMRB

indicates that the actual calculation of road traffic noise levels should be conducted using Calculation of Road Traffic Noise (CRTN) (1988).

Calculation of Road Traffic Noise (CRTN)

This guidance document provides a method for calculating noise levels arising form the movements of vehicles on roads. Originally intended to allow assessment of the requirement to provide sound insulation to residents affected by changes to roads, the guidance is the generic guidance in the United Kingdom for road traffic noise calculation. The calculation methods include various correction factors to take account of the percentage of heavy goods vehicles, road surfaces and inclination, screening by barriers, relative height of source and receiver etc. The calculated noise levels are given as the dB $L_{A10\ (18hour)}$ Annual Average Weekday Traffic (AAWT), that is, the mathematical average of the hourly-averaged 10^{th} percentile noise levels between 06:00 and midnight on a typical weekday.

Noise Impact Criteria

There are currently no stipulated criteria in the UK against which the potential significance of relative changes in noise level might be assessed. Partly this is because the impacts of noise are very subjective in addition to which the existing nature of a site, its existing context, may affect the relative perception of a particular noise level change by the local community.

In this instance, Falmouth itself is a relatively busy town and the port operates continuously, potentially making noise level changes less significant here than at Trefusis which is a much more tranquil environment. With this in mind, separate significance criteria were used for Falmouth and Trefusis.

The criteria are derived from research that demonstrated that whilst the human ear may detect noise levels changes as low as 1 dB under laboratory conditions, a 3 dB change is generally the lowest noise level change detectable by the ear. The research also indicated that a 5 dB change may be clearly audible and, because of the way that the human hearing mechanism works, a 10 dB change is generally perceived as a doubling (or halving) of the noise in question. This then leads to the noise impact criteria presented in Table 17-1.

Table 17-1 Noise Impact Significance Criteria

Noise Level Change	Significance at Falmouth	Significance at Trefusis
0 to 0.9dB	Negligible	Negligible
1 to 2.9 dB	Negligible	Minor
3 to 4.9 dB	Minor	Moderate
5 to 9.9 dB	Moderate	Major
≥10 dB	Major	Severe

17.2.5 Assessment Techniques

Consultation

Consultation regarding the potential noise impacts of the development was undertaken with Mark Hitchen, Environmental Health Officer (EHO) at CDC. Consultation took the form of telephone calls and a formal consultation response letter from Mr Hitchen (reference: MH\WK/200702054), dated 25 May 2007.

The response from CDC included a concern over noise from on-board ship-generator noise and from repair activities within the port area. Unfortunately, the on-board activities and operations of visiting cruise ships and other vessels are beyond the control of the Port Authority whilst activities within the port ship repair yards are beyond the scope of this assessment. However, the assessment showed that the relocation of berthing will have a beneficial impact in respect of the potential ship-board noise.

On-site Construction Noise

The noise from certain of the construction activities was assessed using the methods provided in BS 5228. In view of the large separation distance between the wharves and the residential areas combined with existing noise from vessel activity in the harbour, with noise from the existing intervening commercial port areas and general urban (traffic) noise, it was presumed that the general noise of plant equipment such as earth movers and the dredger would not be significantly audible for properties in and around Falmouth. The exceptions to this are breaking out of concrete and piling, the percussive nature of which are likely to be clearly audible in Falmouth. Noise level predictions in respect of properties within Falmouth were, therefore, only undertaken for these two specific activities.

In conducting the assessment, all ground surfaces were presumed to be hard and potentially noise-reflective. Water is generally a hard noise-reflective surface. In addition, no reduction in noise levels was presumed for screening by buildings. This was presumed on the basis that the potentially most affected properties are either elevated relative to the docks or have direct line of sight of the docks from the waterfront area and, therefore, do not benefit from such screening effects.

With regard to properties near Trefusis Beach the potentially quieter ambient environment dictated that, in addition to the piling and breaking out, capital dredging noise impacts at Trefusis be assessed. The properties are, however, 700 metres from the proposed new cruise quay. This significant separation distance combined with existing port and harbour noise indicated that general construction activity noise, whilst potentially audible, will not be significantly greater than existing daytime noise levels from the docks area. Accordingly, these receptors were not included in the assessment of dredging noise.

It was presumed that significant movements of vessels occur within the areas of Carrick Roads and that additional movements of dredgers and barges associated with the capital dredging activities would not give rise to any significant increase in ambient noise levels for properties to the west of St Mawes, which are located approximately 570 metres or further from the capital dredge area. Accordingly, these receptors were not included in the assessment of dredging noise.

Due to the relatively soft nature of the sediments and underlying lithology around the wharves, it was conservatively presumed that percussive piling would be utilised for the construction of the cruise quay; occurring only during the day time. Detailed information regarding the proposed piling equipment to be used is not currently available so an assumed source noise level for such equipment of 113 dB L_{Aeq} at ten metres was used; this is based on previous experience of assessing similar waterfront redevelopment schemes. It was further presumed that the piling equipment would operate at full power for approximately 30% of the working day. All other equipment was conservatively presumed to be working at full power for 40% of the working day. It was presumed that the piling activities will occur between 08:00 and 16:00 Monday to Saturday with no working on Sundays or bank holidays and no overnight activity.

In accordance with the guidance contained in BS 5228, due to the particular percussive character of the piling and concrete breaking out noise, a tonal penalty of 5 dB was added to the predicted noise levels for these activities.

In setting an acceptable construction activity noise limit at the surrounding properties it is normal practice in such assessments for an acceptable noise limit of between 70 and 75 dB L_{Aeq} to be set for such relatively temporary activities. This is due to construction activities being inherently noisy: therefore, attempting to set noise limits based on existing background noise levels would be far too stringent and would be impractical for the appointed contractor. For the Falmouth Cruise Project EIA, a conservative limit of 70 dB was used. Assessment of construction activities against existing background noise levels would be acceptable with regard to night time or quiet weekend periods when rest and sleep disturbance are critical issues; this was not the case for the cruise quay piling since it is presumed that only daytime construction activities will occur.

The typical plant equipment and their associated source noise levels are presented in Table 17-2.

Table 17-2 Presumed Typical Construction Plant and their Noise Levels

Operation	Plant	Source Noise @ 10 m (dB LAeq)	% on time
Piling	Piling activity	113	30
Dredging	Back-hoe dredger	77	
	Loading barge	79	
	Total:-	81	
Breaking out	Breaker mounted on back-hoe	92	40

Construction Traffic Noise

The project description indicates that potentially significant numbers of heavy goods vehicles will access the docks estate bringing stone for the eastern docks foreshore improvement works. However, there are as yet no detailed TA data on the numbers of existing vehicles on the road outside the docks and so it is not possible to conduct a quantitative comparison. Therefore, qualitative observations regarding off-site construction vehicle movements are provided in this report.

It was assumed that all on-site construction-related vehicles, travelling between the wharf areas and the eastern dock areas, will move along the main length of the central Western Wharf before passing around the southern end of the dry docks. The closest approach distance between these route and the recently constructed Maritime Apartments was taken to be approximately 20 metres with the apartments judged to be raised approximately 5 metres higher than the construction route. The draft project outline indicates that a total of 2,302 vehicle movements will pass along this route over a three-month period. Presuming a ten-hour working day and a six-hour week, this approximates to 32 movements per day or 3 movements per hour. This is not a particularly large number of vehicle movements but may have an impact at the Maritime Apartments and assessment of this element of the construction activities was quantitatively assessed, providing predictions of both the hourly average noise levels (dB $L_{Aeq,\ 1h}$) and the maximum event noise level for a single vehicle passage (dB L_{Amax}). The speed of these vehicles was taken to be 30km/h.

The source noise data for the construction-related on-site vehicle movements, derived from BS 5228 and the updated database, are presented in Table 17-3.

Table 17-3 On-site Construction Vehicle Noise Levels

Operation	Plant	Source Noise @ 10 m (dB LAeq)	% on time
HGV on haul route to eastern docks	Drive-by dB LAmax	87	
	Time-averaged dB LAeq	75	N/A

The next closest properties are those on Castle Drive, approximately 100 metres away. In view of the separation distance, the intervening topography and the busy commercial nature of the docks, it was presumed that the movements of construction-related vehicles, whilst potentially audible, will not give rise to day time noise levels of any significance and this element of the construction activities was not further assessed.

Movements of construction-related vehicles were not judged to be significant in respect of properties near Trefusis Beach and construction vehicle-related noise predictions were not made in respect of these receptors.

Operational Site Noise

There are unlikely to be significant adverse noise impacts from the operation of the proposed Falmouth Cruise Project with the possible exception of public address system ('tannoy') noise. Detailed data on the intended public address system and its sound power level are not currently available so qualitative assessment was undertaken.

A potential significant beneficial impact will arise from the relocation of cruise ship berthing from County Wharf to the cruise quay along the combined Queens and Northern Wharves. For the purposes of quantitative assessment, the distance difference between the properties on Tinners Walk and a berthed vessel was used to calculate the potential reduction in noise levels that will occur as a result of the relocation.

As vessels already moor at Empire Wharf there is not judged to be a significant impact at Trefusis of relocating ship berthing to the new cruise quay and no detailed assessment of noise impacts was conducted.

The data so far available indicate that the number of cruise vessels using the port will increase from 46 in 2008 to 68 in 2020. With regards to noise, this represents a potentially negligible increase: a doubling of the number of cruise vessels over a very short period of time might be expected to lead to a localised increase in noise levels of the order of 3 dB but as this lesser increase is spread over a period of a year the impact will be diminished.

The project description also indicates that maintenance dredging of the approach channel and deep water berth will not be required, so no noise impact will occur.

Operational Traffic Noise

The Arup (2008) report indicates a significant increase in passenger numbers which may result in increased traffic to and from the docks and increased noise associated with the eastern docks car parking areas.

At this time, detailed data on the existing levels of traffic using the public roads and the car parks are not available and quantitative assessment was not possible. Qualitative observations of potential impacts were therefore conducted.

17.2.6 Assessment of Impact Significance

Impact significance has been assessed using the methodology set out in Section 1.4.3 and terminology set out in Table 1-1.

17.3 BASELINE ENVIRONMENTAL CONDITIONS

Falmouth Docks is an existing source of noise (see Section 16.3.1). Of the potentially noise sensitive receptors, the locations can be divided into two clearly distinct environments within Falmouth itself: waterfront Falmouth (see Section 16.3.2) and suburban Falmouth (see Section 16.3.3). Trefusis Beach represents a third and completely different environment (see Section 16.3.4). Measured noise data recorded during the survey are described in Section 16.3.5.

17.3.1 Falmouth Docks

The docks estate is located east of Falmouth town centre, operates as a commercial port for cruise, cargo handling and ship repair. On the whole, the activities are continuous (i.e. 24 hours a day). The areas immediately surrounding the docks comprise a mix of residential suburban / urban, commercial and industrial uses.

17.3.2 Waterfront Falmouth

Noise measurement locations 1 to 3 (see Figure 17-1) are located on the waterfront and are mainly subject to noise from the activities within the local marinas and the movements of small to medium sized vessels in the harbour. The closest residential properties to the quayside are those at Port Pendennis at the end of Tinners Walk,

approximately 630 metres from the proposed work areas at Queens Wharf and potentially only 60 metres from vessels that currently moor up at County Wharf. Intermittent private leisure craft moving within the harbour, often with very noisy outboard engines, contribute significantly to the existing daytime noise levels, particularly at the weekend.

The occasional movement of large cruise vessels to and from County Wharf contributed significantly to the existing noise environment for waterfront areas of Falmouth and ship-board diesel generator exhaust noise of the berthed vessels was a significant contributor to the noise levels at all three locations; the perceived audibility decreasing with distance.

The existing night time noise environment at all three noise measurement locations was relatively steady comprising an even contribution of noise from both the docks and the town, urban noise with occasionally elevated noise levels from the movement of cars on Falmouth High Street, late night revellers, and the sound of water lapping at the quayside. Night-time measurements were also taken with a large vessel berthed at the Kings Wharf, during which ship-board generator noise was clearly audible at all waterside locations.

17.3.3 Suburban Falmouth

Noise measurement locations 4 to 7 (see Figure 17-1) are south of the docks and comprise mostly suburban residential areas overlooking the port, some from an elevated position. The closest residential receptors are the recently completed Maritime Apartments, the upper storeys of which will overlook the docks; the apartments are approximately 610 metres from Queens Wharf and approximately 20 metres from the centre-line of the haul route to be used for movements of fill material within the docks estate.

The main contributors to the existing daytime noise environment in this area are local traffic on nearby roads and maintenance activity noise and generator ‘hum’ from the dry docks area. The character and level of the docks-generated noise was highly variable and dependant on the type of works taking place. The on-board diesel generator exhaust noise from cruise vessels berthed at the County Wharf was distantly audible at these locations but was qualitatively judged to not make a significant contribution to the existing ambient noise levels.

The primary contributor to the night-time noise environment at these locations was generator / maintenance activity noise from the dry docks area, which was relatively steady at night. The other main contribution to the ambient noise was from occasional traffic on local roads. At Pendennis Rise an extractor fan mounted on the external façade of the “Ocean Bowl” building operated intermittently throughout the day and night and when operating was qualitatively judged to make a significant contribution to the existing ambient noise levels for the neighbouring properties.

17.3.4 Trefusis Beach

The area was not visited during the site visit and survey, but examination of Ordnance Survey mapping and aerial imagery indicates that the area is generally semi-rural. Its proximity to Falmouth suggests that it will be subject to many of the same sources of noise but at a very much reduced level. The most significant source of noise at these

locations is likely to arise as the result of the large numbers of small private leisure craft in the harbour at the weekends.

Noise measurements were not conducted in this area but our experience of conducting noise surveys in such areas indicates that background noise levels will be in the region of 35 to 45 dB L_{A90} during the day and between 25 and 40 dB L_{A90} at night. Therefore, for the purposes of this assessment daytime background noise levels were presumed to be a median value of 40 dB L_{A90}.

The receptors around Trefusis Beach are considered principally in relation to potential noise from dredging, piling and breaking out of the old concrete wharf surface.

17.3.5 Measured Existing Noise Levels

A summary of the existing noise levels recorded during the noise measurement survey are presented in Table 17-4. Note that, on the whole, these noise levels are presented for information only, as insufficient operational activity detail is available to allow detailed quantitative assessment of operational noise relative to existing noise levels to be conducted. This data may be subsequently utilised should further assessment be required and once more detailed information is made available.

Table 17-4 Summary of Existing Measured Noise Levels

Location	Time	dB LA90		dB LAeq	
		Boat in	Boat out	Boat in	Boat out
	Weekday	51	42	52	45
	Sunday	49	46	50	50
King Charles Quay	Night	45	38	46	39
	Weekday	59	38	60	46
	Sunday	57	46	56	45
Custom House Quay	Night	-	-	-	-
	Weekday	61	43	62	46
	Sunday	56	49	57	52
Port Pendennis	Night	43	38	43	39
	Weekday	45	45	49	49
	Sunday	-	46	-	49
Pendennis Rise	Night	37	36	39	37
	Weekday	42	39	57	57
	Sunday	-	43	-	57
Tredynas Road	Night	37	41	38	42
	Weekday	40	-	42	-
	Sunday	-	39	-	41
Top (SE) Tredynas Road	Night	-	42	-	43
	Weekday	Non recorded due to construction noise			
	Saturday	45	-	47	-
Docks railway station car park	Night	-	42	-	43

17.4 POTENTIAL IMPACTS DURING THE CONSTRUCTION PHASE

17.4.1 Impact on Noise due to On-site Construction

The results of the predictive assessment of weekday daytime piling, dredging and concrete-breaking noise activities are summarised in Table 17-5. Locations at the top of Tredynas Road and the railway station are not included as daytime weekday noise levels were not recorded at these locations. For the purpose of this impact assessment, the measurement location at the junction of Tredynas Road and Castle Drive can be taken to be representative of the other 2 locations due to their relative proximity. Table 17-6 presents the results of the predictive assessment of the construction noise levels relative to the suggested construction noise limit of 70 dB L_{Aeq}.

Table 17-5 Predicted Receptor Noise Levels from Construction Activities

	Activity and Noise (dB LAeq)		
Receptor (and Distance)	**Piling**	**Dredging**	**Breaking Out**
King Charles Quay (770 m)	75	38	54
Custom House Quay (650 m)	77	40	56
Port Pendennis (630 m)	77	40	56
Pendennis Rise (610 m)	77	40	56
Tredynas Road (770 m)	75	38	54
Trefusis (700 m)	76	39	55

The assessment indicates that the piling activity will have a potentially moderate adverse impact around Falmouth and a potentially (just) major adverse impact for properties near Trefusis Beach. The other construction activities will have no impact on the surrounding residents.

Mitigation and Residual Impact

There are numerous generic mitigation options for mitigating piling noise, the most successful being the enclosure of the pile and ram by 'bellows'. In practice, however, this mitigation has been shown to create significant difficulties for piling contractors dealing with soft ground conditions in ensuring that piles are being driven straight. It may be possible for quieter piling techniques such as vibro-piling or pile-pressing to be used, but the application of these techniques will be dictated by the advice of the appointed contractor.

Of greater significance with regard to perceived mitigation, is the importance of undertaking community liaison. Experience has shown that local residents will be very tolerant of very high noise levels provided they have been forewarned of the occurrence of the activities, their reason and the potential duration, and are given details of a contact telephone number to contact in the event of a perceived annoyance. Any such complaints should be followed up and the resolution, if any, communicated to the complainant. In this way, trust in the developer and the appointed contractor is created.

Agreement over working hours and conditions should be agreed with the local Environmental Health Department by way of a Section 61 Consent, to include hours of working and construction methods, including piling, to be employed. In addition, a general application of the principles of Best Practicable Means (BPM), as defined in BS

5228 and The Control of Pollution Act 1974, should be utilised to minimise or avoid adverse impacts from construction-related noise.

With mitigation in place and successfully implemented by the appointed contractor, there will be a temporary and reversible minor to moderate adverse residual impact during when piling works take place during construction. No mitigation measures are recommended for other works and no residual impact will remain.

Table 17-6 Predicted Construction Noise Impacts

Location	Suggested noise limit (dB LAeq)	Piling noise (dB LAeq)	Difference + impact significance	Dredging noise (dB LAeq)	Difference + impact significance	Breaking out noise (dB LAeq)	Difference + impact significance
King Charles Quay		75	+5 (moderate)	38	-32 (none)	54	-16 (none)
Custom House Quay		77	+7 (moderate)	40	-30 (none)	56	-14 (none)
Port Pendennis		77	+7 (moderate)	40	-30 (none)	56	-14 (none)
Pendennis Rise		77	+7 (moderate)	40	-30 (none)	56	-14 (none)
Tredynas Road		75	+5 (moderate)	38	-32 (none)	54	-16 (none)
Trefusis	70	76	+6 (major)	39	-31 (none)	55	-15 (none)

17.4.2 Impact on Noise due to Construction Traffic

Noise will be generated by construction traffic on site (i.e. within the docks estate) and off site (i.e. on the local road network).

On site, Table 17-7 presents the results of the predictive assessment of construction-related traffic movement noise within the docks estate that will affect the Maritime Apartments.

Table 17-7 On-site construction traffic impacts

Operation	Source noise @ 10 m L_{Aeq}	Distance (m)	Angle of view (^{O})	Vehicles /hr	Speed (km/h)	Receptor noise levels (dB) $L_{Aeq, 1 hour}$
Dump truck drive-bys	**75**	20	120	4	30	**21**
	L_{Amax}		-	-	-	L_{Amax}
	87		-	-	-	**81**

Table 17-7 shows the significant difference between single event noise levels and the time-averaging effect, including as it does significant periods of no vehicle noise. The dB L_{Amax} noise level is therefore a clearer indicator of potential disturbance at the Maritime Apartments. However, whilst the quantitative assessment might indicate an major impact magnitude of +11 dB relative to the suggested 70 dB construction noise limit, it is necessary to view the result in terms of the following factors:

- a high noise level will not necessarily occur with every vehicle passage;
- the assessment is based on the conservative assessment of an empty vehicle passing three times an hour when in reality one or two of the events will be by a fully-laden vehicle; and
- the events are intermittent and short-lived with significant periods of quiet in between thus potentially slightly reducing the impact.

In view of these extenuating factors it would be more reasonable to suggest that the passing vehicle movements will incur moderate impact on the Maritime Apartments and adjacent properties.

Off site, a quantitative assessment of traffic related noise is not possible without a TA to establish baseline and predicted traffic numbers. However, qualitatively, it can be inferred that the movements of a large number of construction-related vehicles bringing stone to the docks for the foreshore strengthening operations may lead to a moderate or major adverse impact for local residents, the impacts being most noticeable on existing roads with low levels of heavy goods vehicle traffic.

Mitigation and Residual Impact

To address the noise impact of traffic on site and as identified in Section 16.4.1, community liaison can be a significant mitigating factor that should be applied to this impact. In addition, as the haul route is within the docks estate, FDEC should ensure that the surface of the haul road is maintained in good condition to prevent adverse noise caused by vehicle jolting over surface irregularities. A slow speed limit is enforced

within the docks estate (10 mph) and this will aid in minimising the potential for disturbance as increased speed can lead to increased vehicle noise. The application of BPM would be expected as would any additional agreements included in the Section 61 Consent. This may include controls on the timing or nature of movements of off-site construction traffic with a view to minimising disturbance. With the mitigating measures adopted, it is anticipated that there will be a minor adverse residual impact.

To address the noise impact of traffic off site, it is recommended that a TA is conducted in order to refine the impact assessment on traffic noise, and, if necessary, to derive suitable mitigation measures to reduce the residual impact to acceptable levels. With the findings of the TA in place and mitigating measures adopted, it is anticipated that there will be a minor adverse residual impact.

17.5 POTENTIAL IMPACTS DURING THE OPERATIONAL PHASE

17.5.1 Impact on Noise due to Cruise Vessels

Quantitative assessment of cruise operational impacts is only possible with regard to the impact of relocating cruise vessel berthing from County Wharf to the new cruise quay to be based alongside the combined Queens and Northern Wharves. Relocation will mean that cruise vessels will be situated approximately 590 metres away from the properties on Tinners Walk, compared to 60 metres separation distance to County Wharf. In practice, this will reduce noise levels associated with the berthed cruise vessels by a magnitude of up to 20 dB. This is a potential ten-fold reduction in noise levels and a very significant magnitude of noise reduction for these residents, which equates to a moderate beneficial impact.

Mitigation and Residual Impact

No mitigation measures are recommended and a moderate beneficial residual impact will remain.

17.5.2 Impact on Noise due to Cruise Quay Operations

Qualitatively, noise from vessels' public address systems may have adverse impacts, particularly for the properties around Trefusis Beach. The level of noise increase can not be quantified at this time, but this type of noise can be perceived to be very intrusive and can give rise to a severe reaction from local residents.

This concern does not apply to emergency warning systems which, by their very nature, need to be loud and so these systems are not considered under this impact assessment. There is no public address system in the docks estate, and it is not considered that one will be required under the proposed Falmouth Cruise Project.

The impact will be intermittent but may occur regularly when vessels are present. Given the potential intrusiveness of this type of noise, there will be an intermittent minor to moderate adverse impact.

Mitigation and Residual Impact

It is recommended that cruise vessel operators are provided with some guidance on the use of their onboard public address systems. The guidance should advise that the use of public address systems be minimised during the day (e.g. avoid unnecessary messaging and background music) and especially during the night, alternatives be used where possible (e.g. walkie-talkies between crew), and the volume be lowered as much as possible. The guidance should be provided to an assigned crew member with the responsibility to implement the measures appropriately. For example, some cruise vessel operators (e.g. Royal Caribbean) have an assigned environmental officer onboard their vessels.

Assuming the guidance is produced and adopted by the operators of the visiting cruise vessels, there will be a minor adverse residual impact.

17.5.3 Impact on Noise due to Operational Traffic

As described in Section 2.4, it is expected that the Falmouth Cruise Project will generate increasing numbers of day calls and turnaround calls and increasing numbers of passengers. Passengers will contribute to an increase in vehicles on the local road network; notably coaches taking passengers on excursions.

A quantitative assessment of traffic related noise is not possible without a TA to establish baseline and predicted traffic numbers, but it is probable that up to a moderate adverse noise impact could arise as a result of the movements of extra vehicles on the roads.

Mitigation and Residual Impact

It is recommended that a TA is conducted in order to refine the impact assessment on traffic noise, and, if necessary, to derive suitable mitigation measures to reduce the residual impact to acceptable levels.

With the findings of the TA in place and mitigating measures adopted, it is anticipated that there will be a minor adverse residual impact.

18 AIR QUALITY

18.1 INTRODUCTION

The proposed Falmouth Cruise Project has the potential to affect local air quality during both its construction and operation.

Construction impacts will comprise fugitive dust from site activities and exhaust emissions from construction traffic, non-road mobile machinery (NRMM) and marine vessels, particularly dredgers.

Fugitive dust emissions can cause nuisance to nearby residents and can also increase local concentrations of fine particles. These issues were assessed following the Greater London Authority and London Councils Best Practice Guidance 9. Emissions from NRMM are not expected to be significant. However, mitigation measures have been proposed in order to minimise their impact. The treatment of contaminated dredged material is not expected to give rise to significant emissions to air. Details of road traffic movements and vessel activities are not yet known so these have been assessed qualitatively.

Operational impacts will result from additional road traffic and more frequent calls by larger cruise vessels. Details of road traffic movements are not yet known so these have been assessed qualitatively. The increase in vessel activity has been reviewed in the context of exiting conditions and Government guidance.

18.2 ASSESSMENT METHODOLOGY

18.2.1 Baseline Data Collection

Baseline air quality data have been obtained from the UK Air Quality Archive (UKAQA) and Carrick District Council (CDC).

18.2.2 Survey

Given the baseline data available, no survey was undertaken to inform the EIA process.

18.2.3 Assessment Criteria

Policy

In 2004 the Office of the Deputy Prime Minister (ODPM) published its Planning Policy Statement 23 (PPS 23): Planning and Pollution Control[3], advising that any air quality consideration that relates to the use and development of land is capable of being a material planning consideration. Whether it is a material planning consideration or not and the weight which should be accorded to it by the decision-maker will depend on the facts of the individual case.

[3] Office of the Deputy Prime Minister (2004), Planning Policy Statement 23: ***Planning and Pollution Control***, The Stationary Office.

Air quality objectives (AQOs) for the UK were first published in the United Kingdom Air Quality Strategy in March 1997[4]. A revised Strategy was published in 2000[5], and an Addendum to the strategy was published in 2003[6]. A further Addendum to the Strategy was published in March 2004. The latest Air Quality Strategy was published in July 2007[7].

Air quality objectives for nitrogen dioxide (NO_2), fine particulate matter (PM_{10} and $PM_{2.5}$) and sulphur dioxide (SO_2), taken from the latest Air Quality Strategy, are shown in Table 18-1.

Table 18-1 Air Quality Objectives for the Protection of Human Health

Pollutant	Objective		Date to be achieved by
	Concentration	**measured as**	
Benzene	16.25µg/m^3	running annual mean	31 December 2003
	5µg/m^3	annual mean	31 December 2010
1,3-Butadiene	2.25µg/m^3	running annual mean	31 December 2003
Carbon Monoxide	10mg/m^3	maximum daily running 8-hour mean	31 December 2003
Lead	0.5µg/m^3	annual mean	31 December 2004
	0.25µg/m^3	annual mean	31 December 2008
Nitrogen dioxide	200µg/m^3 not to be exceeded more than 18 times a year	hourly mean	31 December 2005
	40µg/m^3	Annual mean	31 December 2005
Particles, PM_{10} (gravimetric)	50µg/m^3 not to be exceeded more than 35 times a year	24 hour mean	31 December 2004
	40µg/m^3	annual mean	31 December 2004
Particles, $PM_{2.5}$ Exposure Reduction	25µg/m^3	annual mean	2020
	Target of 15% reduction in concentrations at urban background	UK urban areas	Between 2010 and 2020
Sulphur Dioxide	350µg/m^3 not to be exceeded more than 24 times a year	hourly mean	31 December 2004
	125µg/m^3 not to be exceeded more than 3 times a year	24 hour mean	31 December 2004

[4] The United Kingdom National Air Quality Strategy, March 1997 (Cm 3587)
[5] The Air Quality Strategy for England, Scotland, Wales and Northern Ireland – Working Together for Clean Air, January 2000 (Cm 4548, SE2000/3, NIA 7).
[6] The Air Quality Strategy for England, Scotland, Wales and Northern Ireland: Addendum, February 2003.
[7] The Air Quality Strategy for England, Scotland, Wales and Northern Ireland, July 2007.

Pollutant	Objective		Date to be achieved by
	Concentration	measured as	
	266µg/m^3 not to be exceeded more than 35 times a year	15 minute mean	31 December 2005
Ozone	100µg/m^3 not to be exceeded more than 10 times a year	8-hour mean	31 December 2005
Polycyclic aromatic hydrocarbons	0.25ng/m^{-3} B[a]P	Annual average	31 December 2010

Exceedances and Percentiles

The short term objectives in Table 18-1 are framed in terms of the number of occasions in a calendar year on which the objective concentration should not be exceeded. This can also be expressed in terms of a percentile of short term mean concentrations. Relationships between the permitted number of exceedances and the equivalent percentiles are provided in Table 18-2 to help express results in relevant terms[8].

Table 18-2 Approximate Equivalent Percentiles to Air Quality Objectives

Pollutant	Time period	Permitted exceedances	Equivalent percentiles
Nitrogen Dioxide	1-hour	18 per year	99.8th percentile
PM_{10}	24-hour	35 per year	90th percentile
Sulphur Dioxide	15-minute 1-hour 24-hour	35 per year 24 per year 3 per year	99.9th percentile 99.7th percentile 99th percentile

Key Pollutants

The atmospheric pollutants considered in this assessment are shown in Table 18-3. They include species that can have an adverse effect on human health and the environment.

[8] Department for Environment, Food and Rural Affairs (2003) ***Local Air Quality Management Technical Guidance TG (03)***. PB7514; London, The Stationery Office.

Table 18-3 Key Atmospheric Pollutants

Species	Description	Impacts	
		Health	Environmental
NO_x	NO_x is a term used to describe the mixture of nitrogen oxides which is present in the atmosphere as a result of combustion reactions in both industry and vehicle engines.	Nitrogen dioxide (NO_2) is the primary concern for effects on health, and is the species for which the health-based standard is expressed. Nitrogen dioxide (NO_2) is associated with both acute and chronic health effects, particularly in people with asthma. At high concentrations, it can cause inflammation of the airways and might predispose people to an increased risk of respiratory infections[9].	The various oxides of nitrogen can also react with hydrocarbons in the atmosphere to contribute to the formation of ozone. Nitrogen oxides can also affect ecologically sensitive sites through deposition, causing acidification and eutrophication. Eutrophication can affect a range of ecosystems, including an increase in the productivity of phytoplankton blooms in ocean waters.
SO_2	Sulphur dioxide (SO_2) results from activities associated with the combustion of fossil fuels containing sulphur. 95% of pollution relating to sulphur oxide emissions are in the form of SO_2, a heavy, odorous, colourless gas. SO_2 is readily soluble and can combine with atmospheric water vapour forming aerosols of sulphurous acid (H_2SO_3), a colourless, mildly corrosive liquid. This liquid may then combine with oxygen in the air, forming sulphate aerosol that includes the irritant and corrosive sulphuric acid (H_2SO_4).	SO_2 can immediately irritate the respiratory system at concentrations greater than 6ppm, and can be fatal at high doses. People with asthma or chronic lung or heart disease are the most sensitive to SO_2[10].	Acidification through mainly wet ('acid rain') and also dry deposition. Increasing particulate load through formation of aerosol which has an impact on climate.

[9] Expert Panel on Air Quality Standards (1998) ***A Recommendation for a United Kingdom Air Quality Standard for Nitrogen Dioxide***, available from www.defra.gov.uk

[10] Expert Panel on Air Quality Standards (1998) ***A Recommendation for a United Kingdom Air Quality Standard for Sulphur Dioxide***, available from www.defra.gov.uk

Species	Description	Impacts	
		Health	Environmental
PM_{10}	Fine particulate matter (PM_{10}) includes a variety of particles, but includes minerals, combustion (carbon) products, or natural materials (e.g. sand and sea salt) which are small enough to be inhaled and many of which will reach the lower (gas exchange) region of the lungs. PM_{10} particles are those with a mean aerodynamic diameter of less than 10 micrometres.	It has been suggested that fine particles might cause lung inflammation and exposure to elevated levels is associated with both cardiovascular and pulmonary illness in susceptible individuals.	Impacts on climate through cloud forming 'hygroscopic' nuclei, and effects on cloud physics and radiative balance.

18.2.4 Assessment Techniques

Aermod (Lakes ISC-Aermod View version 5.9) was used to calculate emissions from relevant sources associated with the proposed Falmouth Cruise Project. This model was developed by the United States Environmental Protection Agency (USEPA) and is frequently used in the UK for regulatory and assessment purposed. It is a so-called "new generation" Gaussian dispersion model; it uses hourly sequential meteorological data and can account for the effect of buildings and terrain on dispersion.

18.2.5 Assessment of Impact Significance

Impact significance has been assessed using the methodology set out in Section 1.4.3 and terminology set out in Table 1-1.

18.3 BASELINE ENVIRONMENTAL CONDITIONS

18.3.1 Air Quality Pollutants

Local background NO_2 and PM_{10} concentrations for Falmouth were taken from the national pollutant maps[11]. These data include estimated contributions from nearby roads and industrial sources. Projected concentrations of NO_2, PM_{10} and SO_2 for 2010 are shown in Figure 18-1, Figure 18-2 and Figure 18-3, respectively. Defra guidance[12] states that "***for the purpose of review and assessment, authorities may assume that background annual mean sulphur dioxide concentrations at the end of 2004 and 2005 will be 75% of the 2001 values***." As a conservative estimate, this figure has also been used for 2010.

[11] http://www.airquality.co.uk

[12] Department for Environment, Food and Rural Affairs (2003***) Local Air Quality Management Technical Guidance TG (03)***. London, The Stationary Office.

Figure 18-1 Annual Mean NO_2 from UKAQA ($\mu g.m^{-3}$)

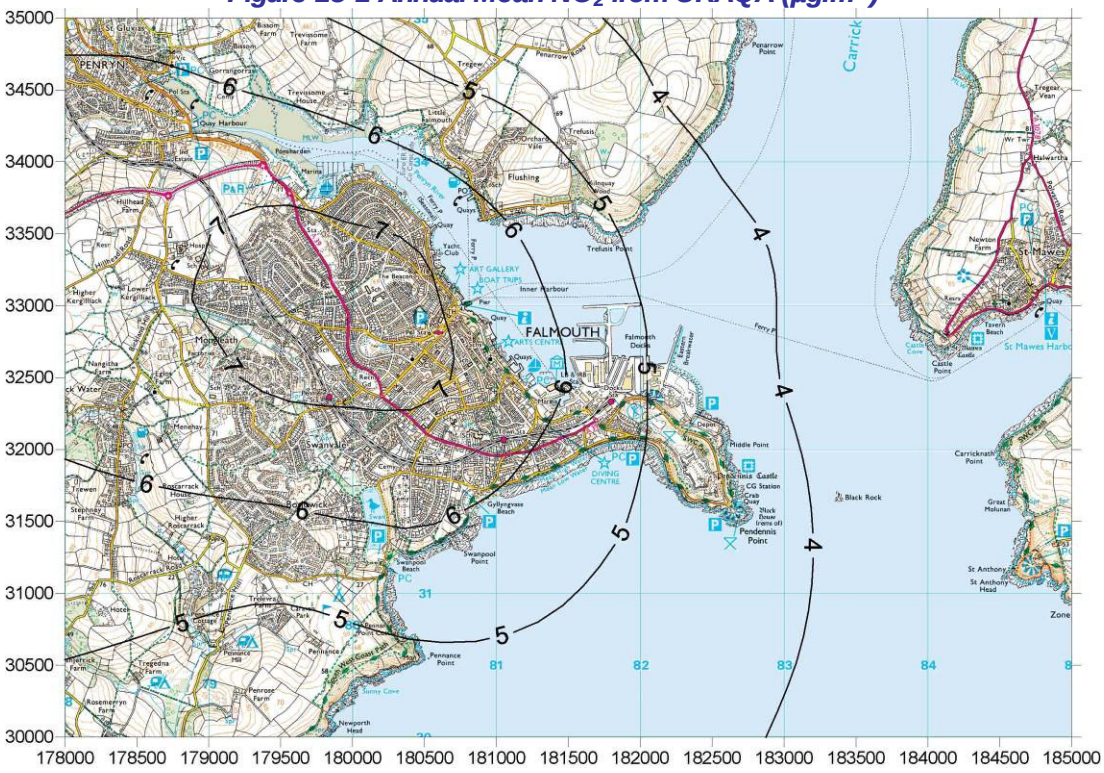


Figure 18-2 Annual Mean PM_{10} from UKAQA ($\mu g.m^{-3}$)

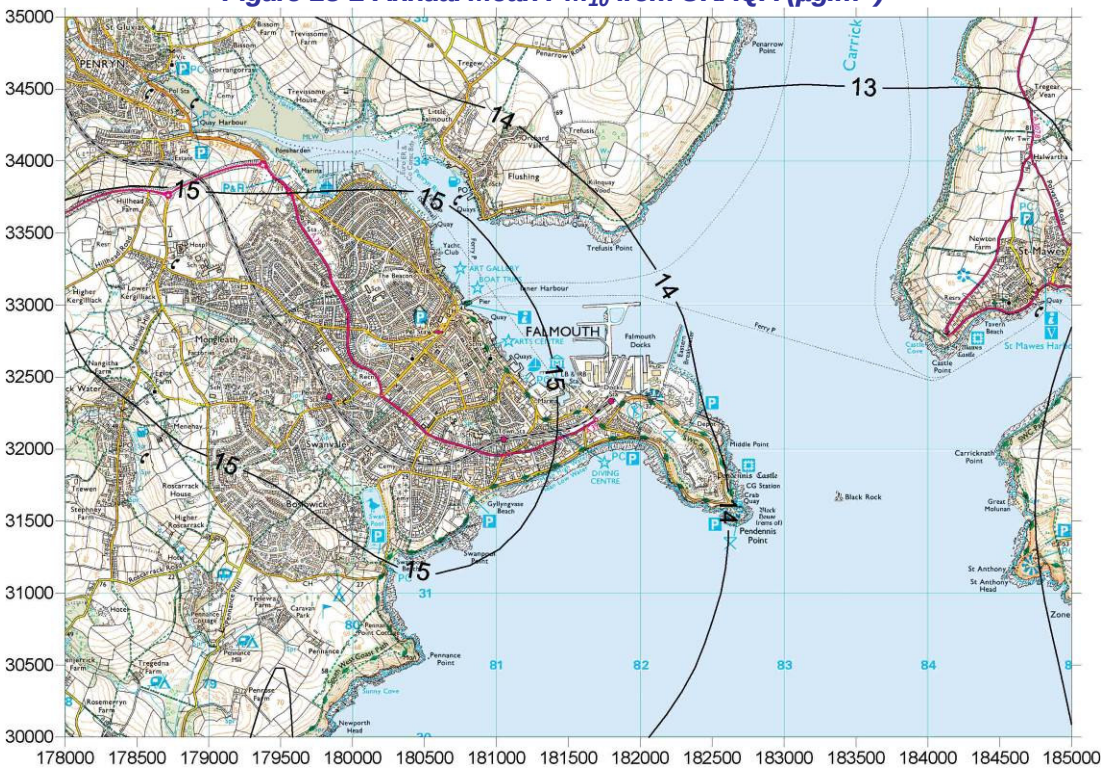
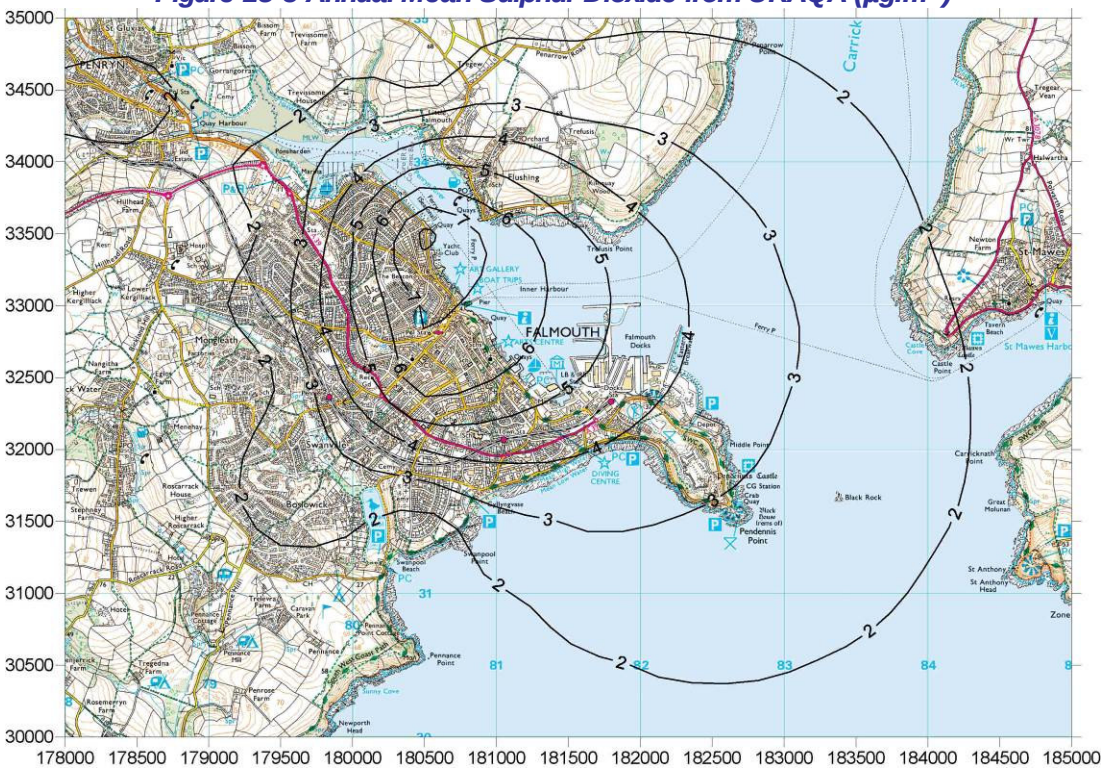


Figure 18-3 Annual Mean Sulphur Dioxide from UKAQA (µg.m^{-3})



18.3.2 Air Quality Objectives

The pollutant figures indicate that the relevant air quality objectives (see Table 18-1) are expected to be achieved and that concentrations, although higher in Falmouth than in the surrounding area, are low in the context of typical urban pollution in the UK.

Locally elevated concentrations of SO_2 are likely to be due to marine activity around Falmouth Harbour. It should be noted that, as a result of the European Directive on the Sulphur Content of Marine Fuels (2005/33/EC), the sulphur content of marine fuels for all ships in the English Channel has been reduced from 4.5% to 1.5% since 2007. From 2010, there will be a 0.1% sulphur limit on fuel used by ships at berth in EU ports. These measures should result in a significant decrease in local concentrations of SO_2.

The Environment Act 1995 introduced a framework of Local Air Quality Management (LAQM) and placed a duty on local authorities to formally assess air quality in their areas. The Government published statutory guidance detailing how local authorities were to undertake the 'review and assessment' (R&A) process, in consideration of UK objectives. The following reports were provided by CDC:

- Updating and Screening Assessment, 2003;
- Updating and Screening Assessment, 2007;
- Detailed Assessment, 2007; and
- Final Report on the monitoring of Nitrogen Dioxide, Falmouth, July-December 2007, 2008.

These reports indicate that all air quality objectives are expected to be achieved across Carrick district in areas where the public might be exposed to air pollution, and to date

the Council has not designated any statutory Air Quality Management Area (AQMA). High concentrations of NO_2 have been recorded in Falmouth along Market Street, Church Street and Arwenack Street but recent monitoring confirmed that the annual mean objective for NO_2 was being achieved. Monitoring was also carried out on the A39, Dracaena Avenue. The annual mean objective for NO_2 was exceeded at the junction with Grenville Road, but it was noted that there are no relevant receptors nearby.

The 2003 Updating and Screening Assessment (USA) states that "***Falmouth is the only large port in the Carrick district that is used by large ships, but here the total number of large ships visiting per year is only 1500***." Defra guidance suggests that ports with fewer than 5000 calls per year do not require detailed assessment as they are unlikely to lead to exceedances of air quality objectives. Subsequent reports confirm that there has been no significant change to this situation since 2003.

18.4 POTENTIAL IMPACTS DURING THE CONSTRUCTION PHASE

18.4.1 Impact on Air Quality due to Construction

Fugitive construction dust emissions have the potential to cause significant nuisance at nearby receptors, such as residential properties, by causing soiling of surfaces. In addition, a proportion of dust emitted will be in the form of fine particles which can have an adverse effect on human health. However, studies have shown that typically only around 20% of total suspended particulate matter from construction activity is in the PM_{10} size range[13,14].

Operations that often result in dust emission include:

- site preparation and earth moving;
- stockpiling and handling of loose materials; and
- movement of vehicles causing re-suspension of road dust, particularly on unmade roads.

The effect of construction dust is difficult to quantify accurately, so this impact is dealt with qualitatively. For the review and assessment of fugitive and uncontrolled PM_{10} sources, including major construction works, TG (03) states: "***Emissions from these sources are not well quantified and it is therefore difficult to predict PM_{10} concentrations with any accuracy***".

The guidance further states that "***concentrations fall off rapidly on moving away from the source***" and the determination of public exposure should consider the distance to the actual source and not to the site boundary.

Potential exposures beyond 200 metres of the source can be ignored (for the purposes of assessment against the PM_{10} objective) if the background concentration is less than 26µg/m^3. Concentrations in Falmouth are estimated by the UKAQA to be well below this

[13] Quality of Urban Air Review Group (1996). ***Airborne Particulate Matter in the UK. Third report for DoE***. ISBN 0 9520771 3 2.

[14] Airborne Particles Expert Group (1999). ***Source Apportionment of Airborne Particulate Matter in the UK.*** DETR/AEA Technology. ISBN 0-7058-1771-7

(see Figure 18-2) and there are no relevant receptors within 200m of the construction activities.

Although there is no definitive national source of guidance on the management of construction dust, useful guidelines have been published in the Greater London Authority and London Councils' Best Practice Guidance[9]. This document proposes a risk-based approach, categorising construction sites into low, medium or high risk. It should be recognised that the site evaluation guidelines are intended for urban developments and are not directly applicable to this site. However, given the scale of development and the distance to any sensitive location, it is appropriate to categorise the Falmouth Harbour development at medium risk as it has the potential for emissions or dust to have an intermittent effect on sensitive receptors.

A number of helpful measures are built into the proposed construction which will help to minimise the number of off-site truck movements during construction. Concrete will be supplied from a temporary batching plant located in the eastern part of the docks estate and dredged material will be re-used on-site where possible. However, it is anticipated that 61,000m^3 of excess material will be removed by road and approximately 3,700m^3 of rock armour will be imported over the construction period. Peak truck movements are not expected to exceed 10 per hour, which is not considered to be significant in terms of air quality.

During the construction phase there will be a large number of vehicle movements' on-site and additional non-road mobile machinery, as detailed in Section 16.4.1. However, given the number of vehicle movements and the separation distance between earth movement activities and the closest residential locations, the emissions associated with these activities are expected to be of minor significance in terms of impact on local air quality.

Contaminated dredged material will be treated on-site, essentially by dewatering and solidification processes. Details of the treatment process are described in Section 2.3.2; emissions to air associated with these activities are not expected to be significant.

Dredging activity during the construction phase is described in Section 2.3.1. For this assessment it was assumed that two dredgers, one of 500kW and one of 1000kW were operating throughout the construction period, working 12 hour days. On the basis of information provided by dredging contractors, average engine load was estimated to be 85%. Emissions were calculated using emission factors for vessels using residual oil published in ES EPA guidance[15], shown in Table 18-5.

Table 18-5 Dredging Vessel Emission Factors

Pollutant	**NO_x**	**PM_{10}**	**SO_2**
Emission Rate ($g.s^{-1}$)	3.21	0.19	1.82

Aermod (Lakes ISC-Aermod View version 5.9) was used to calculate emissions from these sources. The model accounted for local meteorology, with 2006 data from the Pendennis observation station, and terrain using OS Profile data. A wind rose for the meteorological data used is given in Figure 18-4. Nine sensitive receptors were

[15] US EPA (2006) Current Methodologies and Best Practices in Preparing Port Emission Inventories

selected to represent nearby residential areas. In addition, a grid of receptors measuring 6.5km x 4.5km with a spacing of 500m was used to investigate the spatial distribution of pollutants emitted during construction. Figure 18-5 shows the receptors used.

Figure 18-4 - Wind Rose for Pendennis (2006)

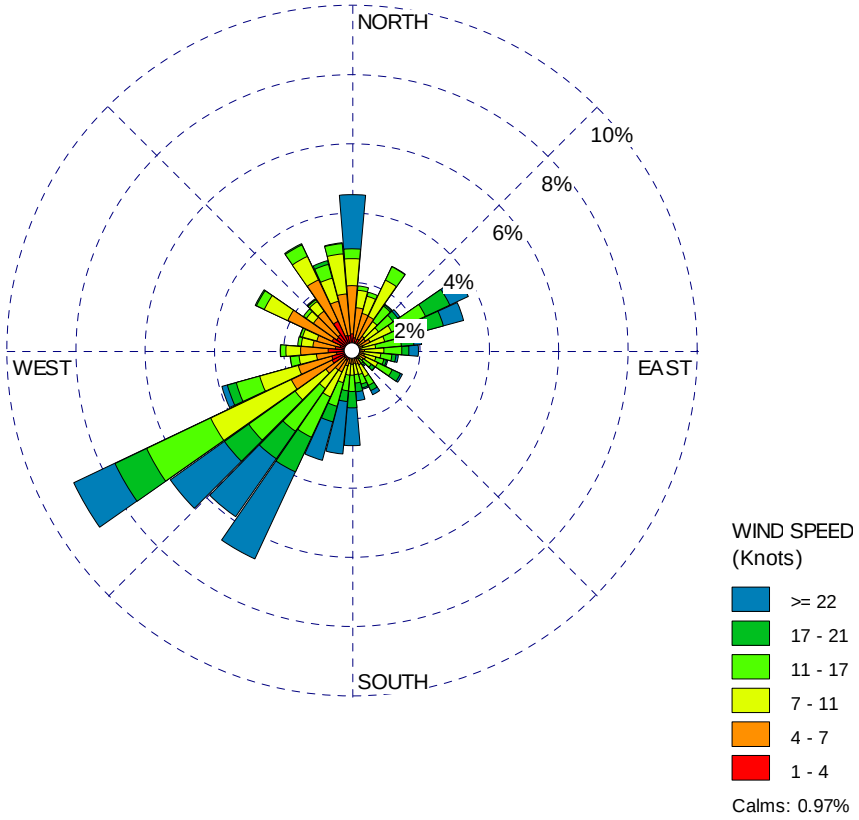
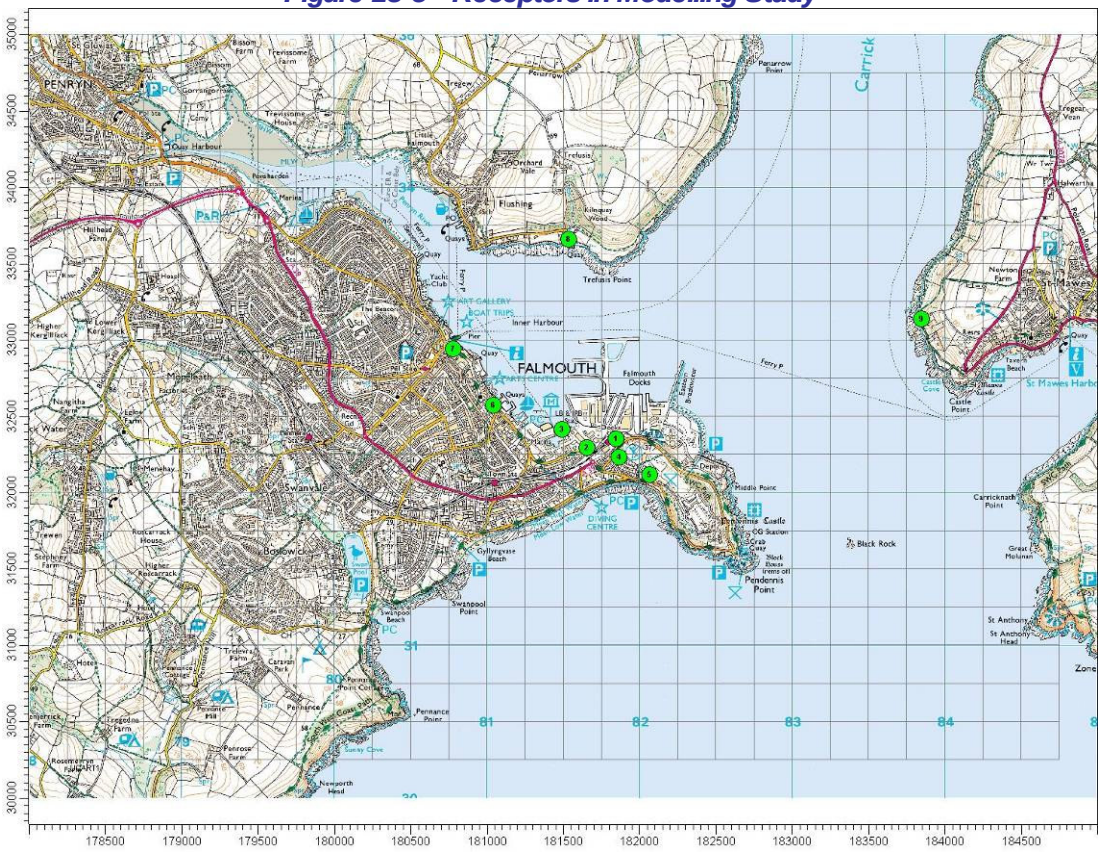


Figure 18-5 - Receptors in Modelling Study



The resulting concentrations, not including background concentrations, at sensitive receptors are shown in Table 18-6 and Figures 18-6 to 18-12. These indicate that the resulting pollutant concentrations are unlikely to affect the relevant air quality objectives. It should be noted that the concentrations given are the maximum recorded for each averaging period, whereas most objectives allow a number of exceedances of the threshold concentration each year (see Table 18-2***).***

Table 18-6 Construction Phase Pollutant Concentrations (µg.m^3)

	NO_2		SO_2			PM_{10}	
Re-ceptor	**1 hour max**	**annual mean**	**15-min max**	**1 hour max**	**24 hour max**	**24 hour max**	**annual mean**
1	41	0.8	61	47	3	0.3	0.03
2	47	0.6	69	53	3	0.3	0.03
3	60	0.7	89	68	3	0.3	0.03
4	29	0.6	42	33	3	0.3	0.03
5	48	0.6	45	34	3	0.3	0.02
6	59	0.7	89	68	3	0.3	0.02
7	65	0.4	87	66	3	0.3	0.01
8	33	0.5	50	41	5	0.5	0.02
9	109	0.3	165	125	5	0.6	0.02
AQO	**200**	**40**	**266**	**350**	**125**	**50**	**40**

Figure 18-6 Hourly Maximum Nitrogen Dioxide (µg.m^{-3})

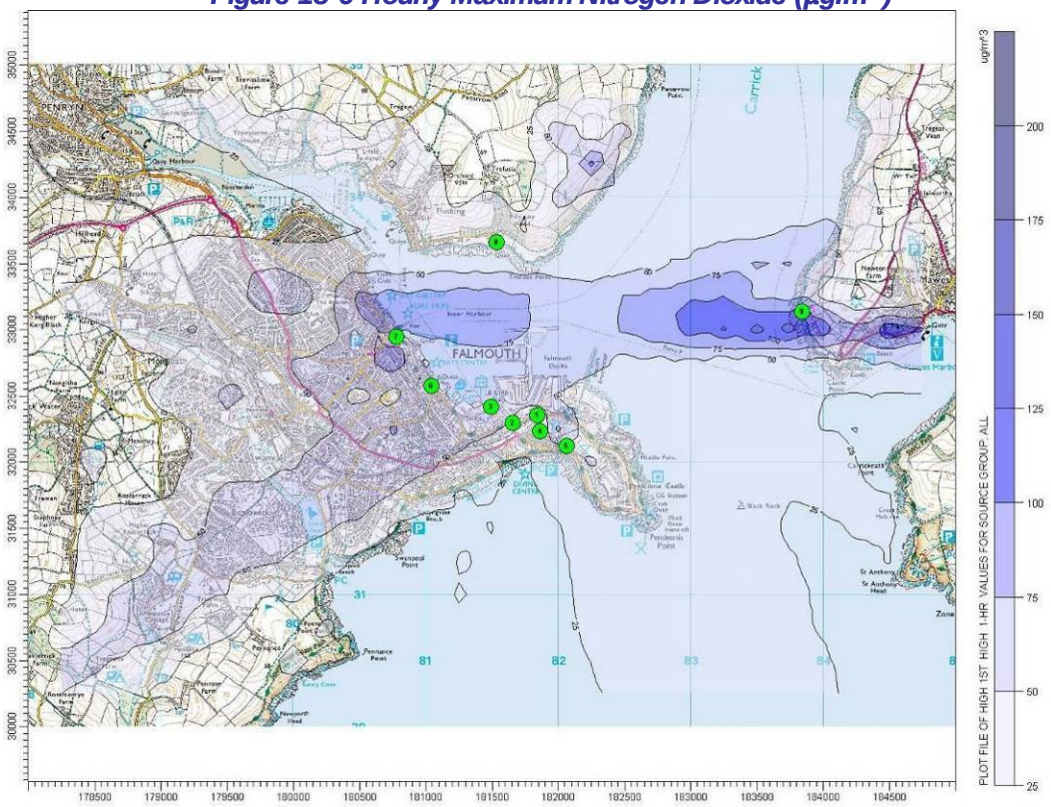


Figure 18-7 Annual Mean Nitrogen Dioxide (µg.m^{-3})

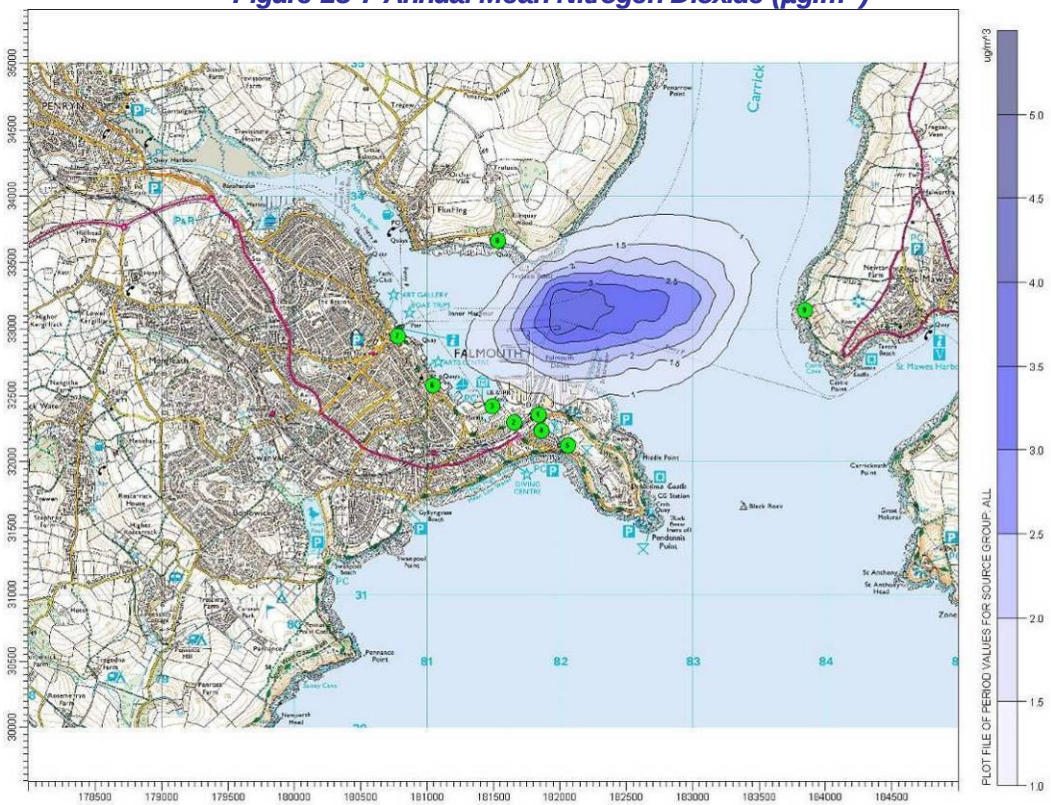


Figure 18-8 Daily Maximum PM_{10} (µg.m^{-3})

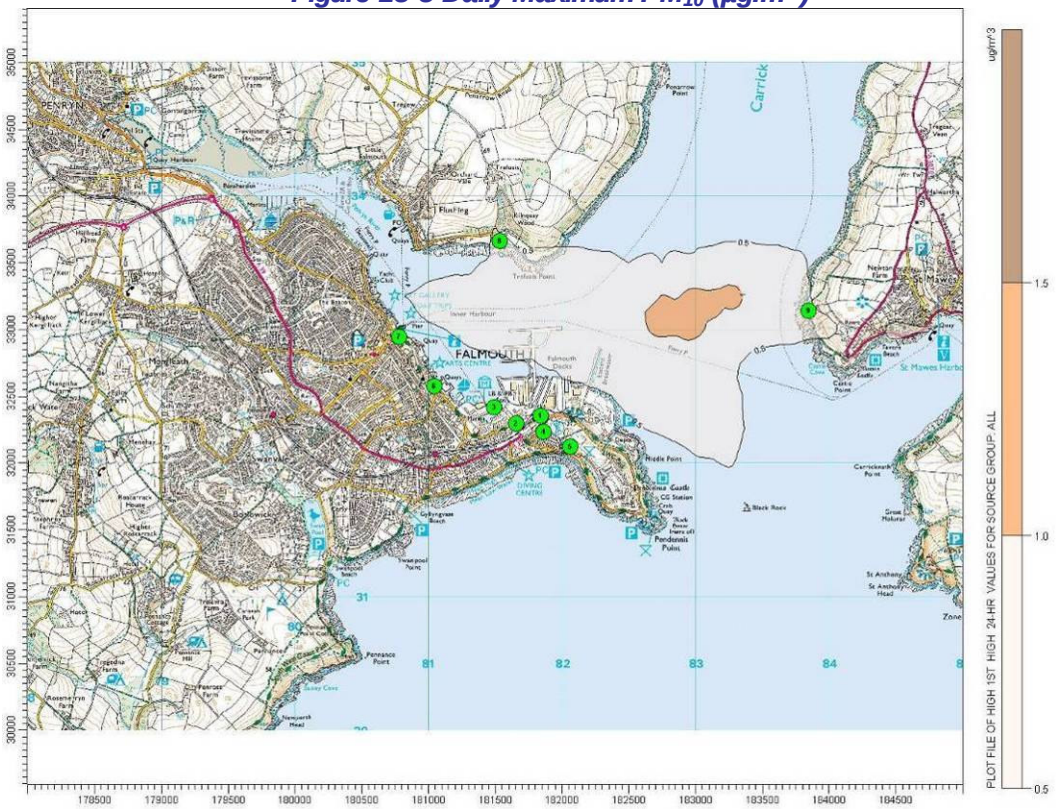


Figure 18-9 Annual Mean PM_{10} (µg.m^{-3})

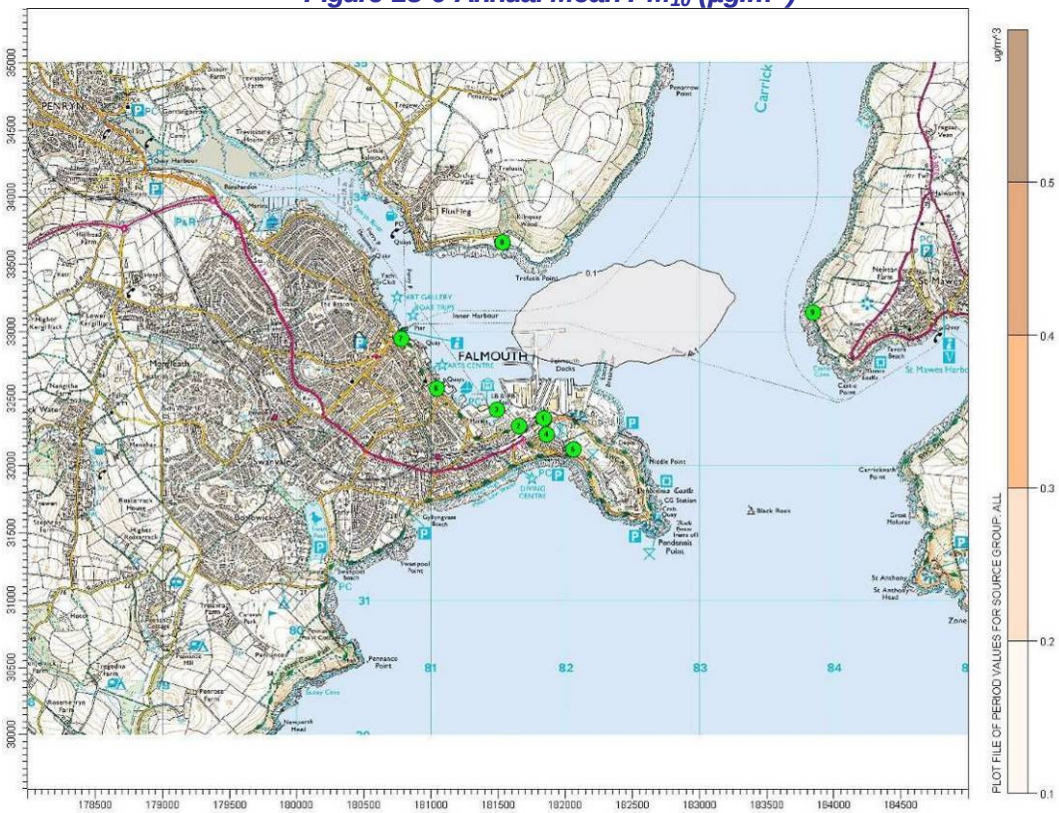


Figure 18-10 Hourly Maximum SO_2 ($\mu g.m^{-3}$)

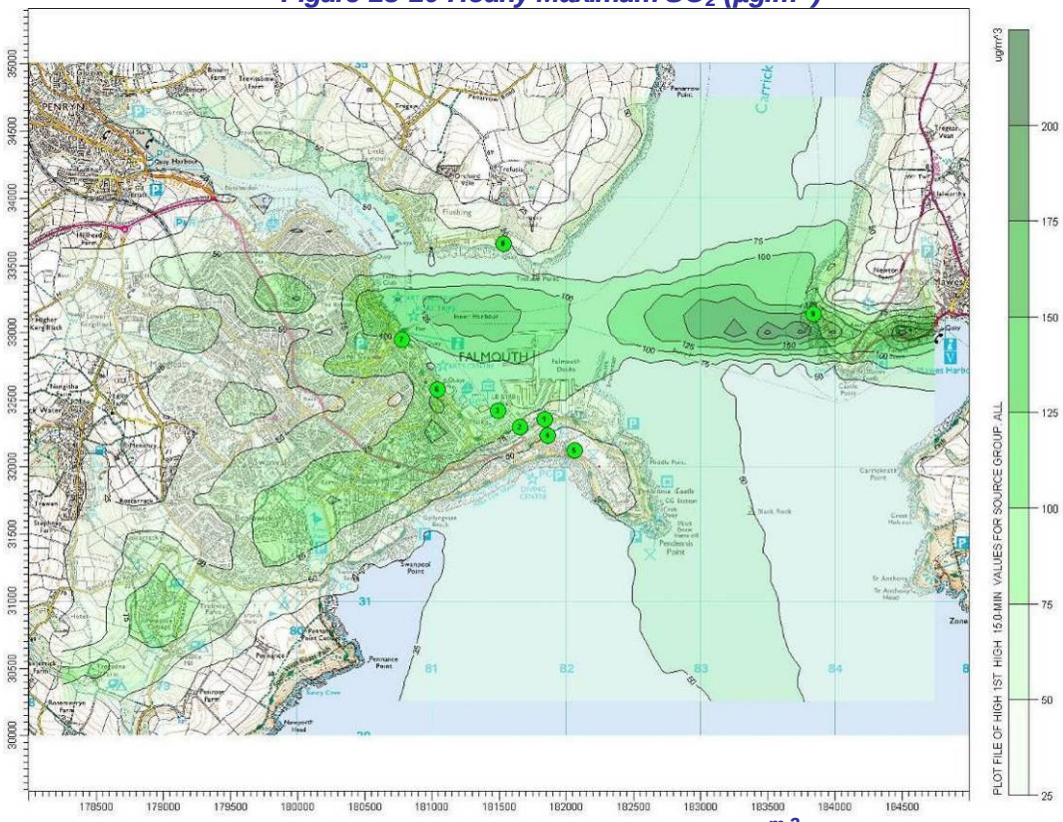


Figure 18-11 Daily Maximum SO_2 ($\mu g.^{m-3}$)

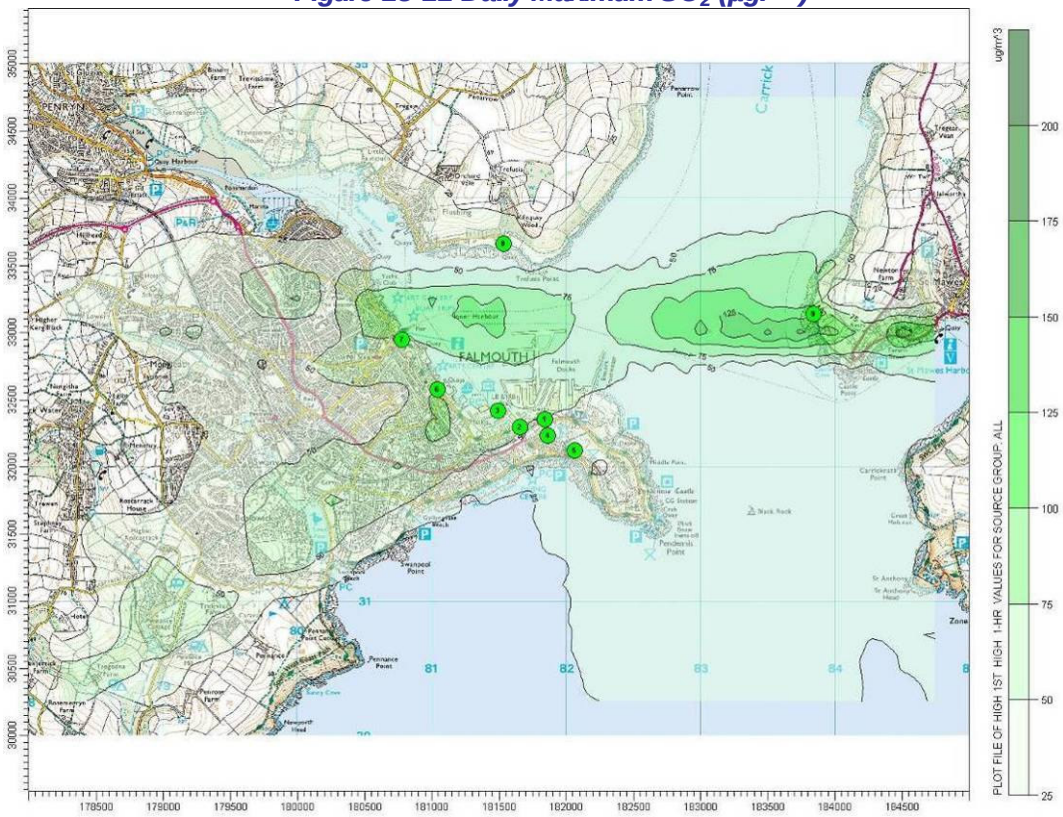


Figure 18-12 Annual Mean SO_2 ($\mu g.m^{-3}$)

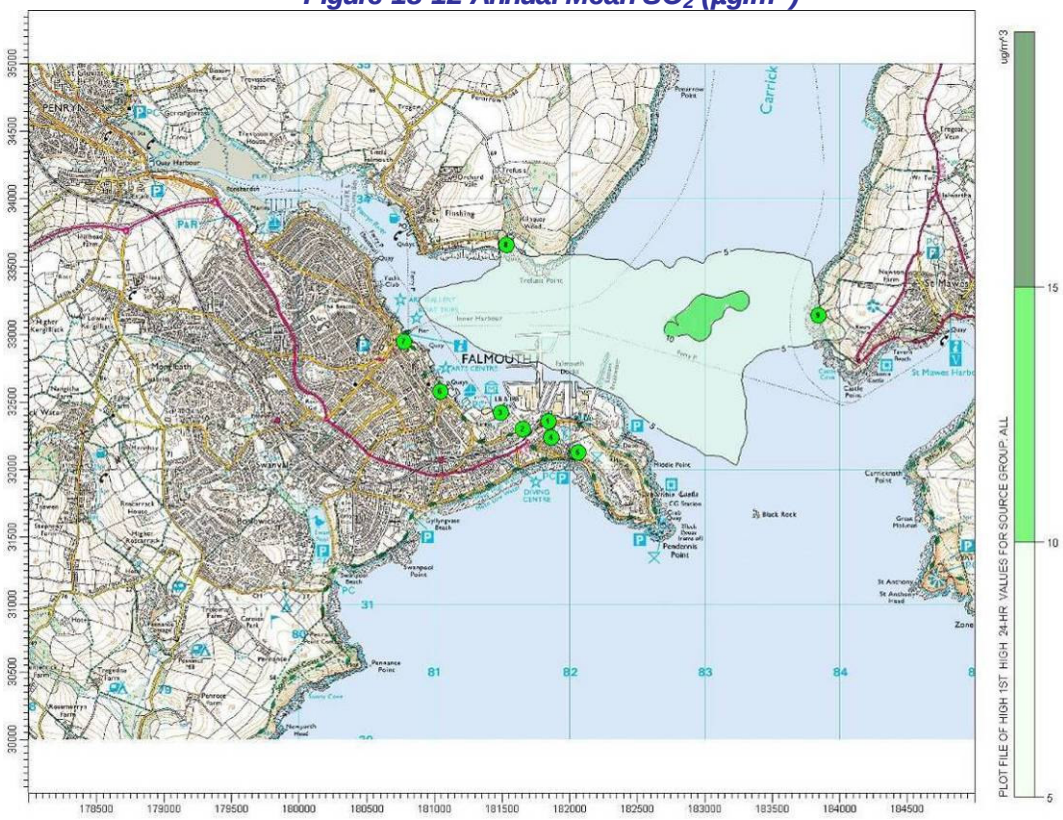


Table 18-6 and Figures 18-6 to 18-12 indicate that predicted air pollutant concentrations resulting from emissions from dredging activities are unlikely to give rise to any exceedances of the relevant air quality objectives at sensitive receptor locations.

However, given the scale of development and the distance to residential and other receptors in closest proximity to the activities, it is possible that uncontrolled fugitive dust emissions from site will give rise to intermittent adverse local effects. As the construction activities are deemed to be of medium risk in terms of potential dust releases, a potentially temporary and reversible moderate adverse impact is predicted. A range of industry good practice measures for the management and control of dust emissions is therefore proposed.

Mitigation and Residual Impact

An environmental management plan would be expected to be compiled for a project such as this, and this would typically include the following site controls and management techniques:

For site planning:

- erect solid barriers to site boundary;
- no bonfires should be permitted on site;
- the site layout should be arranged such that machinery and dust causing activities are located away from sensitive receptors;
- the site haul routes should be hard-surfaced, and
- a person responsible for dust management and controls should be identified

For construction traffic:

- all vehicles to switch off engines – no idling vehicles should be permitted on site;
- effective vehicle cleaning and specific wheel-washing on leaving site;
- all loads entering and leaving site to be covered;
- no site runoff of water or mud;
- on-road vehicles to comply with minimum exhaust emission standards; and
- hard surfacing and effective cleaning of haul routes and appropriate speed limit around site.

For demolition works:

- use water as dust suppressant;
- cutting equipment to use water as suppressant or suitable local exhaust ventilation systems;
- securely cover skips and minimise drop heights; and
- enclose buildings to be demolished.

For site activities:

- minimise dust generating activities;
- use water as dust suppressant where applicable;
- enclose stockpiles or keep them securely sheeted; and
- if applicable, ensure concrete crusher or concrete batcher has an Environmental Permit to operate.

For non road mobile machinery (NRMM):

- all NRMM and plant should be well maintained: if any emissions of dark smoke occur then the relevant machinery should stop immediately and any problem rectified;
- all NRMM to use ultra low sulphur tax-exempt diesel (ULSD) where available;
- all NRMM shall comply with either the current or previous EU Directive Staged Emission Standards (97/68/EC, 2002/88/EC and 2004/26/EC): as new emission standards are introduced the acceptable standards will be updated to the previous and most current standard;
- all NRMM shall be fitted with Diesel Particulate Filters (DPF) conforming to defined and demonstrated filtration efficiency (load/duty cycle permitting); and
- the ongoing conformity of plant retrofitted with DPF, to a defined performance standard, shall be ensured through a programme of on-site checks.

Implementation of energy conservation measures including instructions to:

- throttle down or switch off idle construction equipment;
- switch off the engines of trucks while they are waiting to access the site and while they are being loaded or unloaded; and
- ensure equipment is properly maintained to ensure efficient energy consumption.

Implementation and ongoing management of the recommended mitigation measures above will control and reduce dust emissions and construction activities would be predicted to give rise to a temporary, minor adverse residual impact.

18.5 POTENTIAL IMPACTS DURING THE OPERATIONAL PHASE

18.5.1 Impact on Air Quality due to Cruise Vessels

Predicted vessel calls at Falmouth are detailed in Section 2.4.1. The total number of turnaround and day calls is expected to increase from 46 in 2008 to 68 in 2020. Vessels are also likely to be larger with increased engine size and emissions.

However, as noted above, the current level of vessel activity at Falmouth, with fewer than 5000 vessel calls, is not considered to be significant enough that air quality objectives for sulphur dioxide are likely to be affected. The increase in vessel calls as a result of the scheme is not considered to be significant in the context of this guidance threshold, published by Defra[12]. Furthermore, the European Directive on the sulphur content of marine fuels now requires passenger vessels operating between EU ports and all vessels in the North Sea and English Channel to use fuels containing less than 1.5% sulphur (previously 4.5%). From 2010 vessels at berth will be required to use fuel containing less than 0.1% sulphur. Emissions of SO_2 from vessels are directly proportional to the sulphur content of the fuel. Therefore, it can be concluded that these measures will ensure that the proposed increase in vessel activity is very unlikely to affect air quality objectives for SO_2.

In terms of other pollutants, road traffic rather than shipping has been identified as the major contributor to air quality problems in Falmouth. It is likely that the prevailing south-westerly wind and low frequency of easterly winds, shown in Figure 18-4, means that Falmouth is rarely affected by emissions from vessels. The location of the berth will move from the County Wharf to Queens Wharf. This relocation, moving the berth further from residential properties, is likely to result in a minor benefit to local air quality.

Overall, it is predicted that the increase in vessel size and number of calls will have a minor adverse impact on local air quality.

Mitigation and Residual Impact

No mitigation measures are recommended and a minor adverse residual impact will remain.

18.5.2 Impact on Air Quality due to Cruise Passenger Traffic

The Arup (2008) report indicated that significant numbers of additional passengers are likely to pass through the port with the development in operation. It is likely that additional vehicles will use the A39 through Falmouth, including Dracaena Avenue. Local monitoring has shown that the air quality objective for annual mean NO_2 is currently being exceeded at the junction with Grenville Road so the impact on nearby residential receptors should be assessed.

A quantitative assessment of traffic related air quality is not possible without a TA to establish baseline and predicted traffic numbers, but it is probable that up to a moderate adverse impact could arise as a result of the movements of extra vehicles on the roads.

Mitigation and Residual Impact

It is recommended that a TA is conducted in order to refine the impact assessment on air quality, and, if necessary, to derive suitable mitigation measures to reduce the residual impact to acceptable levels.

With the findings of the TA in place and mitigating measures adopted, it is anticipated that there will be a minor adverse residual impact.

19 LANDSCAPE AND VISUAL SETTING

19.1 INTRODUCTION

This section of the ES summarises the Falmouth Cruise Project Landscape and Visual Impact Assessment (LVIA) prepared by CEC (2008) (see Appendix G). It covers the predicted direct and indirect landscape and visual effects of the proposed Falmouth Cruise Project on potentially sensitive receptors. A clear distinction is made between landscape effects and visual effects, which are discussed in separate sections. It should be noted that where visual amenity is cited as a key element in the value or purpose of a landscape designation or landscape character area, it is discussed as integral to the landscape receptor. Predicted visual effects are solely concerned with the potential changes to views experienced by contemporary human receptors from publicly accessible areas or residential properties.

Consultation took place with CDC to agree the overall approach to the LVIA, including issues with the proposed project and determination of preferred viewpoints and the five photomontages locations used to inform the LVIA.

19.2 ASSESSMENT METHODOLOGY

19.2.1 Baseline Data Collection

Information used in the LVIA was derived from the publicly available documents and online database sources listed in the references in Appendix G. Information was gathered through:

- a desktop study identifying the main landscape designations relevant to this study, listing existing landscape character information and outlining the planning background;
- detailed field observations covering site appraisal (i.e. land uses, vegetation, context, etc) and a visual analysis of the study area using viewpoints as a guide in identifying potential visual receptors;
- brief appraisal of long distance views and landscape character areas within the study area to confirm and inform desk study results; and
- analysis of maps including topographical data.

19.2.2 Survey

Zone of Theoretical Visibility

Appendix G describes how the Zone of Theoretical Visibility (ZTV) has been generated using the computer program KeyTerraFirma (Version KTF 7.00 with AutoCAD Map 3D 2007). A ground model was generated from Ordnance Survey Landform Profile data in xyz (DTM) format to a 10m grid. The model covered a 12 by 12km data square allowing for full coverage of a 5km radius around the study area.

In addition, a number of ZTV models were generated for the visually most prominent components of the scheme, including:

- ZTV for the proposed terminal building at approximate eye height of main body of building;
- ZTV for the proposed terminal building at approximate tower height;

- ZTV for the cruise ship at the quay at approximate half ship height above sea water; and
- ZTV for the cruise ship at the quay at maximum height of ship height above sea water.

19.2.3 Assessment Criteria

Appendix G describes the assessment criteria for the LVIA in terms of qualitative values for landscape (very poor to exceptional), landscape receptor sensitivity (low to high), and visual receptor sensitivity (low to high).

19.2.4 Assessment Technique

The LVIA methodology is based on the principles outlined in the Guidelines for Landscape and Visual Assessment (The Landscape Institute, 2002), which is widely accepted as the industry standard.

19.2.5 Assessment of Impact Significance

As described in Appendix G, impact significance is based on a combination of receptor sensitivity and the magnitude of change to the landscape or visual receptor (negligible to high). Assessment is based on professional judgement using the scale outlined in Table 19-1 below.

Table 19-1 Degree of Effect Matrix and Impact Significance

		Sensitivity		
Assessment Criteria		High	Medium	Low
Magnitude	High	Substantial	Moderate/Substantial	Moderate
	Medium	Moderate/Substantial	Moderate	Slight
	Low	Moderate	Slight	Negligible
	Negligible	Slight	Negligible	Negligible
Significant			Not significant	

19.3 BASELINE ENVIRONMENTAL CONDITIONS

19.3.1 Land Use

The landside components of the proposed project are located within the existing Falmouth Harbour and Docks area. The wharves area including the reclamation is made up of artificial ground, purpose built for harbour and dock uses. The eastern docks area including the car park and existing waste tip area is partially on existing ground, and partially on a waste tip modified by armouring, fill, grading and surfacing. The majority of surfaces within the site consist of hard and gravel surfaces of various types, including concrete and tarmac. The existing car park is partially on top of a former waste tip. Some of the structures are built of timber dating back to earlier days of dock operation. The site is currently used for dock and harbour activities including mooring, maintenance, loading and unloading of large ships, operation of cranes and storage of materials.

19.3.2 Site Boundaries

The Queens and Northern Wharves, including the reclamation, are bounded by water on all sides, except the narrow access point from the main dock area to the south. The boundaries are not fenced or specially delineated other than by the change between land and water.

In the eastern docks, the existing car park has a sea-facing northern boundary, which is partially affected by erosion (where there is no rock armour). The western boundary runs along a vegetated slope. The southern boundary roughly follows the access track to the car park. There are dock uses to the west and south, including storage tanks. A South West Water tank is partially overlapping the site eastern boundary, which runs across an area of compacted gravel and hard standings.

19.3.3 Access and Circulation

Access to the main proposal site by land can only be gained from the south via a hardcore and concrete track running on wharf structures. Access by water exists from the west, north and east, via the Queens Wharf, Northern Wharf and Western Wharf. Although the site is not secured by fencing, the security policies and measures applicable to the docks and harbour area apply and access is controlled via those.

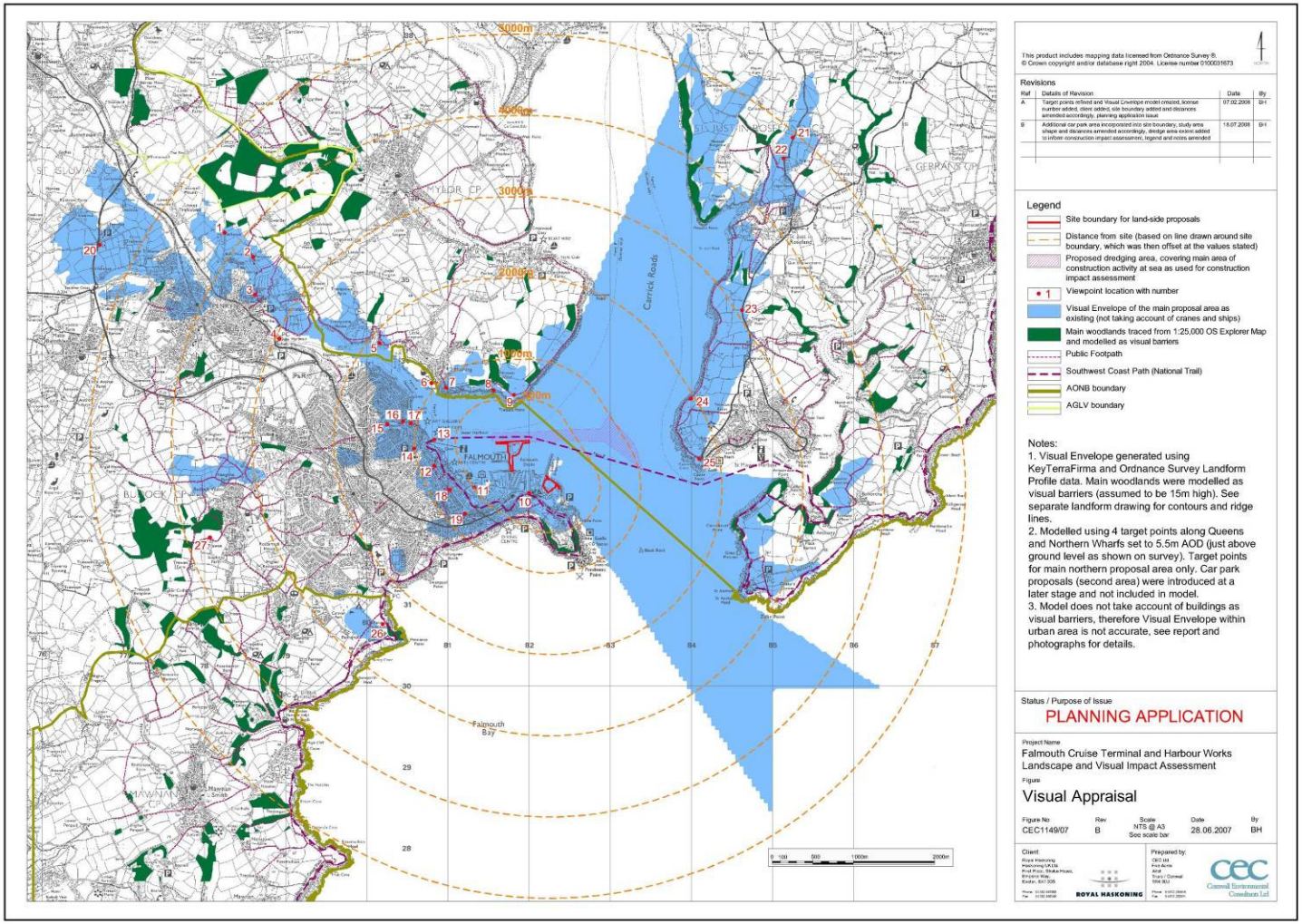
The existing car park is accessed via concrete and tarmac surfaces through the docks, then turning into a hardcore and gravel track near the site boundary. Cruise passengers are normally escorted from the docks entrance to the car park and then taken by bus to the departure point. There is no access from the water to the car park.

19.3.4 Public Rights of Way

There are numerous public footpaths and rights of way within the study area, including a dense network of roads in the Falmouth and Penryn areas. The Southwest Coast Path National Trail runs through the study area. It is shown on the GIS mapping to include the ferry crossing from the Prince of Wales Pier Falmouth to St Mawes. The Falmouth-St Mawes ferry route runs past the site in close proximity to the north. Public rights of way are illustrated on Figure 19-1.

No open access land was identified to be located within the study area.

Figure 19-1 Visual Appraisal Baseline (source: CEC, 2008)



19.3.5 Vegetation

There is no vegetation on the main proposal site. Although there are a few strips of rough grass, those have developed on soil and debris deposits on man-made ground below. The appearance of the site is therefore hard and unscreened.

The existing car park does have some taller vegetation on the slopes between the upper and the lower level and that along the western site boundary. The vegetation mainly consists of self-seeded buddleia, brambles and a few other shrubs. Although not particularly valuable in the wider context, the strips of taller vegetation do break up this area in views from Trefusis Point and from water areas to the north of the site including the Southwest Coast Path water route. The strips help to tie the site in with the greener slopes to the east and in the back and screen some of the cars parked in the lower level in views from there.

In the wider area, Falmouth and Penryn urban areas do not feature much vegetation, only a few treetops can be seen between the houses. The rural landscapes within the study area, in contrast, are characterised by good tree and shrub cover along hedge lines and a number of woodlands and copses. Combined with the undulating topography, this creates a small-scale and intimate landscape in many areas to the south, west and north of Falmouth and Penryn. Tree cover on the Roseland Peninsula is slightly less evident in comparison to the western study area.

19.3.6 Topography

The main proposal site is flat and raised just above the sea water level (approximately 5.3m AOD), being a man-made surface created to support marine activities associated to the docks and harbour.

The existing car park lower level is also raised just above the sea level (approximately 5m AOD), but the upper level on top of the former waster tip is slightly higher (approximately 10 to 10.5m AOD).

The landform within the study area is undulating and sometimes rolling, creating a relatively small to medium scale landscape. There are wider views from the ridgelines, but often those are cut short by tall vegetation along hedge lines and woodlands on slopes.

The undulating inland character is in contrast with the often steep coastal areas, cliffs and long views from shore lines to opposite landscapes.

19.3.7 Water Sea and Drainage

There is open sea to the south of the study area, extending into the study area with the Carrick Roads and Falmouth and Penryn Rivers. The site and study area is dominated by the seaside location and associated marine influences. The Carrick Roads narrow into Falmouth River to the north of the study area. Within the study area, a number of creeks spur off the main Carrick Roads (Penryn River, Mylor Creek and Restronguet Creek on the Falmouth / Penryn side and Pencuil River and associated creeks on the St Mawes side). The undulating landscape with steeper falls towards the sea results in

presence of many local streams running along shaded local valleys, which adds to the character in the area.

There is no specific site drainage; rainfall runs off into the sea. Proposals for the Falmouth Cruise Project do not include for changes to the existing surface drainage (i.e. water will continue to run-off the site into the sea). However, it is assumed that the new cruise terminal building will be connected to the sewage and drainage system or have a closed sewage and waster water collection system.

19.3.8 Buildings and Settlements

Existing buildings on the main proposal site are limited to temporary storage and two small maintenance buildings. Those are likely to be removed and / or relocated as part of the marina and cruise terminal works. There are large industrial halls and buildings just to the south of the site in the main docks area. The site is seen in the foreground to the large halls and buildings in all views from the northern landscape areas, merging into that background.

The existing car park does not accommodate buildings. It is located in front of a number of round storage tanks, including a large light green South West Water tank with a domed roof. There are larger buildings and structures to the west of the site.

Falmouth's urban areas are in immediate vicinity to the site in the south and southwest. This includes larger buildings such as the Ships and Castles Leisure Centre and the Maritime Museum and Events Square. Penryn is located to the northwest of the site, approximately 3km distant.

In addition to Penryn and Falmouth, there are a number of small towns and villages within the study area. Those are Budock Water, Mylor, Flushing, St Just in Roseland and St Mawes. Restronguet Point at the southern end of Devoran also encroaches into the study area.

Farmsteads and converted barns are characteristic for the settlement pattern in the area. There are also many campsites and some holiday villages. The latter are mostly well screened and hidden by the landform in longer views.

Pendennis Castle and St Mawes Castle are imposing features to either side of the entrance to Carrick Roads. They are Scheduled Monuments and have a strong visual influence on the landscape as well as a strong visual link between each other (see Figure 19-2).

Figure 19-2 Extract from Photomontage from Viewpoint 10



19.3.9 Infrastructure

Transport

Falmouth and Penryn are busy urban centres connected to Truro and other areas in Cornwall by the A39, the main road transport corridor in the area. There are no motorways in the study area. Roseland Peninsula is relatively isolated, the quickest access to it being via the King Harry Ferry north of the study area.

Waterways are an important means of transport in the area. There are regular ferries running between Falmouth and St Mawes. Summer routes include Falmouth – Helford River and ferries going up Carrick Roads and Falmouth River to destinations like the Smugglers Cottage and Trelissick Gardens.

Falmouth Harbour is one of the largest natural deep sea harbours in the world and large ships can always be seen on the approach routes to Carrick Roads. Sometimes several large vessels are anchored at sea just outside Falmouth waiting for service boats or entry to the harbour (can be observed for example from Gyllyngvase Beach, a popular destination for residents of Falmouth and visitors alike).

Falmouth is already a cruise ship destination. For example, in 2007 the Queen Victoria vessel came to Falmouth being a tourist attraction to watch from the surrounding coastal areas and Falmouth. In 2008, Falmouth is set to host the Tall Ships Races.

Pylons, Masts and Overhead Power Lines

No major power lines were identified in the study area. Masts and pylons are not a common feature. There are tall cranes associated with the existing docks and harbour, which are a prominent feature in many views. No wind farms are located within the study area.

Marine Developments

These are prominent and dominant features within the study area, located around the site and along Carrick Roads, the rivers, creeks and coastal areas. The most important one is the Falmouth Docks and surrounding harbour sites within the centre of the study area. The docks are visible from many vantage points in the area, marked by its cranes and large industrial buildings. One of the main views is from the docks viewing area at Pendennis Road.

There is a flurry of private boats and yachts present on the waters within the study area, moored in various marinas and mooring places around the edges of the rivers and creeks. The number of boats is illustrated on many of the photographs in Appendix G, Appendix 3. They have a major influence on the visual scene and contribute much of the marine character of the area. Examples are the Falmouth Marina, Penryn Harbour and Mylor Yacht Harbour.

The ferry system is served by a number of quays and piers in the area, including Prince of Wales Pier and Custom House Quay in Falmouth, Flushing and St Mawes Quays and local drop-off points.

The marine industry entails a number of businesses including boat yards, specialised boat dealers, storage areas and water sports centres. These lead to a variety of larger buildings and structures along some of the coastal stretches, especially in the Penryn and Flushing areas (for example Ponsharden Boatyard).

19.3.10 Designated Sites

Area of Outstanding Natural Beauty (AONB)

The study area includes areas of the Cornwall AONB as close as 400m to the site boundary; the essential elements of each are outlined below.

Key aims and policies of the AONB Management Plan that are also of relevance to the proposed development are described below.

Policy WL 2 Encourage the development of a sustainable approach to the management of the tourism industry in Cornwall to benefit the economy, community and natural beauty of the AONB.

To be achieved by applying the recommendations of research carried out by the Cornwall Tourism Forum to ensure landscape management is adequately planned and funded in order to maintain the quality of the landscape to which tourism is so closely linked.

Policy CL 2 Ensure appropriate management of sites, structures and landscapes designated for their international, national, regional or local importance in the historic environment.

To be achieved by ensuring that landscape and historic landscape character assessment is reflected in local design guidance and by producing a specific design guide for the Cornwall AONB.

Given the proximity of the Cornwall AONB to the proposed development site and the potential significance and likelihood of effects of the proposed development on its landscape and visual amenity, it has been scoped into the remainder of this assessment as a potential landscape receptor. Potential effects on views experienced by visitors to and residents of the Cornwall AONB will be assessed separately in the LVIA if they are located in areas indicted by the ZTV and field observations as having visibility of the development.

South West Coast Path (National Trail)

The South West Coast Path runs along the coastline across the study area for approximately 31km of its 1,014km total length from Minehead to Poole, with one section from Falmouth to St Mawes on a waterway by ferry passing the site immediately to the north. None of the path is located within the proposed project area, but does cross the existing and proposed new navigation channels.

The path is promoted as of interest for its scenic value with wide, dramatic, and varied views of rugged cliffs and sheltered valleys along the coast, as well as its wildlife, heritage, geological and cultural interest.

Given that the path is not located within the proposed project area (other than the variable water section within the new navigation channel) and therefore neither its physical fabric nor its designation can be directly or significantly affected by the proposed development, it has been scoped out of the remainder of this assessment as a potential landscape receptor. Potential effects on views experienced by users of the path will be assessed separately in the LVIA if they are located in areas indicted by the ZTV and field observations as having visibility of the development.

Heritage Coast

Heritage Coasts are non-statutory designations that are applied to ensure their natural beauty and heritage value is conserved. They are defined by agreement between the relevant local authority and Natural England and generally managed as part of an AONB.

Within the study area there is one section of Heritage Coast of relevance to the assessment: 29 The Roseland. Stretching for 54.2km along the southern coast of Cornwall The Roseland's southern end extends across the north of the study area. It is described by Natural England as "a more gentle coastline, still dominated by cliffs but with smoother lines softened by coastal heath and scrub, curving around bays containing sandy beaches, but becoming rugged on promontories such as Dodman and Chaple Points. The colours and lushness of the historic park and gardens around Caerhays Castle are evidence of the mild maritime climate."

Heritage Coasts are defined by their coastal character, and generally 'unspoilt' nature, with views and visual amenity focussing on the sea, up tidal creeks and along the coastline itself. The majority of the Roseland is physically and visually separated from the site by higher ground rising behind St Mawes and St Anthony Head which serves to reinforce the coastal landscape character and restrict views looking west and inland. Although a relatively small proportion of the overall area, elevated locations along the stretch of coast from St Anthony Head north to St Just in Roseland may experience open and partial views of the proposed development.

Given the proximity of the Roseland Heritage Coast to the docks and the potential significance and likelihood of effects of the proposed development on its landscape character and visual amenity, it has been scoped into the remainder of this assessment as a potential landscape receptor. Potential effects on views experienced by visitors to and residents of the Roseland Heritage Coast will be assessed separately in the Visual Assessment if they are located in areas indicted by the ZTV and field observations as having visibility of the development.

Cornwall and West Devon Mining Landscapes World Heritage Site (WHS)

World Heritage Sites are ratified by UNESCO's World Heritage Committee for their outstanding and universal cultural and heritage value, inclusion on the list of sites also encourages their active promotion and management. The Cornwall Mining WHS is managed as a "…distinctive, evolving, living pattern of landscapes…" by a partnership project based at Cornwall County Council.

Inscribed in 2006, the Cornwall Mining WHS is considered of importance due the substantial remains of the 18th and 19th century copper and tin mining industry which are a "…testimony to the contribution Cornwall and West Devon made to the industrial revolution in the rest of Britain and to the fundamental influence the area had on the mining world at large…". The WHS consists of several areas across Cornwall, with the Carnon Valley on the southern tip of the Gwennap – Chacewater district extending a short way into the north of the study area approximately 5km from the development site. The valley was significant for its location on the Fal estuary with the important copper port of Devoran and unique Carnon Stream Mine, the setting of the area is described on the Project's website as now being characterised by small scale settlement in evidently planned small scale field patterns.

Given the distance of the area from the proposed development site and the very small part of this designation being just within the study area, it is considered that no effects on the character and visual setting of the area will arise as a result from the proposed development. It has therefore been scoped out of the remainder of this assessment as a potential landscape receptor. It is also unlikely that visitors to the WHS or residents of the area will experience any views of the development; they have therefore also been scoped out of the remainder of the assessment as potential visual receptors.

Scheduled Monuments

SMs are designated by English Heritage under the Ancient Monuments and Archaeological Areas Act 1979 and the National Heritage Act 1983 and are considered to be of national significance for their historic, architectural, traditional, artistic or archaeological interest. The designation effectively preserves the monument in the state in which it was designated with any works within the monument site requiring consent from English Heritage.

There are no SMs located within the proposed development site boundary likely to experience direct landscape effects as a result of the development. The fortifications around Pendennis and St Mawes Castles are listed, and given their elevated location likely to experience effects to the visual character of their setting. The key points of relevance to the assessment are.

10552 Pendennis Peninsula Fortifications:

- projects south-eastwards into Falmouth Bay and, with St Anthony's Head and St Mawes, guards the entrance to the Carrick Roads, a large natural anchorage with a long and distinguished commercial and naval history;
- incorporates numerous important defensive structures dating from the Prehistoric period to the 20th century;
- is one of the finest examples of a post-medieval defensive promontory fort in the country; and
- demonstrates the development of coastal defence from Tudor to modern times and has not suffered losses due to recent demolition or development.

15420 St Mawes Castle:

- includes an early 16th century artillery castle at St Mawes, on a broad headland flanking the east side of the Carrick Roads;

- the wider curtilage which includes a blockhouse, the artillery castle, magazines and outer defences in this monument are Grade I Listed and this monument is contained within a wider area in the care of the Secretary of State; and
- the monument is an important and rare example of the development of such defences, with interpretative value given a wider context by the association with St Anthony Head and Pendennis.

15421 Early 20th century Gun Battery 150m north of St Mawes Castle:

- situated on the upper slope of a broad headland flanking the east side of the Carrick Roads;
- design and location reflects major developments in armament technology, the nature of the perceived threat and defensive policy; and
- set in its wider context by the monument's association with the surviving and complementary defences at Pendennis and, for later periods, St Anthony's Head.

Though setting is not noted per se in any of the listings, the importance of the location of the monuments in close proximity therefore each enhancing the context of the others, is cited as one reason for their importance. The development of Falmouth Docks and presence of large navy ships may already have influenced the modern setting of the monuments but given the reference to the importance of context and potential effects on this as a result of the proposed development, they have been scoped in as a grouped potential landscape receptor. Visitors to the monuments may be assessed as visual receptors if publicly accessible areas are indicated by the ZTV as having visibility of the proposed development.

Registered Parks and Gardens

Registered Parks and Gardens are designated by English Heritage to protect their special historic interest; some may also have particular amenity or other interest. There are no RPGs within, or immediately adjacent to the proposed development site though there are a number in the general study area as follows:

- Enys approximately 3.6km north of the development site, one of Cornwall's oldest gardens to the west of Mylor;
- Falmouth General Cemetery approximately 1.6km south east of the proposed development site, on the opposite face of the Pendennis Headland overlooking Swanpool; and
- Penjerrick approximately 4km south east of the proposed development site, in a wooded valley leading down to Maenporth.

Due to the physical and visual separation of the RPGs from the site and the nature of the majority of their views being internal or screened by vegetation, it is unlikely that any of the RPGs will experience effects to their fabric or setting as a result of the proposed development. They have therefore been scoped out of the remainder of the assessment as landscape receptors, visitors to the gardens may be assessed as visual receptors if publicly accessible areas are indicated by the ZTV as having visibility of the proposed development.

Areas of Great Landscape Value

Designated by Cornwall County Council under Policy 2 of the Cornwall Structure Plan, Areas of Great Landscape Value contribute to the overall aim of the policy to 'protect and enhance the character, diversity and local distinctiveness of the natural and built environment of Cornwall.' Kerrier District Council implements AGLVs under Policy Env4 Landscape – Siting and Design in the Areas of Great Landscape Value of the Kerrier District Local Plan within which development will not be permitted unless the siting and design seeks to conserve the characteristic "degree of exposure of the open countryside, patterns of settlement and traditional locally distinctive building styles" and "there is no significant harm to the appearance, visual amenity or character of its landscape of county wide value".

The St Gluvias AGLV lies approximately 3.6km northwest of the development site, separated from it by the Penryn River and undulating landscape with some development and settlements. It is designated in the Kerrier Local Plan as AGLV 314, with a small part extending over the Carrick District Boundary where it is covered by Policy 3D of the Carrick District Wide Local Plan. It includes part of the deeply incised and wooded Kennall Vale and the river valley around Ponsanooth with an overall character defined by an intimate scale landscape becoming more of a parkland landscape to the east around Enys House and woodlands.

The area is physically separated from the development site, only a small part of the designation is within the study area and the ZTVs do not show the area as being affected visually. The AGLV has therefore been scoped out of the remainder of the assessment as landscape receptor, visitors to the AGLV have also been scoped out as visual receptors due to lack of visibility.

Conservation Areas

Conservation Areas are designated by Carrick District Council under the following policies:

- Generally - Policy 4F which states that "Proposals for development in a Conservation Area should preserve or enhance the special character of the area in terms of scale, height, form and massing, respecting the traditional pattern of frontages, vertical or horizontal emphasis, detailing and materials."
- Setting - Policy 4M which states that "Proposals which significantly adversely affect the setting of a Conservation Area and/or inward or outward public views which contribute to the character of the Conservation Area will not be approved."

Polices 4G to 4L are also relevant to specific design issues within conservation areas. Conservation Areas within the study area include Falmouth to the south (approximately 150m at closest point) and west (approximately 700m at closest point) of the development site, Flushing approximately 900m north west of the development site, St Mawes approximately 2km east of the development site, Penryn approximately 3km westnorthwest of the development site, and Mylor approximately 3.5km to the north. Given their proximity and existing visual connection to the development site and therefore the potential for effects on setting, the Falmouth and Flushing Conservation Areas have been carried forward as potential landscape receptors. The Penryn and Mylor Conservation Areas have not been carried forward as they are physically and visually separated from the development site by landform. The St Mawes Conservation

Area has not been shown to be within the Visual Envelope of the site and ZTVs for the proposals, therefore no effects can occur, and it has been scoped out of the assessment.

Ancient Woodland

Ancient woodland, recorded on the Ancient Woodland Inventory for England, is defined by Natural England as any area of woodland over 2ha on the 1920s Ordnance Survey maps which is either:

- "Ancient semi-natural woodland - ancient woodland sites that have retained the native tree and shrub cover that has not been planted, although it may have been managed by coppicing or felling and allowed to regenerate naturally; or
- Ancient replanted woodland - ancient woodland sites where the original native tree cover has been felled and replaced by planting, usually with conifers and usually this century."

There are no areas of Ancient Woodland within or adjacent to the proposed development site boundary that would be likely to experience significant effects as a result of the proposed development. The designation has therefore been scoped out of the remainder of this assessment as a potential landscape receptor.

Additional Policies and Supplementary Planning Guidance

In addition to the above designations, the following Supplementary Planning Documents may be of relevance to the building design proposals in terms of the guidance they set out for the design of developments within the study area:

- A Design Guide For Cornwall, which emphasises the need for good design to consider the context, character and vernacular of the development site's setting;
- Carrick District Design Guide, which reiterates the need for new development to reflect the characteristic patterns and scale of the area and reinforce views and skylines which contribute to the definition of setting; and
- Falmouth and Penryn Area Action Plan (to be adopted), which will provide a coherent strategic vision for the development of the two towns.

19.3.11 Landscape Character

The landscape character for Cornwall is described in the following documents:

- The Countryside Agency's Character Map of England – a national assessment identifying regional Joint Character Areas (JCAs); and
- Cornwall County Council's Cornwall Landscape Assessment (County assessment identifying local Landscape Character Areas (LCAs) [NB a new assessment is being produced but was not available at the time of preparing this report].

The documents identify several character areas within the study area. These are identified below and described fully in Appendix G.

The Cornish Killas JCA

JCA 152 includes some of the proposed development site along the access, with adjoining areas having clear views due to the site's waterside location. However, the

main part of the development site is shown to be part of the open water outside the boundary of the character area. This would correspond with the site being on man-made ground and structures built into the water. Key elements of the character area including the wide open views are likely to experience effects as a result of the proposed development and therefore the area will be carried forward as a potential landscape and visual receptor (combined to address landscape character).

Carnmellis JCA

JCA 155 is located approximately 3.5km to the west of the development site. It will be not be carried forward as a potential landscape and visual receptor given its physical and visual separation from the development site and lack of likely effects on key characteristics or elements.

LCA 7b Fal Ria

At a local level, the proposed development site lies within the Falmouth Urban Area which is surrounded by LCA 7b Fal Ria which stretches from Pennance Point in the south west, around the estuary of the River Fal and its various tributaries, along the Carrick Roads to Truro in the north and across to St Anthony's Head in the south east.

LCA 7b has been scoped into the remainder of this assessment as a potential landscape receptor, because potential effects as a result of the development could be both direct and significant.

LCA 7a Helford Ria

LCA 7a lies in the south west of the study area, approximately 2.8km south west of the development site extending west from Pennance Point and Nare Point along the Helford River to Gweek.

LCA 7a has been scoped out of the remainder of this assessment as a potential landscape receptor as potential effects as a result of the development are not likely to be significant given its physical and visual separation from the development.

LCA 8 Carnmellis

LCA 8 lies to the west of the study area covering a relatively large area from Camborne in the north to Helston in the south and Ponsanooth in the east.

LCA 8 has been scoped out of the remainder of this assessment as a potential landscape receptor as potential effects as a result of the development are not likely to be significant given its physical and visual separation from the development.

LCA 11 Central Cornwall South Facing

LCA 11 covers a small sliver of land to the east of the study area as it extends along the headland enclosing Gerrans Bay from Nare Head in the north to Zone Head in the south.

LCA 11 has been scoped out of the remainder of this assessment as a potential landscape receptor as potential effects as a result of the development are not likely to be significant given its physical and visual separation from the development.

19.3.12 Visual Baseline

Extent of Existing Visibility

The extent of visibility of the existing main proposal site is shown on Figure CEC1149/07 – Visual Appraisal in Appendix G. Visibility of the existing car park area is covered within that visual envelope as was ascertained during site visits.

Characteristically, visibility is confined to the open water and adjacent coastal strips. Those views are open and direct. They are characterised by a strong existing marine influence including industrial buildings and structures. Falmouth Docks and harbour area is a dominant and prominent feature in many existing views within the visual envelope.

There are a few small islands of visibility further inland on higher ground. However, as illustrated in the viewpoint photographs in Appendix 3 of Appendix G, those are of long distance, glimpsed or partial character and often screened by intermittent local vegetation (which was not included in the computer model for the visual envelope).

Falmouth is shown to experience views of the site from the northern slopes. However, the actual visibility is limited to glimpsed views through gaps between properties and along local lanes and roads, also illustrated in Appendix 3 of Appendix G. Buildings could not be included in the computer model for the visual envelope for practicality reasons; therefore the actual visibility from ground level is significantly reduced from that shown on the plan. It should be noted, however, that there may be more views from upper floors in properties and the computer model is likely to resemble that situation more closely. All those existing views from properties, lanes and roads are already dominated by marine features and structures such as boats, ships, cranes and often large buildings and sheds associated with marine activities.

Seasonal and Atmospheric Influence

All landscapes are dynamic, changing seasonally – with leaf loss in winter increasing visibility across greater distances -, temporally – as changes in land use and land management affect views through introduction, removal or alteration of key elements – and in different weather conditions. Rainfall, air frost, sea mists and low light levels can all affect the extent and clarity of views of a development, and therefore this assessment has taken into account information from the Met Office's weather record archives to enable a better understanding of the potential visibility of the proposed development.

Climate averages for the period from 1971 to 2000, based on data recorded by the closest weather station at St Mawgan, indicate:

- air frost was recorded on 12.5 days during the winter months (November to February) indicating that visibility could be substantially reduced in long distance views for approximately 3.5% of the year;
- an average of 1,703.7 hours of sunshine was recorded per year predictably peaking during summer months from May to August; assuming a probable

average of 12 hours potential sunshine per day this data indicates that during these periods visibility of the proposed development could be substantially increased in long distance views for approximately 38% of the year; and

- average rainfall of >=1mm was recorded for 155 days per year, rising from around 9 days a month during the summer (May to July) to 15-16 days a month in the winter (November to January) indicating that visibility could be substantially reduced in long distance views for approximately 41% of the year.

Viewpoints

The views listed in Table 19-2 on the following pages were photographed and evaluated to inform the visual impact assessment as well as to provide illustrative material for landscape character and visual characteristics within the study area. Photomontages have been prepared for the five key views used to assess the impact of the proposals. The Key Views are No. 7, 10, 13, 16 and 25, highlighted in bold in Table 19-2 and carried forward into the impact assessment.

19.3.13 Predicted Future Change of Baseline

Change to the overall character and appearance of the study area in the future is limited and no major proposals are set out in the development framework for Carrick district. Further smaller scale marine development and residential development is likely to occur along the water frontages of the developed areas. Development pressure in areas close to Falmouth and Penryn is likely to be sustained and increased over time with demands for more residential accommodation. None of the anticipated future changes are considered to have an impact on the outcome of this assessment and are therefore not discussed further.

A marina immediately adjacent to the site has gained planning permission recently. Although increasing the development within this area, it is seen to complement the proposed cruise facilities rather than being a constraint. The marina is in line with other development in the area and is not considered to affect the outcome of the landscape and visual impact assessment for the cruise terminal facilities.

Table 19-2 List of Viewpoints

Viewpoint Reference	Viewpoint Name	Distance from site	Within AONB	Comments / Description
1	Bellevue	4.2km	No	Illustrating the well vegetated nature of Cornish hedges within the landscape to the north of Penryn, rural character, no views of Falmouth, Penryn, docks and harbour, sites not visible
2	Pencoose Farm, Penryn	3.8km	No	Illustrating the well vegetated nature of Cornish hedges within the landscape to the north of Penryn, rural character, no views of Falmouth, Penryn, docks and harbour, sites not visible
3	Bohelland Rise, Penryn	3.5km	No	Urban view of Falmouth illustrating the screening effect of existing development and associated vegetation for views towards the site, sites not visible
4	Penryn Harbour / Jubilee Wharf	2.9km	No	Marine view with marina, Penryn harbour, marine businesses and associated large buildings, showing the screening effect of protruding ridge in combination with large buildings for views towards the site, sites not visible
5	Beach between Flushing and Trevissonne House	1.9km	Yes	Marine view with many moored boats in the foreground, looking directly at the docks and harbour with Pendennis hill and Ships and Castles Leisure Centre prominent in the background. View dominated by urban development to the right along the slopes towards Falmouth and to the left by Flushing in the middle distance. Main proposal site visible in middle distance, existing car park not visible.
6	Flushing, end of quay near Sticky Prawn Restaurant	1.1km	No (directly next to boundary)	View illustrates the localised effects of built form on views with the key in the centre of the photo screening the view towards the site and docks / harbour. Only taller structures such as cranes visible, sites cannot be seen. Properties in Flushing to the west from this viewpoint are screened from views by landform, buildings and orientation of view towards the opposite side of the river rather than focus on the docks and harbour. The Maritime Museum is prominent in this view.
7	**Key View - Flushing, open space with memorial**	**850m**	**Yes**	**Views from the memorial open space are panoramic and long, but partially screened by trees in the foreground. The view is dominated by Falmouth and Flushing development and the docks and harbour are part of the overall view. It is a busy and interesting view. Both sites can be seen from here, the existing car park and the cars parked there can be seen above Queens Wharf, with the vegetation on the slopes below and above the cars. A photomontage has been prepared for the view.**
8	Flushing, beach at Trefusis Estate	650m	Yes	This is a view from a local, yet popular beach directly opposite the docks area. The existing view is dominated by the docks and harbour activities, structures, machines and ships as well as by the urban areas of Falmouth. St Anthony's Lighthouse and the open sea are visible to the left, but are

Viewpoint Reference	Viewpoint Name	Distance from site	Within AONB	Comments / Description
				not the main focus of the view. As several of the other views evaluated for this assessment, this view is busy and interesting. The main proposal site is in the foreground, the existing car park is seen to the left of the wharfs.
9	Trefusis Point footpath	550m	Yes	This view is relatively similar to view 8; however, it becomes more open and focused on the sea beyond as the coastline turns north opening up southern and eastern views. The headlands of St Mawes, St Anthony's and Pendennis are prominent and their visual relationship is clear in this view. The contrast between the rural Roseland Peninsula, the open sea and the urban, marine and industrial character of Falmouth is well illustrated here. Main proposal site and existing car park visible. The vegetation associated with the existing car park softens the view and helps to integrate the site with the green cliffs behind and to the left.
10	**Key View - Docks viewing area on Pendennis Road**	**150m**	**No**	**The docks dominate views from this area and the purpose of the viewing area is to observe the dock and harbour and associated activities. It is a popular spot with visitors and residents alike. The landscape beyond forms a calming background to the otherwise busy and industrial view illustrating the contrast between Falmouth and the surrounding landscapes. The main proposal site is fully visible from all of the viewing area. The existing car park is screened by development for viewers along the western half, but views open up towards it when looking down from the eastern half of the viewing pavement.**
11	Maritime Museum, Event Square	500m	No	Event Square is surrounded by buildings, containing the visual focus within it. The building of the Maritime Museum screens views from the square to the docks. However, when moving towards the edges of the square near the water, views open up a bit more and some of the dock area including the site becomes visible. The foreground of the views to the main site is composed of moored boats and yachts and ships anchored in the docks screening direct views. The existing car park is not visible. There are views of the docks and site from within the museum and observation tower, but this is part of the experience of visiting the museum.
12	Well Lane / Lawn Steps Park area	800m	No	Views from here and the open space below are centred on the site and adjacent docks area with Trefusis Point to the left and the Roseland Peninsula coast line in the background. Marine and dockland activity are integral parts of the existing view. Roofs of houses on terraces below are in the foreground and give the view an urban feel. The view is framed by trees and buildings to either side. Only the main proposal site is visible, the existing car park is screened by development.

Viewpoint Reference	Viewpoint Name	Distance from site	Within AONB	Comments / Description
13	**Key View - Prince of Wales Pier**	**750m**	**No**	**This view is characterised by the urban waterfront of Falmouth to the right, the dock and harbour area in the centre with Pendennis hill and Ships and Castle Leisure Centre beyond and the ridges of Roseland Peninsula in the left of the view. Moored boats and yachts dominate the foreground. It is a busy and partially urban view with many marine features and structures including cranes, sheds and large vessels. Only the main proposal site is visible, the existing car park is screened by development.**
14	Near Falmouth Old Ambulance Building	1km	No	Views are over urban areas to the wide landscape beyond and Carrick Roads are in the centre of the view. The docks are partially screened by buildings and vegetation in the right side of the photo. The main proposal site is stretching into Carrick Roads, seen from here as an extension to the main docks area. It is prominent, but does not dominate the view, and blends in with the boats and character of the area. A large vessel was moored at Queens Wharf at time of survey. The existing car park is not visible from here.
15	The Beacon Falmouth	1.4km	No	The view from the Beacon area is relatively similar to view 14, but is more elevated. Therefore it appears wider and more panoramic as it is not cut short by buildings on either side and looks across the landscape beyond rather than at it. Compared to view 14, a larger area of the docks is visible, but at greater distance. The docks are prominent, but not dominant and a glimpse of the open sea is visible in the right-hand side of the photo. The main site is visible, but the existing car park is screened by development.
16	**Key View - Local open space in Falmouth near the sea front**	**1.2km**	**No**	**The small open space is located between the Beacon and the Prince Albert Gardens and features a number of benches, which are well used by residents in warm weather. The view has many urban components and centres on Flushing, Trefusis Point and Roseland Peninsula beyond. The dock area is seen in the right-hand side of the photo. The main site is at the end of the dock area in a relatively prominent position; however, the existing car park is partially screened by structures and cranes in the foreground.**
17	View from the Prince Albert Gardens, Falmouth	1.1km	No	Only a small proportion of the park at the western end has existing views of the site as shown on photo 17. From most parts, including those with the majority of benches, the docks and sites are not visible and the views focus on Flushing on the other side of Penryn River. The view includes urban characteristics and many buildings.
18	Glimpsed view from urban	800m	No	Views from ground level in the areas south of the High Street are difficult to obtain and are limited to

Viewpoint Reference	Viewpoint Name	Distance from site	Within AONB	Comments / Description
	area, Falmouth			views along streets and through gaps in development. There will be more views from upper floors, but this could not be assessed in detail. All those views are dominated by urban development in the foreground. The background is provided by the ridges of Roseland Peninsula and Trefusis Point. Visibility of the docks area varies, but no location could be found where all of the docks area is visible.
19	Glimpsed view from urban area near train station, Falmouth	800m	No	As above, but showing the influence of local vegetation and buildings on ground level views and illustrating the increased visibility of cranes.
20	A39 lay-by between Treluswell and Tremough roundabouts	5.5km	No	This viewpoint is outside the study area, but was included for illustrative purposes to show the negligibility of views of the docks within the overall scene. Urban areas of Falmouth are prominent in the view. The docks merge with the urban areas and the background, not being prominent or particularly visible.
21	Roseland Peninsula near St Just – study area boundary	4.9km	Yes	The viewpoint is just within the study area boundary, but views of the site are still of very limited detail. The docks and sites merge with the background and are not perceived as a separate feature. The view is strongly influenced by the undulating landscape with many trees and hedges on the other side of Carrick Roads.
22	Roseland Peninsula near St Just – glimpsed view	4.6km	Yes	Similar to view 21, the docks are still at great distance. This view has been included to show the strong effect of local vegetation and hedges on views from this part of the study area. Most views are glimpsed or partial.
23	Roseland Peninsula south of St Just	3.1km	Yes	Getting closer to the site, some detail becomes apparent, but the docks and sites still merge with the urban background of Falmouth. Falmouth is a feature in the view, but the docks are not prominent as such. Views are characterised by the headlands.
24	Roseland Peninsula footpath north of St Mawes	1.9km	Yes	At this distance, details of the docks become distinguishable and can clearly be perceived as a separate entity from the urban mass beyond. However, the proposal sites are still difficult to spot in the mass of dock and harbour structures, The headlands are prominent in the views and the influence of hedges along the footpaths on views is illustrated. Along significant length, the path runs very close to the hedge not allowing for views out.
25	**Key View - Roseland Peninsula St Mawes**	**1.8km**	**Yes**	**This view illustrates the strong visual relationship between the St Mawes, Pendennis and Trefusis headlands and the two castles. It shows the location of the docks and site in relation**

Viewpoint Reference	Viewpoint Name	Distance from site	Within AONB	Comments / Description
	Castle			**to the headlands and castles and how views are already influenced by marine and land-side development. Basically all the background between Pendennis and Trefusis headlands is developed. The sites are in front of the main area of development, but visually merge into it.**
26	Pennance Point	2.4km	Yes	The southern beaches of Falmouth and Pendennis Castle are prominent in this view. The main docks area (and therefore the sites) cannot be seen from here, except for the cranes reaching above the ridgeline running between Pendennis and Falmouth. The sea is to the right in the photo and large vessels can normally be seen mooring and waiting for supplies or harbour entry further to the right (not in photo). The golf club is approximately 200m to the south of this photo location on higher ground.
27	Budock Water	3.7km	No	The character of views from near Budock Water is determined by local vegetation and landform and is not focussed on Falmouth or the sea. Views are of a more inland, rural character. The sites cannot be seen, only the tops of cranes are vaguely perceptible in the distance. It was difficult to obtain a view from this area at all due to the strong screening effects of vegetation.

19.3.14 Potential Sensitive Receptors

Tables 7 and 8 in Appendix G describe the potential landscape and visual receptors within the site and study area and the key viewpoints agreed during the consultation process, together with an outline of their sensitivity, distance from development and rationale for selection.

No landscape elements, features or characteristics were identified as potential receptors due to the man-made, industrial nature of the site. Landscape receptors are therefore limited to designations and character areas only.

Visual receptors have been divided into areas by distance and nature of views. This helps to simplify the assessment and shortening the tables by grouping the categories of visual receptors.

The Visual Envelope and ZTV drawings showed some visibility beyond the study area extent of 5km (around Mawnan Smith, around Mabe and Treluswell / A39 and north of St Just on the Roseland Peninsula and at sea). The study area of 5km was determined during site assessment work and impacts beyond that distance are deemed to be negligible and insignificant. The areas beyond 5km shown on the ZTVs and associated receptors will therefore not be taken into account in the assessment. Photograph 20 in Appendix G was included for illustrative purposes to show the character of the view from a distance beyond 5km.

19.4 POTENTIAL IMPACTS DURING THE CONSTRUCTION PHASE

The construction phase will have major effects on the area for a period of approximately 15 months (considered a medium-term time period, assuming that some elements of work occur simultaneously). Tables 9 to 11 in Appendix G detail the impacts of construction activities during that period of time. No construction impacts are anticipated to have effects beyond the end of the construction period.

Impacts on the existing car park vegetation are covered under operational impacts and are not repeated here as it is a permanent effect, which will be mostly noticed on completion of the works when car park use increases. Key views have not been assessed separately for construction impacts, as impacts are covered sufficiently in the area assessment and photomontages were prepared for operational stage only.

Please note that distances given are to the land-side development and construction activity, sea-side construction is closer as shown on the drawings in Appendix G.

19.4.1 Summary of Construction Impacts on Landscape Designations

The relatively long duration of construction activities (estimated 15 months in total if some works occur simultaneously) in combination with the extent of construction areas and size of equipment required could lead to a number of potentially significant construction impacts.

Significant impacts on landscape designations have been identified as follows:

- limited (in time and area) major adverse impact on Cornwall AONB (Mylor and Roseland Area) within 2km of the construction site for the duration of the

construction period, this impact is considered to be temporary and reversible so it will have no impact on overall value, setting and integrity of the designated area; and

- major adverse impact to the South West Coast Path National Trail within 2km of the construction site for the duration of the construction period, this impact is considered to be temporary and reversible so it will have no impact on overall value, setting and integrity of the designated area.

Mitigation and Residual Impact

There are not any mitigation measures which can be employed to reduce the impacts to landscape designations. There will remain temporary major adverse residual impacts.

19.4.2 Summary of Construction Impacts on Landscape Character

No significant construction impacts on landscape character were identified due to the vast extent of the national character area combined with presence of other industrial and construction elements within it and the exclusion of water areas from the local character area.

Mitigation and Residual Impact

No mitigation is required and there will remain no residual impact.

19.4.3 Summary of Construction Impacts on Landscape Elements and Features

No construction impacts on landscape elements and features have been recorded.

Mitigation and Residual Impact

No mitigation is required and there will remain no residual impact.

19.4.4 Summary of Construction Impacts on Visual Interests

A number of significant visual construction impacts on receptors, such as users of designated areas, residents, visitors and employees, were recorded as follows (see Table 12 in Appendix G for details):

- major impact to receptors in the Cornwall AONB (Mylor and Roseland Area) within 2km of sites;
- moderate impact to receptors in the Roseland Heritage Coast within 2km of sites;
- moderate impact to visitors to St Mawes Castle;
- major impact to receptors within the Cornish Killas landscape character area 152 within 1km of sites (excluding water areas);
- major impact to receptors within the Fal Ria character area 7b within 1km of sites (excluding water areas);
- major impacts to medium and high sensitivity receptors in water areas including users of South West Coast Path within 2km of sites;
- moderate impact to residential receptors and coast path users along Pendennis Road / Pendennis coast path section, where open or partial views occur;

- moderate impact to residential receptors and coast path users along Falmouth sea front / High Street / coast path alignment from docks to Prince of Wales Pier;
- moderate impact to residential receptors on higher ground in Falmouth Beacon area;
- major adverse impact to users of landscape at and near Trefusis Point; and
- moderate impact to users of landscape along coast line from St Mawes to St Just on Roseland Peninsula within 2km of sites.

The impacts identified above are not assessed in terms of being adverse or beneficial, since this is generally a subjective point of view.

Mitigation and Residual Impact

The construction activities cannot be mitigated as such, but an effort should be made to optimise timing and duration of those activities to keep disturbance to a minimum. The shorter the duration, the less serious visual impacts would be. Due to the lack of available mitigation, all impacts will remain as moderate to major adverse residual impacts, as identified above.

19.5 POTENTIAL IMPACTS DURING THE OPERATIONAL PHASE

19.5.1 Changes to Landscape and Visual Interests due to Cruise Vessels

The operational impacts of the cruise vessels are described in Section 6.1.2 of Appendix G.

There will be no landscape impacts arising from the presence of vessels at the cruise quay or when approaching the harbour. There is no mitigation required and there will remain no residual impact.

The visual impact of large vessels such as the design vessel, Freedom of the Seas, will also be temporary and infrequent. During those periods, the impact magnitude of the vessel is likely to be substantial (close proximity and large vessel size). For most people, including visitors, this will be a major beneficial impact, as the vessel will be considered an attraction to be viewed.

Mitigation and Residual Impact

No mitigation is required and there will remain a major beneficial impact.

19.5.2 Changes to Landscape Designations due to Land-side Development

Operational phase impacts for the land-side works are detailed in Tables 13-17 in Appendix G. The impacts are summarised below.

No significant impacts on landscape and historic designations with landscape setting could be determined. The proposals will not impact on the status, setting or quality of any designation, including the AONB, the South West Coast Path and the Scheduled Monuments of Pendennis and St Mawes Castles.

Mitigation and Residual Impact

No mitigation is required and there will remain no residual impact.

19.5.3 Changes to Landscape Character due to Land-side Development

No significant impacts on landscape character could be determined. The proposals are generally in line with existing uses and character as well as being located within the footprint of existing similar uses, therefore, not resulting in a change to the existing character.

Mitigation and Residual Impact

No mitigation is required and there will remain no residual impact.

19.5.4 Changes to Landscape Elements and Features due to Land-side Development

Some loss of poor quality vegetation occurs within the existing car park area which currently acts as a screen. The loss of this vegetation will be a minor adverse impact as it affects views from the AONB (i.e. increases the visual impacts of the proposals).

Mitigation and Residual Impact

There is scope to reduce this impact through replacement planting along remaining banks and possibly newly created planting strips. Following planting there will be a reduced negligible residual impact.

19.5.5 Changes to Visual Interests due to Land-side Development

The visual assessment determined that the following visual receptors are likely to experience the following impacts as a result of the proposed development:

- change in landscape character due to vegetation removal. This will have a moderate impact to users of footpaths and other publicly accessible areas within the Cornwall AONB within 2km of the site;
- major impact to users of footpaths and other publicly accessible areas within JCA 152 Cornish Killas within 600m from site;
- major adverse impact to users of footpaths and other publicly accessible areas within LCA 7b Fal Ria within 600m from site;
- moderate impact to medium and high sensitivity users of water areas within 2km of the site including visitors, people living on boats and users of the Southwest Coast Path water section;
- moderate impact to residents, coast path users and visitors to outdoor SAM areas (high sensitivity receptors) in the area from the docks to Pendennis Castle;
- moderate impact to residents and coast path users in the area from the docks to the Prince of Wales Pier (seafront up to High Street / Argyle Street);
- moderate impact to residents of some higher ground properties with direct views towards the docks in area from The Moor to the Beacon;
- major impact to residents with direct views and users of open space in southeastern part of Flushing; and

- major impact to users of footpaths and beaches between Flushing and Trefusis Point.

The remaining potential receptors experience non-significant impacts or no change as a result of the proposed development.

The impacts identified above are not assessed in terms of being adverse or beneficial, since this is generally a subjective point of view.

Mitigation and Residual Impact

Typical landscape and visual mitigation measures such as planting and softening of built form do not readily apply to this type of development in an exposed area with existing industrial uses and much of the construction impacts occurring at sea. The scope for mitigation is therefore limited, mainly concentrating on choice of materials, layout and design of scheme components and sequencing of construction works to minimise disruption and reduce construction time.

The cruise terminal building has been designed to be in line with other marine development in the area and also utilises curved shapes and varied heights to break up the mass of the built form. Mitigation is already part of the design assessed in the LVIA (i.e. Appendix G) and no further mitigation is currently considered necessary or feasible. The scheme is in keeping with the visual character and existing uses of the area and is likely to be considered beneficial by many users of the surrounding landscape and urban areas.

The quay improvements have to follow stringent engineering criteria and requirements, which limits scope for mitigation. Within the overall scheme, the improvements are causing the least impacts as it is an improvement of an existing structure, which enhances the visual appearance of the currently partially dilapidated wharves. No further mitigation could be identified.

Moderate to major residual impacts will remain, as identified above.

20 LAND QUALITY

20.1 INTRODUCTION

This section provides an interpretation of the existing land quality aspects of the proposed Falmouth Cruise Project. It is based on a Contaminated Land Phase 1 Desk Study (Royal Haskoning), which was undertaken in accordance with current UK legislation and guidance for the development of potentially contaminated land.

Impacts are described made in terms of the potential risks of construction and operational activities may impact or be impacted by land quality (i.e. soil and groundwater quality). The assessment technique is unique to Section 20 of the Es and is described in Section 20.2.3.

20.2 METHODOLOGY

20.2.1 Baseline Data Collection

The following data sources were utilised in the desk study:

- historical maps were obtained from Landmark Information Group to assist in the desk study (see Appendix H);
- a search of Environment Agency and Local Authority records for potentially polluting processes, discharge consents, landfill sites, water abstraction points and other potential sources of pollution that have been registered and are present on public registers (see Section 20.3.1); and
- a review of findings from a site investigation, which was undertaken by Integral Geotechnique (Wales) Ltd on behalf of Bailey Investments Limited in March 2007 (see Section 20.3.3).

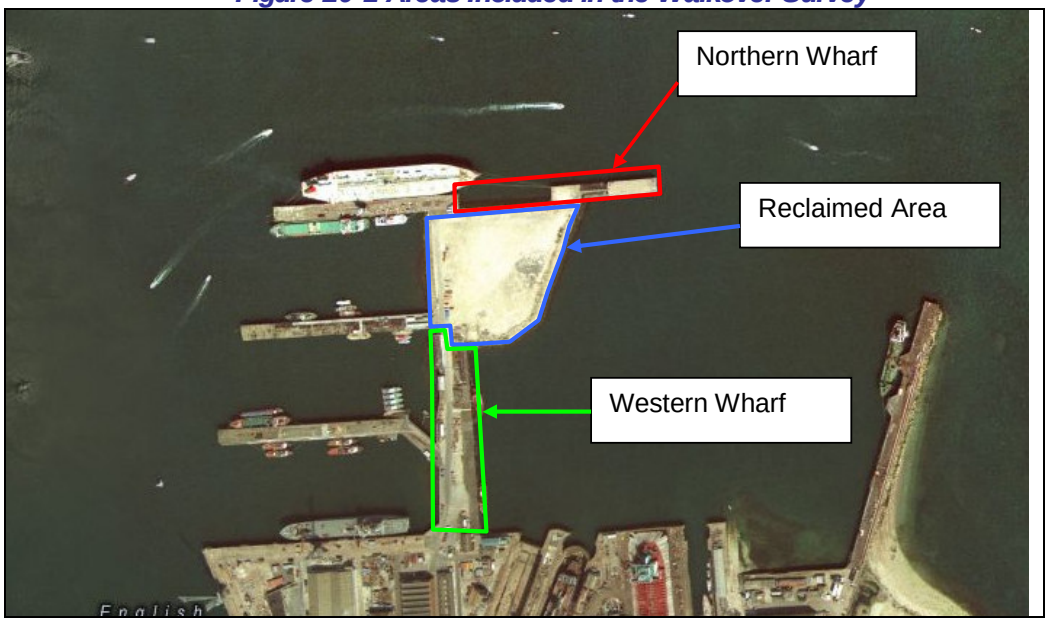
20.2.2 Survey

The site walkover survey was undertaken in April 2007. Figure 20-1 denotes the boundaries of the site walkover.

20.2.3 Assessment Criteria and Technique

Impact assessment has been carried out in accordance with Part 2A of the Environmental Protection Act 1990. A conceptual model of the site has been produced based on the findings of the desk study, which describes the likely sources and pathways associated with the site and the potential receptors which may be adversely impacted by a pollutant linkage. The findings of this are presented in Appendix H.

Figure 20-1 Areas Included in the Walkover Survey



In order to assess the risk posed by the various source, pathway and receptor linkages that may exist at the site, a linkage model has been produced and is presented in Table 20-1. The risk rating terms used to describe the risks identified at the site are based on the Department of Environment (now Defra) and Contaminated Land Research Report series (CLR Report No. 6) site prioritisation and categorisation rating system as defined in Table 20-1 below.

Table 20-1 Contamination Risk Rating Terminology

Contamination risk rating terminology:	
Risk Rating	**Description**
High risk	Contaminants very likely to represent an unacceptable risk to identified targets Site probably not suitable for proposed use Enforcement action possible Urgent action required
Medium risk	Contaminants likely to represent an unacceptable risk to identified targets Site probably not suitable for proposed use Action required in the medium term
Low risk	Contaminants may be present but unlikely to create unacceptable risk to identified targets Site probably suitable for proposed use Action unlikely to be needed whilst site remains in current use
Negligible risk	If contamination sources are present they are considered to be minor in nature and extent Site suitable for proposed use No further action required
Based upon the DoE CLR report No. 6 'Prioritisation and categorisation procedure for sites which may be contaminated'	

20.2.4 Assessment of Impact Significance

The significance of impacts is assessed in terms of the risk ratings shown in Table 20-1, rather than the significances identified in Table 1-1.

20.3 BASELINE ENVIRONMENTAL CONDITIONS

20.3.1 Site Description

The site is approximately 3.87 hectares and comprises two wharfs; the Northern Wharf and the Western Wharf. The site is mainly surrounded by the sea with the exception of the south of the site, where Docks and associated buildings, services and industries such as an oil depot, sewage works and works are present. Residential areas are located further south and to the west of the site. For ease of description, the site has been divided, as outlined in Figure 20-1 each area is described in turn below.

Northern Wharf

The Northern Wharf is composed of two concrete units separated by a derelict wooden wharf, which has been replaced by a metal bridge (see Plate 1). The majority of the wharf is used to store derelict ship equipment such as wooden piles, ropes, plastic and metal pipes and bollards (see Plate 2). To the west of the Northern Wharf was the Queen's Wharf, which was used to host ships following repairs in the Docks. Between the Northern Wharf and the Queen's Wharf, the site was bordered by a rock revetment covered by tall vegetation. At the time of the visit, there was no visible evidence of the presence of Japanese Knotweed.



Plate 20-1 The Northern Wharf, view from the south



Plate 20-2 Western Wharf, view from the east

Reclaimed Area

The reclaimed area was bounded by the Northern Wharf to the north, the Western Wharf to the west and a rock revetment with the sea beyond that to the east and south (see Plate 20-3). According to the FDEC, fill materials mainly comprised construction debris originating from various sites. The site was occupied by the following features.

A tarmac area is located in the north-west corner. This area was empty with the exception of a portakabin in the south-east corner, used by site workers and for the storage of some drums. Drums were situated along the southern boundary of this area and stored on wooden pallets. The content of those drums was unknown.

A car park area is located in the centre of the reclaimed area. The car park was covered by bare ground, consisting of mainly imported gravel type material, and used by site workers (see Plate 20-4).

A storage area is located in the west part of the reclaimed area. This area was used by a company named Submarine Services Ltd to store equipment. Materials stored included containers of unknown contents (they could not be opened) and underwater engineering, dredging, piling and environmental desilting equipment. Equipment is stored directly onto a bare ground (see Plate 20-5).

An open area is located in the south-east and south-west of the reclaimed area and covered by bare ground consisting of gravels and fragments of stones. Five portakabins were situated in the western part and were used by site workers. At the time of the visit, three empty tanks, of unknown contents, were being cleaned (see Plate 20-6). The nature and type of cleaning (e.g. inside, outside, etc) was unknown.

The eastern and southern edges of the reclaimed area were used to store derelict ship equipments such as ropes, metal pipes and a propeller and other materials such as tyres, construction debris, Intermediate Bulk Containers (IBCs), of unknown contents, concrete blocks and an old truck (see Plate 20-7). A heap of wooden piles was situated in the north-east corner of the reclaimed area (see Plate 20-8).

The south-eastern part of the reclaimed area was occupied by an oil pollution unit owned by A&P Falmouth Ltd, a concrete ramp giving access to the sea and containers used by an engineering workshop for maintenance (see Plates 20-9 and 20-10). It is considered likely that oil and other chemicals such as solvents may be used or stored there. The edge of the site was covered by bare ground with a variety of materials stored directly onto it.



Plate 20-3 View from Western Wharf of Reclaimed Area



Plate 20-4 Car Park located on the reclaimed area



Plate 20-5 Storage area (Submarine Services Ltd)



Plate 20-6 Empty tanks on the reclaimed area



Plate 20-7 Eastern edge of the reclaimed area – construction debris, truck, etc.



Plate 20-8 Eastern edge of the reclaimed area – Wooden piles



Plate 20-9 Oil de-pollution unit and ramp in the south of the reclaimed area



Plate 20-10 Workshop in the south of the reclaimed area

Western Wharf

The Western Wharf is located between the Northern and Queens Wharves and Falmouth Docks. An access road extended along its length.

In the northern part of the wharf and to the right of the road, were the offices of Submarine Services Ltd and four unbunded above ground tanks (see Plate 20-11). The tanks were in a relatively poor state of repair. It is possible that these were used to store and distribute fuel. Black stains, possibly fuel, were observed on the concrete slab in the area immediately around the tanks (see Plate 20-12). It is not known whether the tanks are still in use or not.

Further south, was an area covered with gravel followed by an electrical substation. Drums were stored on the gravelly area, on pallets. A label showed that the drums contained reclaimed insulting oil (see Plate 20-13). In addition, spills were noted around them.

The west edges of the Western Wharf were made of rock revetments in the north and central part and of a stone wall in the southern part (see Plate 20-14). Rock revetments and the stone wall were covered by ruderal vegetation. On the west side of the Western Wharf there were two wooden quays which hosted ships and barges (see Plate 20-15). These two quays were not included into the study area.

To the east of the road, there was an area of bare ground on which wood, metal and plastic pipes, pallets, empty tanks, derelict engines, chains and containers were noted (see Plate 20-16). In the southern part of the Western Wharf, a storage area for gas

cylinders was noted within a locked cage (See Plate 20-17). Further south, large plastic boxes were observed and noted to contain shells from a fishery located few meters further to the south. An old wooden wharf was found beyond the area of bare ground. There were some services running all along its length (see Plate 20-18).



Plate 20-11 Four tanks next to a building occupied by Submarine Services Ltd



Plate 20-12 'Suspended' tanks with stains at the bottom



Plate 20-13 Drums stored on pallet with the electric substation beyond that



Plate 20-14 Wall located between Duchy Wharf and Empire Wharf on the western bank of the Western Wharf

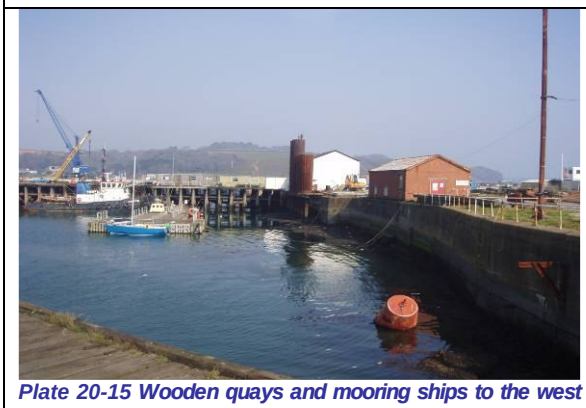


Plate 20-15 Wooden quays and mooring ships to the west of Western Wharf

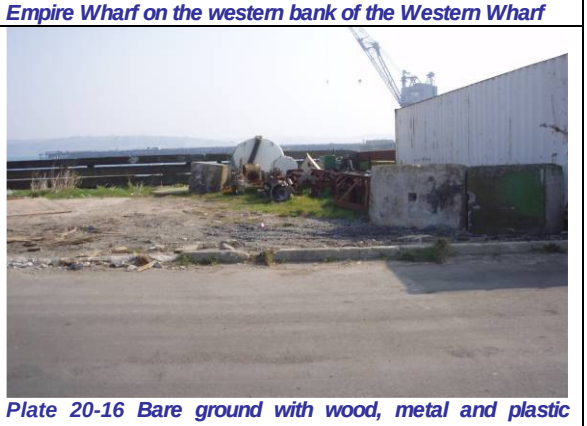


Plate 20-16 Bare ground with wood, metal and plastic pipes, pallets, empty tanks, derelict engines, chains and containers tipped

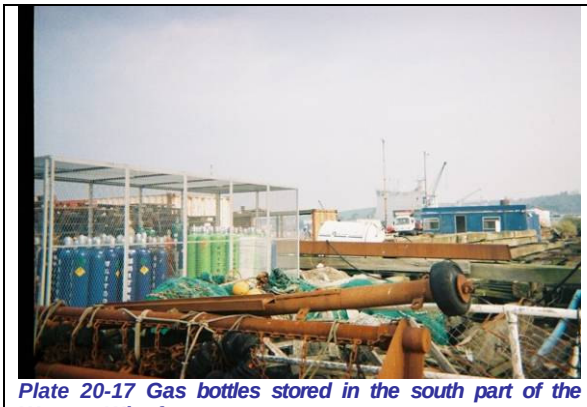


Plate 20-17 Gas bottles stored in the south part of the Western Wharf

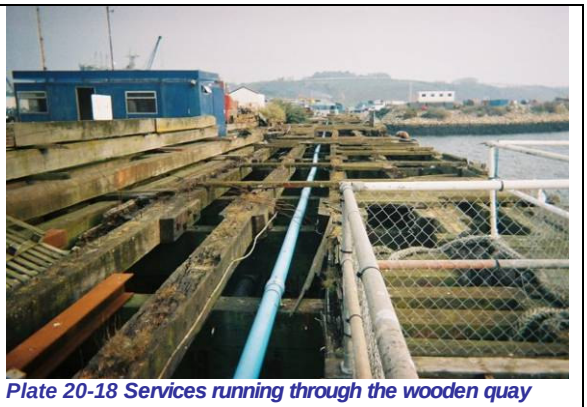


Plate 20-18 Services running through the wooden quay

Docks Estate

The study area was surrounded by the sea to the west, north and east. To the south, were the Falmouth Docks and the following immediate neighbouring activities within the estate:

- depot;
- electrical workshop;
- engineering workshop;
- fishery; and
- ship repair (see Plates 20-19 to 20-21).

Generally, the study area is located within an industrial area comprising a ship repair and refitment yard and a waste oil facility (see Plate 20-22).



Plate 20-19 Engineering Workshop located immediately to the south of the study area



Plate 20-20 Workshops and offices located to the south and south-west of the study area

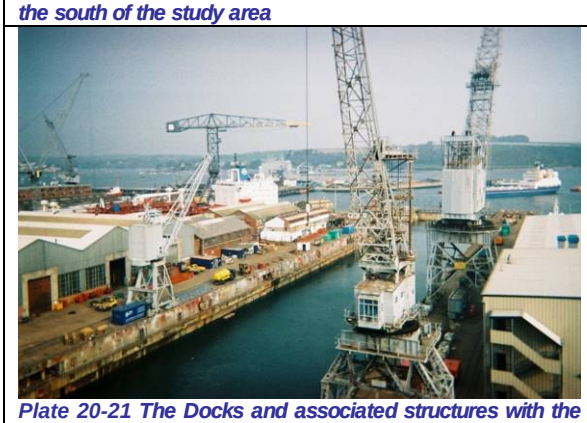


Plate 20-21 The Docks and associated structures with the wharfage area beyond that



Plate 20-22 Waste oil treatment facility located to the south-east of the study area

20.3.2 Site History

Historical maps were obtained from Landmark Information Group to assist in the desk study. A summary of relevant information obtained from the historical maps is provided in Table 3.4 of Appendix H.

Based on the interpretation of the historical maps of the site there is evidence of potential sources of contamination or processes having taken place on the site. Such potential sources include the following features.

Wharf and trackways. These may have been contaminated with metals, organic compounds such as oils, fuels and solvents, inorganic compounds such as pesticides and asbestos associated with pipeworks and buildings.

Made Ground and fill in the reclaimed area and across the site. The Made Ground at the site may include demolition and construction materials such as bricks and tarmac but also metals, petroleum hydrocarbons and possibly asbestos. Therefore, there is a risk for a wide range of contaminants to be present within this deposited material. Certain contaminants may have the potential to generate hazardous leachate and gas.

Tanks and drums. A wide range of contaminants may be present depending upon the material stored. Contamination may have occurred through leakage and spillage during the delivery, storage and / or transfer.

Electricity sub-station. Cooling oils and polychlorinated biphenyls (PCBs) from former electrical transformers and capacitors and oils and solvents from the maintenance of plant and equipment may be encountered on this type of site. In some cases, asbestos can also be found, if used for insulation, cladding or roofing materials.

Engineering works (ship repair). May have been contaminated by fuel oils, lubricating oils, hydraulic fluids, solvents used in paints, heavy metals from welding, cutting, grinding, discing and shot blasting operations. Metal compounds may have been used as pigments or corrosion inhibitors in paints or as the active ingredient in antifouling treatments and their oxides and asbestos may have been used as an insulation material. Remnants of coal stores and waste ash may still be found on very old sites. In the past, electrical transformers may have used (PCBs) as dielectric fluid. PCBs may be associated with scrapped instrumentation on some sites. It is not known whether the site has been used for military purposes. Should the site have been used for military purposes, some low-level radioactive wastes from luminous paints and/or scrapped military instruments may be found.

Based on the historical maps of the site there is evidence of potential sources of contamination on land surrounding the site. These potentially contaminating sites include the following features.

Iron foundry. Metals and metal compounds and the products of coke making and metal finishing are potentially the most significant contaminants at iron works / foundry. The potential for contamination will be related to the type of process and material storage taking place on the site and potential leaks and spills from tanks and pipework carrying process products and wastes. In addition, on historic sites, contaminants may be present

associated with on-site landfills, lagoons or soakaways. Furthermore, transformers and other equipment may contain PCBs and asbestos may have been used as roofing or cladding to buildings and pipeworks.

Railway lines and sidings. In some areas, ash ballast may be found, as well as fuel oils, lubricating oils and greases. Ash ballast from the nearby Iron Foundry may have been used on the railway lines and sidings. Herbicides may have been used on the tracks and immediate trackside margins. Contamination is also possible through spillages of the cargoes (the nature of the contamination will depend on the types of cargoes handled) and through leaks.

Timber yard and timber ponds. Contaminants may comprise metals, PCB, asbestos and organic compounds such as solvents, phenols and creosote used for wood treatment. In addition, there is the potential for contamination from fuel oils used for on-site power generation and traffic, through leaks and spills.

Made Ground and tip. The Made Ground of the site may include demolition and construction materials such as bricks and tarmac but also metals, petroleum hydrocarbons and possibly asbestos. Therefore, there is a risk for a wide range of contaminants to be present within this deposited material.

Depot. May have been contaminated through leaks and spillages of petroleum products, oils and greases.

Works. As the sector of activity is unknown, a wide range of contaminants may be present such as metals, petroleum hydrocarbons, solvents, asbestos, etc.

Docks and harbour. May have been contaminated with metals including lead, zinc, cadmium, copper, chromium, tin and arsenic; less common metals such as molybdenum and beryllium may also occur. Organic compounds such as oils, fuels and solvents may be present along with inorganic compounds such as nitrate and sulphate, asbestos associated with pipeworks and buildings and other potential contaminants including fuel waste, cleaning agents, paint residues (including toxic antifouling compounds) and hydraulic fluids.

Engine house. The most common contaminants may include oils, solvents, hydrocarbon fuels and metals. Other contaminants may also include asbestos, PCBs, acids and alkalis.

Tanks. A wide range of contaminants may be present depending upon the material stored. Contamination may have occurred through leakage and spillage during the delivery, storage and / or transfer.

Engineering works (ship repair). This activity may have resulted in contamination by fuel oils, lubricating oils, hydraulic fluids, asbestos and solvents. Heavy metals may be present as a result of processes such as welding, cutting, grinding etc. Metal compounds such as those used as corrosion inhibitors or antifouling ingredients in paints (e.g. tributyl tin) may also be present. PCBs from electrical transformers or scrapped instrumentation may be present. There may also be a potential for some low-level radioactive wastes from luminous paints and/or scrapped military instruments may if the site was used by the Military.

From the initial information reviewed, it is apparent that former surrounding land uses may have had the potential to result in contamination of local soils or impact the quality of groundwater or surface waters, particularly where such contaminants are mobile and have the potential to migrate. It is likely that the risks posed by these former surrounding land uses on the site in question are somewhat limited as the site is located within tidal waters with limited connectivity to the mainland. However, the quality of the groundwater beneath the site or the surface water within the estuary may have been impacted as a result of contaminant migration via tidal waters from adjacent sites.

There is a potential for soils and dredging materials used to make up the site to be contaminated to a certain extent by both past and current land use of the site and past and present land use of the areas adjacent to the site.

20.3.3 Previous Studies

A site investigation was undertaken by Integral Geotechnique (Wales) Ltd on behalf of Bailey Investments Limited in March 2007. Bailey Investments Ltd was proposing to reclaim and redevelop Falmouth Docks and wharfage areas. The report relates to an area of approximately 15 hectares including the area studied; the Northern Wharf, the reclaimed area and the Western Wharf. The report is an interim report and presents the initial findings of the site investigation. Integral Geotechnique (Wales) Ltd have also used available data taken from a desk study report dated April 1997, prepared by Moorehead Consulting within their report.

The findings of the report are detailed in Appendix H. In summary, the following information can be gathered from the site investigation regarding the study area:

- The ground investigation comprised 11 window samples boreholes to depth of 4mbgl and 2 rotary boreholes to depth of 15mgbl;
- Made Ground was encountered ranging from 4mbgl to 15.5mbgl and comprised generally a sandy clayey shale matrix with some ash and fragments of brick, concrete, coal, tarmac, wood and slate. The Made Ground is noted to be underlain by the Portscatho Formation (sandstones and interbedded slates);
- Groundwater was recorded in borehole BH1, the 7th of March 2007 at 5.85mbgl. It is not know whether this measurement was taken at low or high tides;
- Soil results showed the presence of concentrations of metals and hydrocarbons across the site. An elevated value of lead (1500mg/kg) was recorded in the window sample WS13 at 2.4mbgl. This value is above the SGV for lead;
- Sulphide was found at concentrations ranging from <0.5mg/kg to 7.9mg/kg; and
- Ammonia and carbon dioxide were detected during the monitoring event dated 07/03/2007.

20.3.4 Authorisations, Consents and Licences from Regulatory Authorities

Discharge Consents

There are two discharge consents located in the south and north of the site which are held by FDEC (shipbuilding) and Maxamillion Properties Ltd, respectively. These relate to the discharge of trade effluent (site drainage) and final / treated effluent, respectively, into the Penryn River – Fal Estuary (saline estuary).

There are four discharge consents within a 250m radius of the site, of which three are active:

- one is held by Maxamillion Properties Ltd for the discharge of final / treated effluent into Carrick Roads (saline estuary) and is located approximately 60m to the north-east of the site;
- one is held by Pendennis Shipyard Ltd for the discharge of trade effluent into the Carrick Roads (saline estuary) and is located approximately 237m to the south-east of the site; and
- one is held by FDEC for the discharge of miscellaneous discharge (mine / groundwater as raised) into the Penryn River and is located approximately 238m to the south-west of the site.

There are two discharge consents located between 251m and 500m of the site. These relate to the discharge of sewage treatment work storm overflow / storm tank and site drainage (contaminated surface water, not waste site) into High Drain Docks (tidal water) and Carrick Roads (saline estuary), respectively. They are located approximately 391m to the south-west and 400m to the south-east of the site, respectively. The status of one of them is described as 'revoked'. Nevertheless, these discharges are unlikely to result in a significant impact on the site.

There are twenty-four discharge consents located between 501m and 1km of the site. These relate to the discharge of sewage treatment works storm overflow / storm tank discharges, storm sewage overflow (public sewage), final / treated effluent, process effluent, sewage discharges from a pumping station and unknown discharge. The status of ten of these is described as 'revoked'. These discharges are unlikely to result in a significant impact to the site and as such have not been detailed further in this section.

Integrated Pollution Controls

There are four Integrated Pollution Controls within 250m radius of the site, of which three are active:

- one is held by Falmouth Energy Ltd for combustion processes within the fuel and power industry and located approximately 174m to the south of the site. The status is described as ' revoked'; and
- three are held by A&P (Falmouth) Ltd for coating processes and printing within miscellaneous industries and located approximately 174m, 178m and 181m to the south of the site. The status of two of these is described as 'superseded' and one as 'authorised'.

Industrial Land Use

There are nine trade directory entries located within 250m radius of the site, seven of which are currently active:

- Beldam Burgmann Seals Ltd (seal and joint manufacturers), located approximately 73m to the south-west of the site. The status is active;
- Faldock Ship Supplies (marine equipment and supplies), located approximately 77m to he south-west of the site. The status is inactive;
- International Paints (coating specialists), located approximately 113m to the south-west of the site. The status is active;
- Falmouth Cargo Handling (cargo handling services), located approximately

155m to the south of the site. The status is active;
- Falmouth Oil Services Ltd (oil companies), located approximately 183m to the south of the site. The status is active;
- A&P (Falmouth) Ltd (cargo handling services), located approximately 183m to the south of the site. The status is inactive;
- Falmouth Towage Co Ltd (ports, docks and harbours), located approximately 183m to the south of the site. The status is active;
- Admiral Marine Supplies (marine equipment & supplies), located approximately 188m to the south of the site. The status is active; and
- Fox Shipping (freight forwarders), located approximately 213m to the south-west of the site. The status is active.

Due to the type of chemicals used within its process (namely solvents and paint compounds which can be high mobile within groundwater, etc), coating specialists may be regarded as potential off-site sources.

There are seven trade directory entries located between 251m and 500m radius of the site. Three of these are currently active and relate to tank cleaning and repairing, sail makers & repairers and marine engineers. There are thirteen further trade directory entries located between 501m and 1km radius of the site. Only two of these are no longer active.

There is the possibility that contamination could have migrated from some of these activities to the site, particularly from the coating specialists, due to the type of chemicals used (namely solvents and paints' compounds which can be high mobile with groundwater etc.). These may be regarded as potential off-site sources. The degree of risk that they present will be dependent on the potential for a pollutant linkage to exist.

There is one fuel station entry registered within 1km of the site, located approximately 620m to the south-west of the site and named Bonners Garage. The status is described as 'obsolete'.

Pollution Incidents

There are five pollution incidents within 250m of the site. One of them has been classified as significant (category 2) for oils – waste oil pollution of the tidal water and is located approximately 8m to the south-west of the site.

There are eleven recorded pollution incidents within 251m and 500m of the site. There were all classified as minor (category 3) and relate to impact to tidal waters by pollutants such as oils – other oil, heavy fuel oil, miscellaneous pollutants, oil – diesel (including agricultural), oils – waste oil, crude sewage and other pollutants.

There are twenty-three recorded pollution incidents within 501m and 1km of the site. Two of them were classified as significant (category 2) and related to pollution by oils – diesel (including agricultural) and heavy fuel oil.

Due to the relative temporary nature of these surface water incidents and their locations, they are not considered to present a significant risk to the site. However, it is possible that localised areas of contamination may remain.

Waste Management Sites

There is a landfill site recorded by CDC in the northern part of the site. No information was supplied as to the waste types accepted or the operational status of the landfill sites. This corresponds to the reclaimed area. No information regarding the Waste Management Licence for this landfill site was provided in the Envirocheck Report.

There is another landfill site recorded by BGS and CDC and is registered. This landfill site is located approximately 400m to the south-east of the site and is named Falmouth Docks. According to BGS, types of waste accepted were commercial, domestic, and industrial waste (e.g. shortblasting, general ship repair, domestic, asbestos, paint, thinners and oily residues). The latest reported status is described as 'closed' / 'surrendered'. This landfill site is considered to be the former quarry and pit identified during the review of the historical maps and located approximately 400m to the south-east of the study area.

There are two registered waste treatment sites within 1km of the site, both located approximately 458m to the south-east of the site and held by Falmouth Oil Services Ltd.

- for one, the maximum input rate is unidentified, and authorised wastes were hydrocarbon oil / water mixtures (oil >5%) and oil / water mixtures (oil >5%). The status is described as 'superseded'; and
- for one, the maximum input rate is described as small (equal to or greater than 10,000 and less than 25,000 tonnes per year), and authorised wastes are Oil / water mixtures (oil content >5%) and special waste comprising water / oil mixtures (oil content >5%). The licence status is described as 'operational as far as is known'.

Hazardous Substances

There are three recorded Control of Major Accident Hazards Sites (COMAH) sites within 1km of the site. These are:

- A&P (Falmouth) Ltd, located approximately 183m to the south of the site. The type is described as 'Lower Tier' and the status as 'record ceased to be supplied under COMAH Regulations';
- Falmouth Oil Services Ltd, located approximately 183m to the south of the site. The type is described as 'Lower Type' and the status as 'active'; and
- WF Fertilisers Ltd, located approximately 186m to the south of the site. The type is described as 'Lower Tier' and the status as active.

There are two recorded explosive sites within 1km of the site:

- FDEC, located approximately 159m to the south of the site. The status is described as 'active'; and
- FHC, located approximately 676m to the west of the site. The status is described as 'active'.

There are two planning hazardous substance consents located within 1km of the site, located approximately 189m and 194m to the south of the site and both held by Falmouth Docks & Engineering. Their status is described as 'unknown at time of report' and 'granted', respectively. Both of them relate to Ammonium nitrate based fertilisers which conform to the Fertiliser Regulations 1991(a) and composite fertilisers containing phosphate and / or potash (where nitrogen content is more than 28% by weight).

Water Abstractions

There was one licensed water abstraction registered within 1km of the site. This related to groundwater abstraction licensed to Mr NJ Trefusis for general farming and domestic use and located approximately 875m to the north of the site. These abstraction licenses may currently be active. The abstraction is not considered to be at risk of impact from the site as it is unlikely to be in hydraulic continuity given its location on the other side of the estuary.

20.3.5 Environmental Setting

Geology

The BGS map (sheet 352: Falmouth) and the memoir entitled Geology of the country around Falmouth (British Geological Survey, 1990) indicate that the majority of the site lies over a layer of Made Ground. The Made Ground is underlain by the Portscatho Formation of the Devonian Period, which consists of alternating grey or greenish grey sandstone flags and grey mudstone (slate) with sporadic thin siltstone beds. The maximum thickness of this formation was estimated to be 5.4km. This is in turn underlain by the Porthtowan Formation, comprising a thick sequence of slate and sandstone of approximately 2.8km thick, and the Pendower Formation (mudstone with interbedded and interlaminated sandstone, limestone and chert).

Ground investigations carried out by Integral Geotechnique (Wales) Ltd identified the presence of Made Ground across the entire site to depths ranging from 4mbgl to 15.5mbgl, both values being the base of the exploratory holes. Made Ground was mainly composed of a sandy clayey shaly matrix with ash and fragments of brick, concrete, wood, slate, tarmac and coal. Portscatho Formation was encountered in the borehole BH1 between 7.8mbgl and 15.5mbgl (base of borehole) and comprised medium dense to dense silty sand and gravel and weathered mudstone and sandstone.

Coal Mining Affected Areas

The site is situated in an area which is not known to be affected by coal mining activities. According to the Envirocheck report, there is a low risk from shallow mining activities.

Radon Gas

The Radon Atlas of England and Wales (National Radiological Protection Board, November 2002) shows that the site is located in an area where between 10% and 30% of homes are above the Action Level. Therefore radon protection measures will be required for the construction of new dwellings or extensions.

Hydrogeology and Groundwater Vulnerability

The Environment Agency Policy and Practice for the Protection of Groundwater Vulnerability Map No. 53 entitled “Groundwater Vulnerability of West Cornwall” indicates that the site lies over a minor aquifer of variable permeability. Soils are classified as having a high leaching potential. It is considered that this minor aquifer reflects the Porthscatho Formation.

Due to the close proximity of the site to the sea it is considered likely that the groundwater present beneath the site is saline. It is likely that groundwater, particularly within the Made Ground and possibly in the Porthscatho Formation, is in hydraulic continuity with the sea and will be affected by the tides.

Previous investigations indicated that perched water was found within the Made Ground between 3.4m and 3.85mbgl and water was again encountered at approximately 13m to 15mbgl. Groundwater monitoring recorded shallow water at 3.89mbgl in the borehole BH1 located in the northern part of the site. Groundwater level monitoring results indicated that there was evidence that the groundwater levels are influenced by the tides.

20.4 POTENTIAL RISKS DURING THE CONSTRUCTION PHASE

20.4.1 Risk to Land Quality due to Construction

The impact on land quality is based on the contaminants and a number of potential pathways and receptors, and is presented as a series of risks based on the ratings in accordance with the assessment criteria and technique described in Section 20.2.3.

Construction Phase Related Pathways

Several construction phase contamination pathways exist, as described below.

Direct contact. During the construction phase the potential for site workers to come into direct contact with contaminants present within the ground and groundwater is significant.

Inhalation of dust. There is a risk that contaminated soil particles may be entrained in the air on-site, and potentially carried off site, due to disturbance of the ground. The scale and extent to which such airborne migration may take place will be dependant on prevailing weather conditions and mitigation measures in place.

Inhalation of vapours. There is a risk that construction operations may encounter and/ or disturb ground gas.

Permeable ground. The construction phase will cause disturbance to the ground. This will, for the construction period, enable greater percolation of rainfall across the site and may enable the mobilisation/ leaching of some contaminants.

Groundwater migration. Contaminants may be able to migrate in soluble, free or dissolved phase along predominant groundwater flow pathways once they reach the groundwater table, which may be affected by construction operations. Particularly through piling operations or the laying of drainage infrastructure with permeable surrounds.

Construction Phase Related Receptors

Several construction phase receptors exist, as described below.

Human health of construction workers. Site workers will be in close/ direct contact with the soils at the site, for a relatively short length of time. Site workers are therefore considered to be a short term sensitive receptor.

Groundwater. The shallow groundwater is already impacted in places by the contamination contained within the ground. The construction phase may increase the mobilisation of contaminants, which may further impact the perched groundwater.

Surface waters and ecological receptors (i.e. fauna and flora). The site is situated within the Fal Estuary which holds national and international designations. The SAC is located approximately 130m to the south-west of the site. Due to the potential for hydraulic continuity between the shallow groundwater at the site and the surrounding surface waters, it is anticipated that the potential for the construction phase operations to increase the mobilisation of contaminants may impact surface water quality – High Sensitivity.

Neighbouring properties and land use. Neighbouring properties are largely industrial - Low Sensitivity.

Buildings and infrastructure. It is possible that foundations will need to be laid which come into contact with contaminated or aggressive material present within the soils or groundwater during development.

Risk Assessment

Table 20-3 identifies the contamination risks and their ratings in accordance with the terms identified in Table 20-1.

Table 20-3 Summary of Risks associated with the Construction Phase

Hazard	Comment / Linkage	Risk	Risk Management Action
Risk to human health – site workers	Site workers are potentially at risk via direct contact (dermal), ingestion or inhalation of contaminants in shallow soil, water or vapours. A preliminary investigation indicated the presence of metals and hydrocarbons within the soil. There is a risk for contaminants to be present in gaseous form also.	Medium	In order to fully determine the risks posed by the site to human health (i.e. site workers during construction and future users) the full set of results obtained from the previous site investigation should be assessed in accordance with best practice guidance for the UK and the development layout. Further site investigation should be undertaken as necessary to target source areas or delineate contaminated areas. This will enable any remediation and/or protection measures necessary to be designed to ensure that the site is suitable for its intended use and that the risks are reduced to acceptable levels

Hazard	Comment / Linkage	Risk	Risk Management Action
Risk to shallow perched groundwater	There is a potential for leachable soil contamination to impact shallow perched groundwater beneath the site. Previous investigation indicated that groundwater is present and that water levels were affected by the tide. As such, any contamination reaching the perched groundwater has the potential to migrate to the estuary.	Medium	Leachate testing of soil was not carried out as part of the previous site investigation, this information may prove useful to determine the risk the soil poses to the quality of the groundwater. Two wells were installed at the site and groundwater samples were collected for chemical analysis (results not available at the time of writing). These groundwater results should be compared against appropriate environmental standard and a risk assessment undertaken to determine the quality of the groundwaters and the risks posed. Further monitoring may be needed to confirm the findings or delineate contamination. This would enable suitable mitigation measures to be adopted (if necessary).
Risk to deep groundwater	The underlying geology (Portscatho Formation) is regarded as a minor aquifer. There is a risk that contamination may migrate from the shallow soils or perched groundwater and affect the quality of the groundwater within the aquifer. Migration may be via pollutant pathways such as deep structures etc. However, it is noted that due to the close proximity with the estuary, it is possible that saline intrusion in the area has reduced the resource potential for the aquifer.	Medium	
Risk to surface water	Site drainage may run-off to the nearby estuary or flooding events may mobilise pollutants within the site to the estuary. In addition, should the groundwaters beneath the site be impacted from contamination, this may affect the surface water quality of the estuary.	Medium to High	An assessment of existing data should be undertaken (once available) and the potential need for further site investigation or testing highlighted. A quantitative risk assessment may be required to determine the risks posed to surface water quality. If risks are identified, then remediation measures should be designed, where necessary.
Risk to neighbouring properties and land use	The site is located within a predominantly industrial area and is located within the tidal estuary.	Low	An assessment of the pending chemical test results would help determine the potential risks to neighbouring properties as a result of site contamination. This information should be used to determine the need for further investigations or assessments to be undertaken as necessary.
Risk to ecological receptors	Risks are considered to be medium the study area is located within a high quality estuary which supports important shellfish fisheries and ecological habitats.	Medium	The full set of results obtained from the previous site investigation should be assessed in order to fully assess potential risks to ecological receptors.
Risks to buildings and structures	There is a potential that contaminants present in soils or shallow groundwaters may impact building materials, structures and services.	Medium	Appropriate construction materials (i.e. concrete type and underground services materials) or appropriate design to protect pipework etc. may be

Hazard	Comment / Linkage	Risk	Risk Management Action
	Results of the previous site investigation showed the presence of TPH, PAHs, phenols and sulphide which could result in deterioration of concrete or plastic pipes etc. In addition, the site is located in an area where between 10% and 30% of homes area at risks from radon.		required. Buildings will require radon protection measures. There is also a potential need for the protection of buildings from other ground gases such methane, carbon dioxide etc. The need for such protection measures should be determined from an assessment of the gas regime at the site in accordance with current UK best practice.

Mitigation of Risks to Human Health

Risks to human health from potential shallow soil contamination, landfill gases and radon gas may be controlled by the provision of a gas protection measures and a capping layer. This capping layer may include concrete hardstanding / tarmac or an engineered soft capping layer of approximately 600mm to 1m thickness (depending on the degree of contamination) in proposed landscaped area. Such a capping layer would break the pathway between site users and potentially contaminated soils thereby reducing the risks to potentially acceptable levels. Structures associated with future works, access roads and footpaths etc. may provide an effective barrier between the soil and future site users in all other areas.

Full radon protection measures will be necessary in the construction of new cruise terminal and associated buildings as the site is shown to be located in an area requiring remedial action. In addition, as soil gases were detected during the site investigation. It is therefore possible that soil gas protection measures may need to be incorporated into the design of the any proposed buildings at the site (subject to the findings of further gas monitoring events and assessment of the results)

Any soils imported to the site for use in the soft capping layer will need to be tested and verified to ensure that they do not pose a risk to human health. They will also need to be accompanied by all relevant Duty of Care documentation, including source details.

It should be noted that any imported soils used during the construction of the new jetties will also need to be tested and verified to ensure that they do not pose a risk to human health or the environmental receptors identified.

Following the assessment of the final set of results from the previous investigation, any areas of contamination identified as posing a risk will most likely require either treatment or removal (see Section 20.3.4).

Mitigation of Risks to Groundwater and Surface Waters

The history of the site is such that it may have resulted in contamination of the shallow groundwater, which may potentially migrate to surface waters and / or deeper groundwater.

Pending groundwater results should be assessed against appropriate guidance values to determine potential impact to controlled waters. If contamination is found to pose a risk then mitigation in the form of groundwater remediation may be required.

There is also a potential for soils at the site to pose a risk to controlled waters (e.g. as a result of leaching of contaminants). Any such significantly contaminated soils that present a leaching risk will need to be either disposed off site or treated.

Mitigation of Risks due to Waste Disposal

Any material excavated and requiring disposal off site will need to be characterised and disposed of in accordance with the Landfill Regulations 2002 (as amended) and the Hazardous Waste Regulations 2005. Any material classified as hazardous waste will require pre-treatment prior to disposal, either to reduce the volume of hazardous waste requiring disposal or to reduce the hazardous nature of the material. In addition, non-hazardous waste requiring disposal to landfill after 30th October 2007 will also require pre-treatment.

Any excavated material proposed for re-use on site will require testing to ensure its suitability for re-use. The re-use of material should be undertaken in accordance with the Waste Management (England and Wales) Regulations 2006 or a relevant exemption.

Mitigation of Risks to Environmental Controls

Future works may involve the use of materials that have the potential to impact the environment. It is recommended that during any future redevelopment work, contractors and designers should ensure that sound environmental practices are adopted. In addition, they must ensure that no environmentally damaging materials or fuels that might be used during the construction process are spilled or otherwise allowed to pollute the site. Care should be taken during any construction work to prevent run-off of waters that may contain suspended solids and fuels and consequently pollute the local soil surface.

Due to the past land use of the site, there is a risk for unidentified contamination to be present. It is therefore recommended that prior to construction, a method statement should be prepared identifying the procedures to follow should previously unidentified contamination be encountered. This should include seeking professional advice from a suitably qualified environmental consultant.

Mitigation of Risks to the Health and Safety of Construction Workers

Risks to construction workers may be controlled though good site practice and hygiene in addition to the use of appropriate personal protective equipment (PPE) and respiratory protective equipment (RPE). A health and safety plan should be developed for all site works to aid identification of such risks and appropriate risk avoidance and reduction measures.

Residual Risk

With the successful implementation of the mitigation actions, the residual risks should be reduced to low adverse risks.

20.5 POTENTIAL RISKS DURING THE OPERATIONAL PHASE

20.5.1 Risk to Land Quality due to Operation

The impact on land quality is based on the contaminants and a number of potential pathways and receptors, and is presented as a series of risks based on the ratings in accordance with the assessment criteria and technique described in Section 20.2.3.

Operational Phase Related Pathways

Several operation phase contamination pathways exist, as described below.

Dermal contact. Following development, it is anticipated that the majority of the proposed development site will be covered with either buildings or hardstanding. It is therefore considered that potential for direct contact with any remaining contaminants present within the ground beneath the surface is regarded as low to negligible.

Inhalation of dust. As the majority of the development will comprise of buildings and hardstanding, the potential for contaminated soil particles to be entrained in the air on-site or transported off-site is considered to be low to negligible.

Inhalation of vapours. Ground gas has the potential to infiltrate buildings and impact on indoor air quality.

Permeable ground. Upon completion of the development, the site will be covered with buildings and hardstanding, from which it is planned to drain to either the surface water sewer or to the river via a drainage system. This will significantly reduce the amount of rainfall percolation into the made ground, therefore, reducing potential leachate formation. This will reduce the potential for further contaminant migration, both laterally and vertically.

Operational Phase Related Receptors

Several operation phase receptors exist, as described below.

Future site users. The future use of the site will be industrial. Future site users will be adults working at the site which are regarded as a moderately sensitive receptor.

Groundwater. The shallow groundwater will still be present in the ground underlying the development. However, as the site is anticipated to be mainly covered by hardstanding or drained to a surface water drainage system it is likely to receive far less water infiltration, reducing the leachate production, and resulting in less movement of contaminants. Therefore the shallow groundwater is not considered a sensitive receptor.

Surface water and ecological receptors (i.e. fauna and flora). Surface water drainage from the hardstanding development may be discharged to the estuary or river. The Fal Estuary holds national and international designations and the closest SAC is located approximately 130m to the south-west of the site. Therefore this receptor is considered to be of High Sensitivity.

Neighbouring properties and land use. Neighbouring properties are largely industrial - Low Sensitivity.

Buildings and infrastructure. It is possible that foundations will need to be laid which come into contact with contaminated or aggressive material present within the soils or groundwater during development.

Risk Assessment

Table 20-4 identifies the contamination risks and their ratings in accordance with the terms identified in Table 20-1.

Table 20-4 Summary of the Impacts arising from the Operational Phase

Hazard	Comment / Linkage	Risk	Risk Management Action
Risk to human health – future site users	It is proposed to redevelop the site for industrial / commercial purposes. Future users are potentially at risk via direct contact (dermal), ingestion or inhalation of contaminants (if present) in shallow soil, water or vapours. Previous investigation indicated the presence of elevated concentrations of metals and hydrocarbons. Future users may also be at risk from the migration of soil gases generated within the fill materials of the reclaimed area (see section 3.3) and found across the site.	Medium	In order to fully determine the risks posed by the site to human health (i.e. site workers during construction and future users) the full set of results obtained from the previous site investigation should be assessed in accordance with best practice guidance for the UK and the development layout. Further site investigation should be undertaken as necessary to target source areas or delineate contaminated areas. This will enable any remediation and/or protection measures necessary to be designed to ensure that the site is suitable for its intended use and that the risks are reduced to acceptable levels.
Risk to shallow perched groundwater	There is a potential for leachable soil contamination to impact shallow perched groundwater beneath the site. Previous investigation indicated that groundwater is present and that water levels were affected by the tide. As such, any contamination reaching the perched groundwater has the potential to migrate to the estuary.	Medium	Leachate testing of soil was not carried out as part of the previous site investigation, this information may prove useful to determine the risk the soil poses to the quality of the groundwater. Two wells were installed at the site and groundwater samples were collected for chemical analysis (results not available at the time of writing). These groundwater results should be compared against
Risk to deep groundwater	The underlying geology (Portscatho Formation) is regarded as a minor aquifer. There is a risk that contamination may migrate from the	Medium	

Hazard	Comment / Linkage	Risk	Risk Management Action
	shallow soils or perched groundwater and affect the quality of the groundwater within the aquifer. Migration may be via pollutant pathways such as deep structures etc. However, it is noted that due to the close proximity with the estuary, it is possible that saline intrusion in the area has reduced the resource potential for the aquifer.		appropriate environmental standard and a risk assessment undertaken to determine the quality of the groundwaters and the risks posed. Further monitoring may be needed to confirm the findings or delineate contamination. This would enable suitable mitigation measures to be adopted (if necessary).
Risk to surface water	Site drainage may run-off to the nearby estuary or flooding events may mobilise pollutants within the site to the estuary. In addition, should the groundwaters beneath the site be impacted from contamination, this may affect the surface water quality of the estuary.	Medium to High	An assessment of existing data should be undertaken (once available) and the potential need for further site investigation or testing highlighted. A quantitative risk assessment may be required to determine the risks posed to surface water quality. If risks are identified, then remediation measures should be designed, where necessary.
Risk to neighbouring properties and land use	The site is located within a predominantly industrial area and is located within the tidal estuary.	Low	An assessment of the pending chemical test results would help determine the potential risks to neighbouring properties as a result of site contamination. This information should be used to determine the need for further investigations or assessments to be undertaken as necessary.
Risk to ecological receptors	Risks are considered to be medium the study area is located within a high quality estuary which supports important shellfish fisheries and ecological habitats.	Medium	The full set of results obtained from the previous site investigation should be assessed in order to fully assess potential risks to ecological receptors.
Risks to buildings and structures	There is a potential that contaminants present in soils or shallow groundwaters may impact building materials, structures and services. Results of the previous site investigation showed the presence of TPH, PAHs, phenols and sulphide which could result in deterioration of concrete or plastic pipes etc. In addition, the site is located in an area where between 10% and 30% of homes area at risks from radon.	Medium	Appropriate construction materials (i.e. concrete type and underground services materials) or appropriate design to protect pipework etc. may be required. Buildings will require radon protection measures. There is also a potential need for the protection of buildings from other ground gases such methane, carbon dioxide etc. The need for such protection measures should be determined from an assessment of the gas regime at the site in accordance with current UK best practice.

Mitigation and Residual Risk

Some contaminants such as hydrocarbons or phenols can attack plastic pipework. As such, pipework placed in contaminated soils, may be at risk of deterioration. Results obtained from previous site investigation indicated the presence of contaminants such as TPH and phenols within the Made Ground. As such, services may need to be protected or comprised of suitable durable materials.

Sulphide was detected within the Made Ground during previous site investigation. An assessment of the potential for chemically aggressive ground conditions may be needed for concrete design. It is recommended that due to the presence of Made Ground and the variation of ground conditions, the design classification for any buried concrete should be confirmed in any future site investigations.

Given the generally low levels of contamination found on the site and provided that the above mitigation measures are adhered to, the residual risk is considered to be of low adverse significance.

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21 SOCIO-ECONOMICS

21.1 INTRODUCTION

This section assesses the impact of the proposed Falmouth Cruise Project on the local economy, including employment, and is based upon the work conducted for the Economic Impact Study and Assessment of Port of Falmouth (Arup, 2008).

Employment impacts are affected by a number of sources, set out below, which have been considered herein:

- project construction – this is a large-scale capital project with a capital value of between £15 and £20 million for the dredging and disposal costs alone;
- project operations – the increased accessibility of the port will enable more cruise ships to come in as well as potentially more and larger ships to be repaired;
- tourism expenditure – increased passenger numbers will lead to increased spend which in turn will lead to further employment; and
- other effects – most notably through supply chain effects.

21.2 METHODOLOGY

21.2.1 Baseline Data Collection

Baseline socio-economic data is taken from the Economic Impact Study and Assessment of Port of Falmouth and, where possible, uses local statistics (i.e. Cornwall) which are presented with reference to national statistics (i.e. England and Wales) and regional statistics (i.e. South West) to provide a basis for comparison.

21.2.2 Surveys

No surveys were undertaken the Economic Impact Study and Assessment of Port of Falmouth.

21.2.3 Assessment Criteria

As described in the Economic Impact Study and Assessment of Port of Falmouth, “the economic impact has been considered in terms of net additional employment generated through increased activities at Falmouth Docks and also through additional visitor spending” (Arup,2008). The impact on the economies of the Falmouth area, Cornwall and the South west has been considered using some assumptions on leakage, displacement and substitution effects have been employed.

21.2.4 Assessment Technique

As described in the Economic Impact Study and Assessment of Port of Falmouth, the economic impact is related to an options analysis. Options include scenarios for “do nothing”, “do minimum” and “do proposed project”. Net impacts for the do proposed project scenario have been calculated by considering A&P, FDEC and FHC activities and assessed by subtracting the do nothing scenario.

21.2.5 Assessment of Impact Significance

Impact significance has been determined qualitatively by relating the results of the Economic Impact Study and Assessment of Port of Falmouth to the contexts described in Section 1.4.3 and terminology identified in Table 1-1.

21.3 BASELINE ENVIRONMENTAL CONDITIONS

21.3.1 Demographics

The population of Cornwall and the Isles of Scilly was estimated to be 538,600 in 2008 (ONS). In the period 2004 to 2008 the population growth rate averaged 1%. The rate of population growth is predicted to decline in the future falling to 0.6% in 2026. The current population projection for the county in 2029 is 643,100.

The total population of the county is slowly increasing. However, within this population the proportion of individuals in younger age brackets is decreasing. The proportion of the population within the 0-19, 20-39 and 40-59 age brackets are all projected to decrease over the next two decades. The population is projected however to see an increase in the proportion of individuals in the 60-79 and the 80+ age ranges. These individuals are expected make up more than a third of the local population by 2028. While the trend of populations getting older is observed across England and Wales it is occurring at a faster rate within Cornwall. Young people are tending to move away from the area and more individuals are choosing Cornwall as a place to retire to.

21.3.2 Economic Participation

Employment rates between 2005 and 2007 fell from being slightly above to being slightly below the England and Wales average. The local employment rate is significantly below the regional average. In 2005 the Cornish employment rate (proportion of the working age population in employment) was 75% as opposed to the regional average of 78%. The gap between these two rates steadily increased between 2005 and 2007.

The unemployment rate for Cornwall between 2006 and 2007 was broadly similar to the regional average and significantly below the national average. The fact that the local employment rate is below the national average but the unemployment rate is similar to the national average would indicate that there are a significant number of “under-employed” individuals within the workforce. These are individuals who are ineligible for unemployment benefits but may be available and willing to work should work be available.

21.3.3 Wage Levels

2007 wage levels in Cornwall and Isles of Scilly are shown in Table 21-1 below. Average earnings are about 8% lower than the South West region and England and Wales as a whole. Growth rates over the preceding five years were slightly higher however.

Table 21-1 Average Gross Annual Earnings (source: ONS)

	Cornwall and Isles of Scilly	South West	England and Wales
Average Gross Annual Earnings in 2007	£20,335	£22,966	£24,242
Average Gross Annual Earnings as Percentage of England and Wales Average	92.1%	94.7%	100%
Average Annual Growth Rate of Gross Annual Earnings 2002-2007	3.8%	3.5%	3.3%

21.3.4 Sectoral Composition

The sectoral breakdown by employment in Cornwall is dominated by the distribution, hotels and restaurant sector and by the public sector (public administration, education and health). Banking, finance and insurance and manufacturing both employ a smaller proportion of the workforce than in the South West region or England and Wales as a whole. Of the two largest sectors, the distribution, hotels and restaurant sector employs only 1% less of the workforce than the public sector. This figure highlights the area's reliance on tourism.

21.3.5 Deprivation

The Indicies of Multiple Deprivation (IMD) is a measure for comparing the relative deprivation of different areas. The lower the IMD score the less deprived an area is. Within Penryn, 12 areas had an IMD score between 40 and 50 indicating moderate to high levels of deprivation. Falmouth is generally less deprived than Penryn with the majority of output areas having an IMD score of 20-40. The areas surrounding the Falmouth/Penryn conurbation generally have scores of between 10 and 20 indicating low levels of deprivation. The town of Redruth is 10 miles to the north-west of Falmouth. Three per cent of the docks' employees commute from this town. Several output areas in Redruth have IMD scores of 57 and are among the most deprived areas in Cornwall.

21.3.6 Education Levels

Qualification levels for Cornwall, the South West and Great Britain are shown in Table 21-2 below. While a greater proportion of individuals in Cornwall hold qualifications at NVQ levels 1-3 than in Great Britain as a whole, a lesser proportion hold qualifications at NVQ4 level four and above.

Table 21-2 Education Qualification Levels

Qualification Level	Cornwall	South West	Great Britain
NVQ4 and above	24.5%	27.3%	27.4%
NVQ3 and above	47.7%	47.3%	45.3%
NVQ2 and above	68.5%	67.2%	63.8%
NVQ1 and above	83.0%	82.5%	77.8%
Other qualifications	7.0%	7.7%	8.5%
No qualifications	10.0%	9.8%	13.8%

21.3.7 Baseline Contribution of Falmouth Docks

Falmouth Docks is situated within Falmouth Harbour, one of the world's largest natural deepwater harbours and is strategically well placed to provide support to shipping operating in North West Europe. Falmouth Docks play an important role in the economy of the town and region. It is the largest private employer in the area currently providing jobs to 978 people. There are five major employers based in the yard:

- A&P Falmouth Limited;
- Falmouth Fishselling Company;
- Falmouth Harbour Commissioners;
- Falmouth Oil Services; and
- Pendennis Shipyard.

In addition 17 other firms are located within the docks area. Marine related businesses at Falmouth are estimated to achieve a combined turnover of £60.5 million per year.

A&P Falmouth handles approximately 100,000 tonnes of cargo per year, most of it imported. Imported cargos include about half of Devon and Cornwall's fertiliser supply as well as animal feed and coal.

Some facilities in Falmouth Docks are currently in a poor condition. Due to the depths of the main approach channel, only ships with a draft of 5.2m or less can be accommodated at all states of the tide. If depreciation of the docks is not addressed the business environment for firms within the docks will become less favourable. Without investment port business would be expected to at best remain static and may well decline.

21.3.8 Baseline and Forecast of Cruise Market

Worldwide, the cruise industry has recently been the fastest growing sector in the leisure industry. UK cruising has seen significant growth over the past decade and some years have seen impressive increases in passenger numbers. Between 2003 and 2004 there was a 13% increase in the numbers of UK passengers on UK cruises and a 44% growth in overseas passengers starting a cruise from a UK port.

Table 21-3 shows the number of day calls and turnaround visits by cruise ships to Falmouth in the past 2 years.

Table 21-3 Cruise Ship Calls to Falmouth 2006/2007 and 2007/2008

Year	Day Calls	Turnaround
2006/2007	27	12
2007/2008	36	2

While day call visits showed significant growth the number of turnaround reduced significantly. This reduction may well be partially related to Travelscope, a local holiday firm that went into administration in late 2007. For example, Travelscope had scheduled eleven cruises to depart from Falmouth in 2008. It should be noted that this reduction may reflect the misfortunes of one local company and the impact on a single port rather than for the general trend in cruise market demand which is more positive.

21.4 POTENTIAL IMPACTS DURING THE CONSTRUCTION PHASE

21.4.1 Increased Local Employment through Construction

The construction works for the proposed Falmouth Cruise Project will create a substantial quantity of short-term and medium-term construction employment.

If a standard construction industry GVA per employee of £33,000 is applied, an estimate of total construction years can be assessed. One Full Time Equivalent (FTE) job is generally assumed to be created for each 10 construction years. This is shown in Table 21-4.

Table 21-4 Direct Construction Jobs Created (source: Arup, 2008)

Capital Costs	Construction Years	Jobs FTE
£39 million	1302	130

Additional construction employment will support additional indirect and induced employment. However because much of the construction employment will be of a specialist nature those employed may well come from outside the local areas. The net increase in employment in these three areas once leakage, substitution and multipliers have been taken into account is shown in Table 21-5.

Table 21-5 Net Additional FTE Jobs by Area (source: Arup 2008)

Falmouth	Cornwall	South West
62	93	199

Additional local employment generated both directly and indirectly through the construction period will be limited and of a short-term to medium-term nature. It is assessed as having a temporary moderate beneficial impact on the local economy.

Mitigation and Residual Impact

No mitigation measures are recommended and there will be a temporary moderate beneficial residual impact.

21.5 POTENTIAL IMPACTS DURING THE OPERATIONAL PHASE

21.5.1 Additional Direct Revenue to Port Based Businesses from Cruise Ships

Once constructed, the proposed project will allow larger cruise ships to dock at Falmouth. In addition, it is forecast that the number of cruise ships will increase over time. These operations will increase the berthing charges, harbour dues and charges for pilot services which are paid to FDEC, FHC and the self-employed pilots. The predicted increase in these revenues over time is shown in Table 21-6.

Table 21-6 Port revenues by Year (source: Arup, 2008)

Year	Revenue	Increase from 2005 baseline
2005	£439,500	£0
2008	£494,438	£54,938
2009	£526,684	£87,184
2010	£548,181	£108,681
2015	£698,662	£259,162
2020	£730,908	£291,408

Revenue from charges represents currently represents 0.73% of the current docks turnover of £60.5 million, a small but significant contribution. At this magnitude, the additional port revenues will have a long-term, minor beneficial impact on the local economy.

Mitigation and Residual Impact

No mitigation measures are recommended and there will be a long-term minor beneficial residual impact.

21.5.2 Additional Spend by Cruise Passengers and Crew

Once constructed, proposed project will support the services required by a greater number of cruise passengers and crew, and the larger cruise vessels.

The forecast of additional cruise passengers to Falmouth was made by Arup (2008) and is shown in Table 21-7 below. The low estimate of additional passengers if the project is built assumes that passenger numbers grow at 10% per year until 2015 and 5% thereafter. The high estimate assumes passenger number increase at 20% per year until 2015 and 10% thereafter.

Table 21-7 Forecast Passenger Numbers for Falmouth (source: Arup, 2008)

	2005	2008	2009	2010	2015	2020	2025
Do Nothing	28,700	38,200	36,290	34,475	29,304	24,908	19,927
Low estimate	28,700	38,200	42,020	46,222	74,440	95,007	121,256
High estimate	28,700	49,594	59,512	71,415	177,703	286,192	365,262

The number of additional ships estimated to call at Falmouth should the project proceed are shown in Table 21-8. The number of ships increases over time however it should also be noted that the projected proportion of day call to turnaround visits is presumed to stay constant at 2008 levels (73% day call, 27% turnaround) and that the average number of passengers per ship increases over time.

Table 21-8 Forecast Ship Numbers for Falmouth (source: Arup, 2008)

	2005	2008	2009	2010	2015	2020
Day Calls	22	34	36	37	47	50
Turnarounds	18	12	13	14	18	18
Total Calls	40	46	49	51	65	68
Average Passengers (low estimate)	718	830	858	906	1,145	1,397

Arup (2008) assumes that 75% of cruise passengers go ashore during day call cruise ship visits to Falmouth. Cruise passengers who go ashore are assumed to spend on £65 on average. Half of passengers who go ashore (37.5% of all passengers) are assumed to go on an excursion which increases spend per passenger by £10. 5% of day call passengers are assumed to use taxis or hire a car spending an additional £20 per head.

Turnaround passengers spend slightly more on average than day visitors as they may choose to stay an extra night in local accommodation ashore. A third of turnaround visitors are assumed to spend an extra night in Falmouth at the beginning or end of their trip spending £100 on average. Other turnaround visitors are assumed to spend the same as day visitors £65.

Arup (2008) assumes that there is a ration of two passengers to one crew on cruise ships. 15% of the crew are assumed to go ashore during day visits and spend on average £40. During a turnaround visit it is assumed that a quarter of the crew disembark and spend a night ashore spending on average £50.

Total spending onshore by cruise ship passengers and crew is presented in Table 21-9.

Table 21-9 Onshore Spending by Cruise Passengers and Crew (source: Arup, 2008)

	2005	**2008**	**2009**	**2010**	**2015**	**2020**
Total passengers	28,700	38,200	42,020	46,222	74,440	95,007
Day visit passenger spending (£)	591,938	1,045,725	1,150,298	1,644,925	2,649,134	3,381,062
Turnaround passenger spending (£)	852,390	680,724	748,796	947,227	1,525,499	1,946,978
Day visit crew spending (£)	47,355	83,658	92,024	101,226	163,024	208,065
Turnaround crew spending (£)	852,390	680,724	768,796	947,227	1,525,499	1,946,978
Excursion Spending (£)	107,625	143,250	157,575	173,333	279,150	356,276
Local Transport spending (£)	15,785	27,886	30,675	33,742	54,341	69,355
Total Spending (£)	1,695,811	2,045,706	2,250,276	2,978,453	4,796,765	6,122,061
Baseline Scenario Spending (£)	1,695,811	2,045,706	1,943,420	2,221,500	1,888,291	1,605,022
Total Additional Spending (£)	0	0	306,856	756,953	2,908,474	4,517,039

It was assumed in Arup (2008) that each £24,000 of additional spending supports one additional tourist sector job. This estimate is lower than that of SWRDA but is considered appropriate due to the lower wages and seasonal nature of tourist sector jobs in the area. Additional employment in the tourist sector due to cruise visitors is shown in Table 21-10.

Table 21-10 Additional Tourism Employment through Cruise Visitors

	2005	2008	2009	2010	2015	2020
Total tourism jobs supported	71	85	94	124	200	255
Additional tourism jobs supported	0	0	13	32	121	188

In addition there is some evidence that holiday makers use cruises as a way of identifying locations for future holidays. A good visitor experience of Cornwall would be expected to increase visitor's propensity to return for a land based holiday, and to recommend the area to family and friends. This multiplier effect has not been confirmed explicitly by any study and as such has not been quantified here.

Increased tourist revenue from cruise passengers represents a long-term effect and is assessed as being a moderate beneficial impact on the local economy.

Mitigation and Residual Impact

No mitigation measures are recommended and there will be a long-term moderate beneficial residual impact.

21.5.3 Additional Employment by A&P Falmouth and Other Port Related Businesses

A&P Falmouth is the most important ship repair facility in south west England in terms of both turnover and facilities. It currently employs around 470 people of whom 80% live in the Falmouth and Penryn area. The industry is inherently fluctuating with work coming in peaks and troughs. The workforce varies rapidly to take account of changing work orders and as such employment is a mix of permanent, casual and agency staff.

Falmouth Docks has strong local labour supply linkages and as such multiplier effects are assumed to be high both at a local and regional level. Arup (2008) have estimated the local multiplier to be 50% and the regional multiplier to be 60%. This is the proportion of extra indirect and induced employment which is generated further up the supply chain within the areas due to the extra direct employment.

The gross direct employment of A&P Falmouth is currently 470 jobs. After the project is completed this is projected to increase to 600 with additional jobs supported by the cruise terminal, increase ship calls and increase repair contracts. Table 21-11 shows the assumptions to convert this base increase in jobs into estimated impacts on employment for both Falmouth and Cornwall.

Table 21-11 Employment Impact Assumptions

Assumption	Description	Falmouth	Cornwall
Leakage	Proportion of employee that live outside the area	20%	0%
Displacement	Market share taken from local competing businesses	10%	10%
Multiplier	Additional work supported by increased activity and local wages	50%	60%
Gross Value Added	GVA added per employee	£25,900	£25,900

The magnitude of employment impacts are shown in Table 21-12. In essence, there will be employment increases within Falmouth and Cornwall, with gross direct employment rising from 470 to 600 jobs.

The assessment of additional employment supported by expanded port activities with the proposed project in place uses the current situation as the baseline for assessment. However if the proposed project does not proceed, it is expected that Falmouth's importance as a cruise port and ship repair facility may decline. As such the "do nothing" scenario would likely see economic activity and employment fall from its current position. The proposed project therefore safeguards existing jobs. Since a declining baseline has not been estimated it is not possible to assess the significance of this effect, however, in the long-term the port may not be sustainable without improvements and dredging.

Table 21-12 Employment Impacts

	Baseline Conditions		**With Project**	
	Falmouth	**Cornwall**	**Falmouth**	**Cornwall**
Gross Direct Effects	470	470	600	600
Leakage	94	0	120	0
Gross Local Direct Effects	376	470	480	600
Displacement	38	47	48	60
Net Local Direct Effects	338	423	432	540
Multiplier Effects	169	254	216	324
Total Net Local Effects	508	677	648	864
GVA	£13.2m	£17.5m	£16.8m	£22.4m

The project is expected to provide a long-term increase in port business as well as safeguarding existing jobs. Recognising the major role the docks have in the local and Cornish economy, the additional and secured employment provided by the proposed project will have a long-term moderate beneficial impact to the local economy. The significance of this impact would be greater if the "do nothing" scenario were to lead to a fall in employment over baseline conditions.

Mitigation and Residual Impact

No mitigation measures are recommended and there will be a long-term moderate beneficial residual impact.

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22 SUMMARY OF POTENTIAL IMPACTS AND MITIGATION MEASURES

Table 22.1 provides an overall summary of the findings of the ES and lists the potential environmental impacts that are predicted to arise during the construction and operational phases of the proposed development, including the disposal of dredged material.

The significance of each of the potential impacts (or change or risk) is stated, along with any mitigation measures that are recommended to reduce or avoid adverse impacts. The residual impact (i.e. the significance of the potential impact remaining following mitigation) is also stated.

Table 22-1 Summary of Potential Impacts, Impact Significance, Mitigation Measures and Residual Impacts

Impact	Significance	Mitigation	Residual impact
HYDRODYNAMICS AND SEDIMENTARY REGIME			
Construction			
Change to suspended sediment concentrations during capital dredging	Minor change around the dredger (50mg/l) to negligible change with distance from the dredger (3-5mg/l)	None required	Minor
Change to sediment deposition due to capital dredging	Minor change (1.7mm) to negligible change (0.5mm)	None required	Minor – negligible
Change to suspended sediment concentrations due to disposal of clean dredged material at sea	Minor change (20mg/l)	None required	Minor
Change to sediment deposition due to disposal of clean dredged material at sea	Moderate change (up to 0.5m) within disposal site, minor change (0.05m) within 1km of the disposal site, negligible change (<0.005m) beyond 1km of the disposal site	None required	Moderate – negligible
Operational			
Change to wave conditions	Minor change (<0.2m) at a few sites (mainly in the docks) under certain conditions and negligible change elsewhere	None required	Minor – negligible
Change to tidal conditions	Negligible change	None required	Negligible
Change to mud transport conditions	Negligible change (610m^3/yr)	None required	Negligible
Change to sand transport conditions	Negligible change (20m^3/yr)	None required	Negligible
Change to coastal processes	Negligible change at Falmouth Docks, Kiln Quay and Trefusis. No change at Gyllyngvase and Castle Beaches, Castle Headland, Port Pendennis Marina, the National Maritime Museum, Discovery Quay, Custom House Quay, Visitors Yacht Haven, Fish Strand Quay, Prince of Wales Pier, Admirals Quay, Greenbank Quay and Flushing	None required	Negligible - no change

Impact	Significance	Mitigation	Residual impact
Sediment quality			
Construction			
Impact on sediment quality in the new navigation channel due to capital dredging	Minor adverse impact physically, moderate to major beneficial impact chemically and toxicologically, negligible biologically	None required	Minor adverse physically, moderate to major beneficial impact chemically and toxicologically, negligible biologically
Impact on sediment quality beyond the new navigation channel due to capital dredging	Negligible impact physically, chemically and toxicologically and no impact biologically	None required	Negligible physically, chemically and toxicologically and no impact biologically
Impact on sediment quality due to disposal of dredged material	Minor adverse impact physically, negligible impact chemically, biological and toxicologically	None required	Minor adverse physically, negligible chemically, biological and toxicologically
Operational			
Impact on sediment quality in the new navigation channel after capital dredging	Negligible impact physically, chemically, biologically and toxicologically	None required	Negligible
Water quality			
Construction			
Impact on dangerous substances water quality due to capital dredging - TBT	Moderate adverse impact for TBT, negligible for other contaminants	None required	Moderate adverse - negligible
Impact on shellfish water quality due to capital dredging	Minor - moderate adverse impact for TSS in Carrick Roads and Penryn shellfish waters, negligible impact for other contaminants in Carrick Roads and Penryn shellfish waters, no impact in Percuil shellfish water	None required	Minor - moderate adverse (TSS) and negligible (other contaminants) in Carrick Roads and Penryn River and no impact in Percuil River
Impact on bathing water quality due to capital dredging	No impact	None required	No impact
Impact on water quality due to	Not applicable – risk, not impact	Oil spill planning and	Not applicable – risk, not impact

Impact	Significance	Mitigation	Residual impact
accidental spills and leaks during construction		pollution prevention guidance	
Operational			
Impact on dangerous substances water quality due to capital dredging	Moderate beneficial impact due to removal of contaminants, especially TBT	None required	Moderate beneficial
Impact on water quality due to wastewater from the cruise terminal building	No impact due to use of appropriate sewage treatment works	None required	No impact
Impact on water quality due to wastewater from cruise vessels	No impact due to international law on ship waste management	None required	No impact
MARINE AND COASTAL ECOLOGY			
Construction			
Loss of maerl in the proposed new navigation channel due to capital dredging	Major adverse impact from removal of viable maerl habitat	Seabed habitat mitigation is proposed in order to replace viable maerl habitat, this will offset any net loss of maerl habitat as a result of the dredge.	Moderate – minor adverse
Loss of benthic communities in the proposed new navigation channel due to capital dredging	Moderate adverse impact as a result of the loss of benthic communities	See above	Minor adverse
Physical impacts to benthic fauna from increased TSS concentrations due to capital dredging	Minor adverse impact on benthic communities from increased TSS from dredging	None required	Minor adverse
Physical impacts to benthic fauna from increased sediment deposition due to capital dredging	Minor adverse impact on benthic fauna	None required	Minor adverse
Chemical impacts on benthic fauna from increased contaminant	Minor adverse impact	None required	Minor adverse

Impact	Significance	Mitigation	Residual impact
concentrations in the sediment due to capital dredging			
Impacts on benthic ecology due to wharf improvements	Negligible impact	None required	Negligible
Impacts on intertidal ecology due to coastal erosion protection	Minor adverse impact	None required	Minor adverse
Physical impact on benthic fauna from sediment deposition due to the disposal of dredged material	Minor adverse impact	None required	Minor adverse
Operational			
Impacts to marine ecology from changes to hydrodynamics and sediment transport due to the new navigation channel	Minor adverse impact	None required, however monitoring is proposed to ensure that there are no unanticipated impacts	Minor adverse
ORNITHOLOGY			
Construction			
Temporary loss of breeding and foraging habitat due to construction	Negligible	None required	Negligible
Noise disturbance from construction activities	Negligible	None required	Negligible
Light disturbance from construction activities	Negligible	None required	Negligible
Operational			
Disturbance to feeding and roosting waterbirds due to increased shipping activity	Negligible	None required	Negligible
TERRESTRIAL ECOLOGY			
Construction			
Loss of habitat	Negligible	None required	Negligible

Impact	Significance	Mitigation	Residual impact
Operational			
None predicted			
FISHING AND SHELLFISH RESOURCES			
Construction			
Physical impacts to shellfish from increased TSS concentrations due to capital dredging	Minor adverse at the nearest point of the Truro oyster beds, when dredging near Carrick Roads	None required	Minor adverse
Physical impacts to finfish from increased TSS concentrations due to capital dredging	Negligible	None required	Negligible
Physical impacts to shellfish from increased sediment deposition due to capital dredging	Minor adverse	None required	Minor adverse
Physical impacts to finfish from increased sediment deposition due to capital dredging	Negligible	None required	Negligible
Chemical impacts to shellfish from increased contaminant concentrations in the water due to capital dredging	Minor adverse for TBT but not other contaminants	None required	Minor adverse
Chemical impacts to shellfish from increased contaminant concentrations in the sediment due to capital dredging	No impact	None required	No impact
Chemical impacts to finfish from increased contaminant concentrations in the water due to capital dredging	Minor adverse	None required	Minor adverse
Physical impacts to shellfish and finfish from sediment deposition due to disposal of dredged material	Minor adverse due to most sediment depositing within the disposal site	None required	Minor adverse
Impacts to fish and shellfish from direct	Negligible	None required	Negligible

Impact	Significance	Mitigation	Residual impact
uptake by dredgers			
Operational			
Impacts to shellfish resulting from changes in hydrodynamic regime due to the new navigation channel	Negligible	None required	Negligible
COMMERCIAL FISHERIES AND SHELLFISHERIES			
Construction			
Potential impact on fishing gear and fishing activity due to capital dredging and the disposal of dredged material	Minor adverse impact on fishing activity immediately adjacent to the disposal site, negligible impact on fishing activity in the Fal Estuary and on fishing gear deployed in Falmouth bay and the Fal Estuary	Extra publicising of works prior to works through media and during work through VHF broadcasts, creation of a dedicated sailing route and deposition zone for works, FHC to revise its Policy on the Deployment of Fishing Equipment within Falmouth Harbour Area	Negligible
Potential impact on commercial fisheries from increased chemical contaminant concentrations due to capital dredging	Minor adverse impact on the Truro oyster fishery from increases in TBT concentrations	None required	Minor adverse
Potential impact on oyster depuration from increased chemical contaminant concentrations due to capital dredging	Minor adverse impact	If the lease is maintained and Falmouth Bay Oysters continue to operate at the site, it may be necessary for the authorities monitoring programme to be extended to cover TBT concentrations.	Minor adverse
Operational			
None predicted			

Impact	Significance	Mitigation	Residual impact
MARINE MAMMALS			
Construction			
Impact of noise disturbance to marine mammals	Temporary moderate adverse impact on marine mammals in the immediate vicinity of piling works at Falmouth Docks	Soft start and/or a MMO, subject to consultation and agreement with relevant agencies	Minor adverse impact
Impact on marine mammals from increased chemical contaminant concentrations in the water die to capital dredging	Temporary minor adverse impact	None proposed	Minor adverse impact
Potential collision risk due to increased construction vessel numbers	Low to moderate risk	Speed restrictions, subject to consultation and agreement with relevant agencies	Low risk
Operational			
Potential collision risk due to increased cruise vessel numbers	Low risk	None proposed	Low risk
NAVIGATION AND RECREATION			
Construction			
Impact on commercial navigation due to construction in the water	Negligible	None required	Negligible
Impact on general recreation due to construction in the water	No impact on marinas, leisure mooring areas and designated zones for water-skiing, bathing and water sports	None required	No impact
Impact on diving due to construction in the water	Moderate adverse impact on diver safety and recreational diving activities	Extra publicising of works prior to works through media and during work through VHF broadcasts, creation of a dedicated sailing route and	Minor adverse

Impact	Significance	Mitigation	Residual impact
		deposition zone for works, FHC to revise its protocol for recreational diving in the Falmouth Harbour and Bay areas	
Impact on angling due to construction in the water	Minor adverse impact on angler safety and recreational diving activities	Extra publicising of works prior to works through media and during work through VHF broadcasts, creation of a dedicated sailing route and deposition zone for works, FHC to revise its Policy on the Deployment of Fishing Equipment within Falmouth Harbour Area	Negligible
Operational			
Impact on commercial and recreational navigation due to the cruise vessel movements	Negligible	None required	Negligible
ARCHEOLOGY AND HERITAGE			
Construction			
Changes to the Northern Wharf and Queens Wharf due to wharf improvements	Minor adverse impact due to demolition and disturbance to the Northern Wharf's structures	Photographic record of the Northern Wharf	Negligible
Disturbance to wrecks and wreckage due to capital dredging	Potential major adverse impact due to disturbance of features and wreckage	Archaeological Protocol and Written Scheme of Investigation including an archaeological watching brief and a system for recording finds	No impact

Impact	Significance	Mitigation	Residual impact
Dredging disturbance to prehistoric landsurfaces	Minor - major adverse impact due to loss of sequence record	Archaeological Protocol and Written Scheme of Investigation including a long vibrocore and full archaeological analysis and dating	Minor - moderate beneficial
Disturbance to prehistoric landsurfaces due to disposal of dredged material at sea	Potential moderate adverse impact due to wreck damage	Under the WSI identified earlier, the condition of wreck 17502 should be verified, and following discussion with English Heritage, a possible exclusion zone for dumping of dredged material may be defined.	Negligible
Operational			
Change to the visual setting of scheduled monuments due to the cruise building and wharf improvements	Negligible impact	Sympathetic and high quality detailed design and architecture for the cruise terminal building	Negligible
Change to the historic landscape character due to the cruise building and wharf improvements	Potential moderate adverse impact	Sympathetic and high quality detailed design and architecture for the cruise terminal building	Minor beneficial
TRAFFIC			
Construction			
Changes to traffic flows on the local road network during construction	Moderate adverse impact on the docks estate's road network	Conduct TA, derive and adopt suitable mitigation measures	Minor adverse

Impact	Significance	Mitigation	Residual impact
Changes to traffic flows within Falmouth Docks during construction	Moderate adverse impact on the local road network	Conduct TA, derive and adopt suitable mitigation measures	Minor adverse
Operational			
Changes to traffic flows due to day calls	Moderate adverse impact on the local road network	Conduct TA, derive and adopt suitable mitigation measures	Minor adverse
Changes to traffic flows due to turnaround calls	Minor adverse impact on the local road network	Conduct TA, derive and adopt suitable mitigation measures	Minor adverse
NOISE AND VIBRATION			
Construction			
Disturbance due to on-site construction noise	Moderate adverse impact on Falmouth receptors and potential major adverse impact on Trefusis receptors due to piling works, and no impact due to other construction works	Agreement with the local Environmental Health Department including hours of working and construction methods, including piling. General application of the principles of Best Practicable Means (BPM), as defined in BS 5228 and The Control of Pollution Act 1974. Community liaison	Minor – moderate adverse during piling works
Disturbance due to construction traffic	Moderate adverse impact on site, particularly to receptors at the Maritime Apartments. Moderate or major adverse impact off site, particularly to receptors along haul routes	On site: maintain surface of haul road in good condition to prevent adverse noise caused by vehicle jolting over surface irregularities. Ensure low speed within the site. Community liaison	Minor adverse

Impact	Significance	Mitigation	Residual impact
		Off site: conduct TA and produce and mitigation measures accordingly	
Operational			
Disturbance due to cruise vessels	Moderate beneficial impact due to berthed vessels	None required	Moderate beneficial
Disturbance due quay operations	Minor to moderate adverse impact	Guidance on the use of PA systems	Minor adverse
Disturbance due to traffic	Moderate adverse impact as a result of extra vehicle movements	Conduct TA and produce and mitigation measures accordingly	Minor adverse
AIR QUALITY			
Construction			
Impact on air quality during construction	Moderate adverse impact from dust emissions on sensitive receptors	Environmental management plan	Minor adverse
Operational			
Emission of pollutants due to increased sizes and numbers of vessels	Minor adverse impact due to more vessel calls and larger engines	None required	Minor adverse
Emission of pollutants due to increased road traffic	Moderate adverse impact on nearby sensitive residential receptors	Conduct TA, refine the impact assessment, and, if necessary, to derive suitable mitigation measures	Minor adverse
LANDSCAPE AND VISUAL SETTING			
Construction			
Impacts to landscape designation	Major adverse impact during works on Cornwall AONB and South West Coat Path National Trail	None required	Major adverse
Impacts to landscape character	No impact	None required	No impact
Impacts to landscape elements and features	No impact	None required	No impact
Visual impacts as a result of the	Various moderate to major adverse impacts	Minimise the duration of the	Moderate to major adverse

Impact	Significance	Mitigation	Residual impact
construction of the project	depending on location of the visual receptor	works as far as possible	
Operational			
Changes to landscape and visual interests due to cruise vessels	Major beneficial impact when design vessel is berthed and no impact when sailing or berthing	None required	Major beneficial and no impact
Changes to landscape character due to landside development	No impact	None required	No impact
Changes to landscape elements and features due to landside development	Minor adverse impact from loss of vegetation on the AONB	Replacement planting	Negligible
Changes to visual interests due to land-side development	moderate to major impact on a number of visual receptors in the area, adverse on beneficial dependant on subjective point of view	Sympathetic choice of materials. Terminal design in line with other marine development in the area.	Moderate to major adverse / beneficial
SOIL QUALITY AND GEOLOGY			
Construction			
Impact to human health – site workers	Medium adverse risk	Various risk management actions	Low adverse
Impact to shallow perched groundwater	Medium adverse risk	Various risk management actions	Low adverse
Impact to deep groundwater	Medium adverse risk	Various risk management actions	Low adverse
Impact to surface water	Medium to high adverse risk	Various risk management actions	Low adverse
Impact to neighbouring properties and land use	Low adverse risk	Various risk management actions	Low adverse
Impact to ecological receptors	Medium adverse risk	Various risk management actions	Low adverse
Impacts to buildings and structures	Medium adverse risk	Various risk management	Low adverse

Impact	Significance	Mitigation	Residual impact
		actions	
Operation			
Impact to human health – site workers	Medium adverse risk	Various risk management actions	Low adverse
Impact to shallow perched groundwater	Medium adverse risk	Various risk management actions	Low adverse
Impact to deep groundwater	Medium adverse risk	Various risk management actions	Low adverse
Impact to surface water	Medium to high adverse risk	Various risk management actions	Low adverse
Impact to neighbouring properties and land use	Low adverse risk	Various risk management actions	Low adverse
Impact to ecological receptors	Medium adverse risk	Various risk management actions	Low adverse
Impacts to buildings and structures	Medium adverse risk	Various risk management actions	Low adverse
SOCIO-ECONOMIC			
Construction			
Increased local employment through construction	Moderate beneficial impact	None required	Moderate beneficial
Operational			
Additional direct revenue to port based businesses from cruise ships	Minor beneficial	None required	Minor beneficial
Additional spend by cruise passengers and crew	Moderate beneficial	None required	Moderate beneficial
Additional employment by A&P Falmouth and other port related businesses	Moderate beneficial	None required	Moderate beneficial

23 CUMULATIVE IMPACTS

23.1 INTRODUCTION

As part of the EIA process, it is important to consider the potential for the significant impacts that are predicted to arise as a result of the proposed development to interact with each other and with those of other past, current or reasonably foreseeable future plans or proposed projects. It is possible that the proposed channel dredging could have an effect on environmental receptors that are being affected by the operational implications of existing projects or which could be impacted by proposed future projects. Cumulative effects imply interaction between potential impacts, possibly resulting in an impact of greater (or lesser) significance than the effects in isolation. The scope of plans or projects to be included in a cumulative impact assessment can be defined as those projects whose effects may overlap with the proposed scheme in space or time.

The consideration of potential cumulative impacts is different to the consideration of the 'in-combination' effects of plans or projects, as required under the Conservation (Natural Habitats &c.) Regulations 1994, which may affect the same receptor but which may or may not interact with each other. The potential for in-combination effects to arise on the habitats and species of European sites is discussed in Section 24.

The assessment of cumulative impacts is limited to plans or projects for which sufficient information exists to allow consideration of the potential for a cumulative effect to arise. In the absence of publicly available information (usually in the form of a planning application), it is not possible to undertake a proper consideration of cumulative effects (i.e. if proposals are speculative or where assumptions regarding potential impacts may be contentious).

23.2 OTHER PLANS AND PROJECTS

23.2.1 Existing Projects

Any impacts arising from already implemented projects (e.g. re-building of the Queens Wharf, National Maritime Museum, Maritime Apartments) are manifest in the baseline conditions described in this ES. Therefore, these impacts have been taken into account in the main impact assessment (i.e. Sections 5 to 21) and are not considered as cumulative impacts.

It is considered that there are three projects in and around Falmouth Docks, the harbour and lower Fal Estuary which have the potential to result in cumulative impacts with the proposed cruise project:

- development of the proposed Port Falmouth Marina;
- extension of Port Pendennis Marina, Falmouth;
- capital dredging at the Yacht Haven, Falmouth; and
- maintenance dredging at Port of Truro.

The following paragraphs describe the other plans or projects that are understood to be under construction and/or consented (i.e. expected to take place). No other proposed projects are sufficiently developed for consideration here (i.e. there is no publicly available information on which to base an assessment of the potential for cumulative impact).

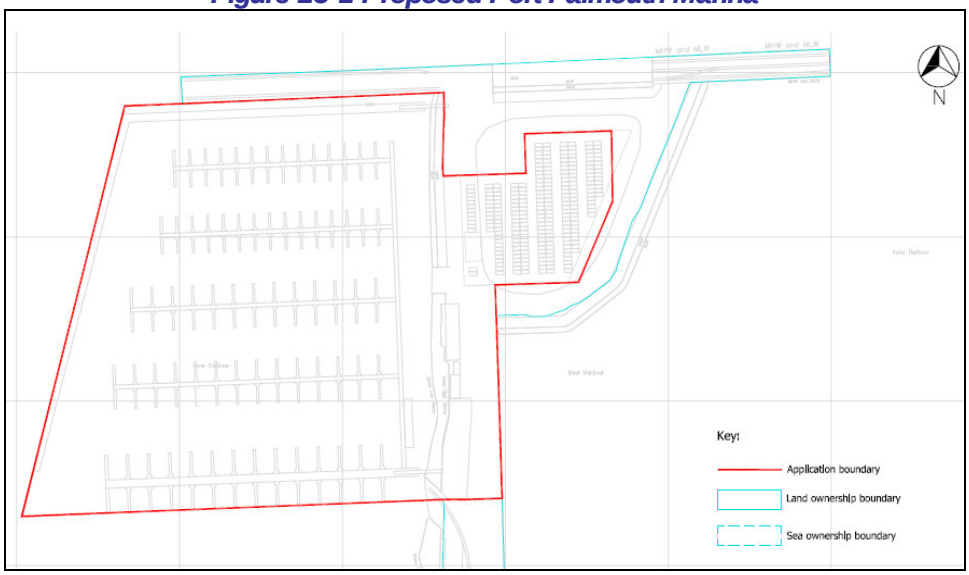
23.2.2 Port Falmouth Marina

This proposed marina will be situated in the western docks between the Queens and Duchy Wharves (see Figure 23-1). It comprises five east-west aligned floating mooring pontoons enclosed by a 6m wide floating breakwater. Its proposal includes c.300 berths, shore-side car parking, for 300 cars, waste reception and recycling facilities, and a marina reception building (converted from a historic dock building) including office, shower, toilet and laundry facilities. The proposed marina has been granted planning permission. It is due to be opened in spring 2009 after a seven month construction programme. Construction will not require dredging.

More details about the Port Falmouth Marina are available from the Falmouth Marina Environmental Statement (RPS, 2008).

Spatially, the proposed marina will be located directly adjacent to the proposed Falmouth Cruise Project since both proposals will be situated within Falmouth Docks and, therefore, their impacts have the potential to interact. Temporally, the proposed marina is expected to be constructed and operational by spring 2009, which is before the anticipated construction of the proposed Falmouth Cruise Project and, therefore, their impacts have the potential to interact but only during the operational phase of the new marina. Cumulative impacts are assessed in Section 22.3.1.

Figure 23-1 Proposed Port Falmouth Marina

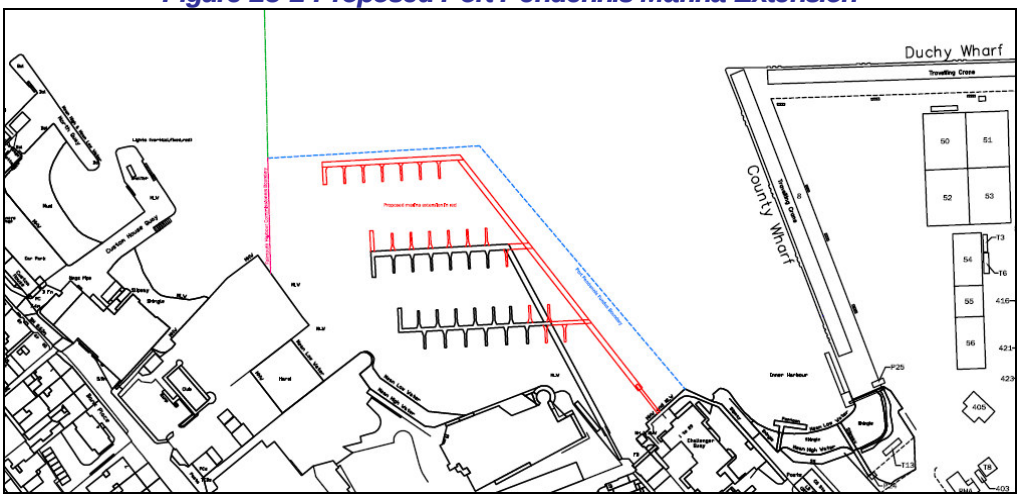


23.2.3 Port Pendennis Marina Extension

Port Pendennis is situated at Challenger Quay, between the National Maritime Museum and the western boundary of Falmouth Docks defined by the County Wharf. The proposed marina extension will require an eastwards re-positioning and northwards extension to the main access pontoon, a new pontoon and some new moorings to create an additional 33 berths (see Figure 23-2). The proposed marina extension has been granted planning permission. It is due to be opened in April 2010 after a seven month construction programme.

Spatially, the proposed marina extension will be located at Challenger Quay, adjacent to the western boundary of Falmouth Docks. Temporally, the proposed marina is expected to be constructed by spring 2010 and, therefore, it will be operational before the anticipated construction of the proposed Falmouth Cruise Project. Cumulative impacts are assessed in Section 22.3.2.

Figure 23-2 Proposed Port Pendennis Marina Extension



23.2.4 Maintenance Dredging Regimes around the Fal Estuary

Maintenance dredging is undertaken at various locations around the Fal Estuary. These regimes are generally irregular since they are only undertaken when the need arises on an occasional basis.

Table 23-1 summarises the maintenance dredging regimes around the Fal Estuary. Annual averages are calculated on the basis of historical data.

Table 23-1Predicted annual average requirement for disposal of material due to maintenance dredging (based on Carrick District Council, 2005)

Location	Date / frequency	Volume (m^3)	Disposal route	Annual average (m^3/yr)
Port of Truro	4 in 1999-2005	24,426	Sea	4,071
Falmouth Yacht Haven	1 in 10 years	1,000	Sea	100
Falmouth Docks No 2 Dock Gate	1 in 3 years	1,800	Landfill	600
Lighterage Quay, Newham	Annually	5	Landfill	5
Mylor Yacht Harbour	1 in 6 or 7 years	1,000	Sea	16
Falmouth Boat Yard	Unknown	Unknown	Sea	25
Falmouth Yacht Marina	3 in 1994-2003	20,325	Sea	6,775
Challenger Marine	1 in 10 years	5,000	Sea	500
St Mawes Harbour - jetty	1 in 1-2 years	100	Sea	50
St Mawes Harbour – inner harbour	1 in 7 years	770	Sea	110
Port Pendennis	1 in 6 years	5,000	Sea	850
Total disposed of to landfill				605
Total disposed of at sea				17,273

Table 23-2 summarises the potential for maintenance dredging regimes to interact spatially and/or temporally with the proposed Falmouth Cruise Project.

Spatially, maintenance dredging at the Port of Truro, Lighterage Quay (Newham), Mylor Yacht Harbour and St Mawes Harbour would be undertaken sufficiently distant not to interact with the proposed Falmouth Cruise Project. The other maintenance dredging regimes would be undertaken within Falmouth Harbour and/or Falmouth Docks, and have the potential to interact with the proposed Falmouth Cruise Project.

Spatially, it is assumed that all dredged material will either be disposed of at the nearest available landfill site or at the Falmouth Bay offshore disposal site. Accordingly, all maintenance dredging regimes have the potential to interact with the proposed Falmouth Cruise Project.

Temporally, at present, it is not known whether any maintenance dredging regimes will take place at the same time as the proposed Falmouth Cruise Project since there are no fixed timescales for either the regimes or the proposed project.

Cumulative impacts are assessed in Section 22.3.3.

Table 23-2Predicted interaction with the proposed Falmouth Cruise Project (based on Carrick District Council, 2005)

Location	Spatial Interaction		Temporal interaction	
	Dredging	Disposal	Dredging	Disposal
Port of Truro	No	Possible	Possible	Possible
Falmouth Yacht Haven	Possible	Possible	Possible	Possible
Falmouth Docks No 2 Dock Gate	Possible	Possible	Possible	Possible
Lighterage Quay, Newham	No	Possible	Possible	Possible
Mylor Yacht Harbour	No	Possible	Possible	Possible
Falmouth Boat Yard	Possible	Possible	Possible	Possible
Falmouth Yacht Marina	Possible	Possible	Possible	Possible
Challenger Marine	Possible	Possible	Possible	Possible
St Mawes Harbour - jetty	No	Possible	Possible	Possible
St Mawes Harbour – inner harbour	No	Possible	Possible	Possible
Port Pendennis	Possible	Possible	Possible	Possible

23.3 CUMULATIVE IMPACTS ASSOCIATED WITH THE PROPOSED FALMOUTH CRUISE PROJECT

23.3.1 Port Falmouth Marina

Hydrodynamic and Sediment Regime

The new marina would be expected to have only small effects on flow and waves in the immediate area of the marina, which is in an area of low currents and wave activity, and RPS (2008) predict no significant impact due to the new marina infrastructure and a negligible impact due to moored vessels. When added to the impacts of the Falmouth Cruise Project, the cumulative effects on the hydrodynamic and sedimentary regime are not expected to be any more significant than those predicted for the proposed Falmouth Cruise Project alone.

Sediment Quality

When operational, the new marina would be expected to have only small effects on sediment disturbance in the immediate area of the marina, and RPS (2008) predict no

significant impact on sediment quality. When added to the impacts of the Falmouth Cruise Project, the cumulative effects on sediment quality are not expected to be any more significant than those predicted for the proposed Falmouth Cruise Project alone.

Water Quality

When operational, the new marina would be expected to have only small effects on sediment disturbance in the immediate area of the marina, and RPS (2008) predict no significant impact on water quality. When added to the impacts of the Falmouth Cruise Project, the cumulative effects on water quality are not expected to be any more significant than those predicted for the proposed Falmouth Cruise Project alone.

Marine Ecology

When operational, the new marina would be expected to have only small effects on seabed disturbance in the immediate area of the marina (e.g. due to propeller action), and RPS (2008) predict no significant impact on benthic ecology including maerl habitat and communities. When added to the impacts of the Falmouth Cruise Project, the cumulative effects on marine ecology are not expected to be any more significant than those predicted for the proposed Falmouth Cruise Project alone.

Ornithology

RPS (2008) does not assess impacts on ornithology. It is expected that, when operational, the new marina may increase the area over which the existing feeding and roosting activity is disturbed within the docks. However, the sensitivity of the ornithology to disturbance is low and, therefore, when added to the impacts of the Falmouth Cruise Project, the cumulative effects on ornithology are not expected to be any more significant than those predicted for the proposed Falmouth Cruise Project alone.

Terrestrial Ecology

RPS (2008) does not assess impacts on terrestrial ecology. It is expected that, when operational, the new marina would not disturb the existing habitats within the docks and, therefore, when added to the impacts of the Falmouth Cruise Project, the cumulative effects on terrestrial ecology are not expected to be any more significant than those predicted for the proposed Falmouth Cruise Project alone.

Fish and Shellfish Resource

RPS (2008) does not separately assess impacts on the fish and shellfish resource since these impacts are covered by assessments for marine ecology and commercial fisheries). Therefore, when added to the impacts of the Falmouth Cruise Project, the cumulative effects on the fish and shellfish resource are not expected to be any more significant than those predicted for the proposed Falmouth Cruise Project alone.

Commercial Fisheries

When operational, the new marina would be expected to have only small effects on seabed disturbance in the immediate area of the marina, and RPS (2008) predict no significant impact on fisheries. When added to the impacts of the Falmouth Cruise Project, the cumulative effects on fisheries are not expected to be any more significant than those predicted for the proposed Falmouth Cruise Project alone.

Navigation and Recreation

When operational, the new marina would be expected to contribute an additional 5,712 recreational vessel movements per annum (RPS, 2008). The additional vessel movements associated with the new marina will be subject to the existing requirements in place to maintain safe navigation within the estuary and RPS (2008) predicts a negligible impact on navigation. When added to the impacts of the Falmouth Cruise Project, the cumulative effects on navigation and recreation are not expected to be any more significant than those predicted for the proposed Falmouth Cruise Project alone.

Archaeology

When operational, the new marina would be expected to have only small effects on seabed disturbance in the immediate area of the marina, and RPS (2008) predict no significant impact on marine archaeology. When added to the impacts of the Falmouth Cruise Project, the cumulative effects on marine archaeology are not expected to be any more significant than those predicted for the proposed Falmouth Cruise Project alone.

Traffic and Transportation

When operational, the new marina would be expected to contribute up to an additional 60 two-way vehicle movements per hour (RPS, 2008). RPS (2008) predicts no significant impact on vehicle traffic flows within the area and, therefore, when added to the impacts of the Falmouth Cruise Project, the cumulative effects on traffic flows are not expected to be any more significant than those predicted for the proposed Falmouth Cruise Project alone.

Noise

When operational, the new marina would be expected to create noise due to activities at the marina and on the water (e.g. engine noise). RPS (2008) predicts no impact on noise and, therefore, when added to the impacts of the Falmouth Cruise Project, the cumulative effects on noise are not expected to be any more significant than those predicted for the proposed Falmouth Cruise Project alone.

Air Quality

When operational, the new marina would be expected to create additional emissions to the atmosphere due to activities at the marina and on the water (e.g. use of engines). RPS (2008) does not assess impacts on air quality. It is expected that activities at the new marina would only contribute very small-scale and localised emissions to air and, therefore, when added to the impacts of the Falmouth Cruise Project, the cumulative effects on air quality are not expected to be any more significant than those predicted for the proposed Falmouth Cruise Project alone.

Landscape

When operational, the new marina would be visible from viewpoints within Falmouth town and the AONB. Given the marina's location within the docks infrastructure, RPS (2008) predicts no impact on landscape and, therefore, when added to the impacts of the Falmouth Cruise Project, the cumulative effects on landscape and views are not

expected to be any more significant than those predicted for the proposed Falmouth Cruise Project alone.

Land Quality

RPS (2008) does not assess impacts on land quality. It is expected that, when operational, the new marina would not disturb the existing land within the docks and, therefore, when added to the impacts of the Falmouth Cruise Project, the cumulative effects on air quality are not expected to be any more significant than those predicted for the proposed Falmouth Cruise Project alone.

Socio-Economics

When operational, the new marina would be expected to create new jobs and economic investment in the area. RPS (2008) do not quantify the resultant socio-economic impacts but predicts a major beneficial impact and, therefore, when added to the impacts of the Falmouth Cruise Project, the cumulative effects on noise are not expected to be any more significant than those predicted for the proposed Falmouth Cruise Project alone.

23.3.2 Port Pendennis Marina Extension

Cumulative Effects

There is very limited information available about the proposed marina extension and its environmental impacts. For example, an environmental statement is not available. However, since the proposed marina extension is situated very close to the proposed new Port Falmouth Marina and is of a smaller scale (33 berths rather than 290 berths), its potential for cumulative effects is considered to be - at worst - the same as that predicted for the proposed Port Falmouth Marina. Accordingly, when added to the impacts of the Falmouth Cruise Project, the cumulative effects are not expected to be any more significant than those predicted for the proposed Falmouth Cruise Project alone.

23.3.3 Maintenance Dredging Regimes around the Fal Estuary

Cumulative Effects of Dredging

As identified in Table 23-2, maintenance dredging regimes at the Port of Truro, Newham, Mylor and St Mawes will occur at locations sufficiently distant from the proposed Falmouth Cruise Project such that they are not expected to have the potential to spatially interact with the capital dredging associated with the proposed Falmouth Cruise Project (e.g. sediment plume dispersion and deposition). Therefore, no cumulative effects are predicted.

However, maintenance dredging regimes will occur at the other locations identified in Table 23-2 (i.e. in and around Falmouth Harbour) such that they are expected to have the potential to spatially interact with the capital dredging associated with the proposed Falmouth Cruise Project. Temporally, maintenance dredging regimes in and around Falmouth Harbour could interact with the proposed Falmouth Cruise Project, but are unlikely to given the frequency of maintenance dredging identified by Carrick District Council (2006; see Table 23-1). If all maintenance dredging regimes were to coincide they would increase the total amount of dredging for the Falmouth Cruise Project (i.e. c.700,000m^3) by 3,508m^3, which equates to approximately half of one percent. Therefore, because of the very low magnitude of increase, the cumulative effects of

maintenance dredging regimes are not expected to be any more significant than those predicted for the proposed Falmouth Cruise Project alone.

Cumulative Effects of Disposal

As identified in Table 23-1, maintenance dredging regimes require the disposal of dredged material at sea (7,755m^3/yr) and to landfill 605m^3/yr).

As identified in Table 23-2, all maintenance dredging regimes could spatially interact with the disposal of dredged material associated with the proposed Falmouth Cruise Project because disposal routes are expected to be the same (i.e. the Falmouth Bay offshore disposal site and the nearest landfill site). Temporally, maintenance dredging regimes in and around the Fal Estuary could interact with the proposed Falmouth Cruise Project, but are unlikely to given the frequency of maintenance dredging identified by Carrick District Council (2006; see Table 23-1). If all maintenance dredging regimes were to coincide they would increase the total amount of disposal at sea for the Falmouth Cruise Project (i.e. c.600,000m^3) by 7,755m^3, which equates to approximately 1.3 percent. In addition, if all maintenance dredging regimes were to coincide they would increase the total amount of disposal to landfill for the Falmouth Cruise Project (i.e. c.61,000m^3) by 605m^3, which equates to approximately one percent. Therefore, because of the very low magnitude of increase, the cumulative effects of maintenance dredging regimes are not expected to be any more significant than those predicted for the proposed Falmouth Cruise Project alone.

24 IMPLICATIONS FOR THE DESIGNATED STATUS OF THE FAL & HELFORD ESTUARIES SAC

24.1 INTRODUCTION

This section builds upon the EIA process to provide information to inform an 'appropriate assessment' of the proposed Falmouth Cruise Project in accordance with the Conservation (Natural Habitats &c) Regulations 1994.

The dredging works for the improvement to the cruise facilities will take place within the Fal and Helford Estuaries Special Area of Conservation (SAC). Natural England has advised that the dredging works should be investigated with regard to any potential significant effect on the SAC. This section is based upon the proposed scheme as described in Section 2.

24.1.1 Requirement for Appropriate Assessment

The need for 'appropriate assessment' arises under the requirements of the EC Habitats Directive (92/43/EEC) and its implementation in the UK under the Conservation (Natural Habitats, &c.) Regulations 1994. Under Regulation 48(1), appropriate assessment is required for a plan or project which, either alone or in combination with other plans or projects, is likely to have a significant effect on a European site and is not directly connected with the management of the site. A European site is either a Special Area of Conservation (SAC) or a Special Protection Area (SPA). In the case of the proposed dredging works for the Falmouth Cruise Facilities, Natural England has stated that the works under consideration could potentially have a significant effect on the Fal and Helford Estuaries SAC and, therefore, appropriate assessment is required.

24.1.2 Appropriate Assessment Process

Appropriate assessment is a decision by the 'competent authority(ies)' as to whether the proposed plan or project would have an adverse effect on the integrity of the European site. Planning Policy Guidance Note 9 (PPG9) (Department of the Environment, 1994) defines a site's integrity as the "coherence of the site's ecological structure and function, across its whole area, or the habitats, complex of habitats and/or population of the species for which the site is classified". An adverse effect on integrity is likely to be one that prevents the site from maintaining the same contribution to favourable status for the relevant feature(s) as it did when the site was designated.

The favourable conservation status of a site is defined through its conservation objectives and it is against these objectives that the effects of a proposed scheme are determined. Details of the conservation objectives for the Fal and Helford SAC are provided in Section 24.2.

24.1.3 Scope of the Appropriate Assessment

Regulation 48(2) requires that a person applying to carry out a plan or project which requires appropriate assessment shall provide information to the competent authority as may be reasonably required for the purposes of the appropriate assessment. Natural England has indicated that for the purposes of this application information should be provided on the potential impacts of removal of the maerl habitats (maerl and maerl/sediment matrix).

The information to be provided has been discussed with Natural England through a meeting held on 3rd June 2008 and during subsequent telephone conversations. They have requested that the information covers the following potential points in relation to the conservation features for the SAC:

- removal of maerl habitats and associated communities from the dredge area;
- recovery potential for the communities present, given appropriate mitigation; and
- potential monitoring that could be undertaken to determine the success of recovery.

24.1.4 In-combination Effects

Under the Habitats Directive, there is a requirement to consider the impacts of a scheme in-combination with other plans or projects. This should include:

- approved but as yet uncompleted plans or projects;
- permitted ongoing activities such as discharge consents or abstraction licences; and
- plans or projects for which an application has been made and which are currently under consideration but not yet approved by the competent authorities.

A cumulative impact arises when impacts from a number of developments, which individually may be insignificant, coincide and have the potential to produce a significant effect. There are a number of plans and projects which meet the above criteria and, in combination with the Falmouth Cruise Terminal project, may have the potential to impact on the marine ecology of the study area. These are detailed in Section 2.5.

24.1.5 UK Guidance

Two main sources of guidance on appropriate assessment have been used during the preparation of this section:

- Habitat Regulations Guidance Note 1 (English Nature, 1997); and
- Planning Policy Guidance Note 9 (PPG 9) Nature Conservation.

Habitats Regulations Guidance Note 1 describes the key stages involved in appropriate assessment. These steps comprise:

- definition of the need for appropriate assessment;
- consultation with Natural England;
- consultation with other organisations (optional);
- definition of the designated status of the site, the qualifying interests and its conservation objectives;
- provision of further information;
- consideration of the potential effects of the scheme on the European site;
- assessment of the influence of any potential effects on the integrity of the European site;
- measures proposed to avoid adverse effects; and
- conclusion regarding the potential for the scheme to adversely effect the integrity of the European site.

The assessment must be made in terms of the impact of the development on the 'integrity of the site'. The scope and content of an appropriate assessment will depend on the location, size and significance of the proposed project. Natural England will advise on a case-by-case basis and has provided such advice in this case (see Section 24.2).

24.2 THE FAL AND HELFORD ESTUARIES SAC

24.2.1 Designated Features

This section presents background information on the Fal and Helford Estuaries SAC. This information is based on the data given in English Nature (2000).

Large Shallow Inlets and Bays

Large shallow inlets and bays are large indentations of the coast with limited freshwater influence, and contain a high diversity of sediments, substrates and benthic communities. The two rias (drowned river valleys) of the Fal and Helford Estuaries SAC contain an unusual range of fully marine habitats from sheltered inlets to tide-swept open coast. This diversity of habitats and species is also supported by the complex topography of rocky areas and the south western location where higher seawater temperatures allow species to occur that typically have a more southerly distribution.

Rocky shore communities along the exposed mouths of the Fal and Helford provide a variety of habitats such as overhangs and rock platforms, rock pools and boulder shores which support diverse and productive communities. In the Carrick Roads, lower shore overhangs and gullies support red algae and a rich sponge fauna with bryozoans, hydroids and spirorbid worms. The gently sloping rocky shores of Penarrow Point, north of the jetty, are characterised by low outcropping bedrock ridges with a lower to mid shore dominated by serrated wrack ***Fucus serratus***. The SAC includes the largest and most south-westerly maerl ***Phymatolithon calcareum*** bed in the UK, almost 2km to the east of the harbour.

Subtidal mud communities form a significant proportion of the shallow inlet and bay and their productivity contributes significantly to the functioning of the system. They also maintain adjacent intertidal areas and are important feeding grounds of fish. Areas of kelp forest constitute the most diverse and productive communities found in the coastal waters of the UK. Moderately exposed bedrock fringing the entrance to the Fal supports Laminaria hyperborea kelp forest, and at more sheltered locations further up the estuary (e.g. St Mawes) the south western kelp Laminaria ochroleuca occurs with an understorey of red algae. This gives way to Laminaria saccharina kelp forest in slightly deeper water.

Sandbanks Which Are Slightly Covered By Sea Water all the Time

This habitat consists of sandy seabed that is covered by shallow seawater (<20m below Chart Datum) at all times. Sediments are colonised by a burrowing fauna of worms, crustaceans, bivalve molluscs and echinoderms. Mobile species at the surface include shrimps, crabs and fish, whereas maerl occurs on the seabed and hydroids, bryozoans and ascidians attach to more stable material. Subtidal sandbanks can also be important nursery areas for fish and feeding grounds for seabirds.

A key sub-feature of this habitat is maerl bed communities, composed of living and dead unattached coralline algae. These occur in the lower Fal around St Mawes Bank, with extensive areas of maerl gravel throughout the Carrick Roads and Falmouth Bay, and harbour a rich variety of epifaunal and infaunal species. The St Mawes Bank live maerl bed is composed of two maerl species, Lithothamnion corallioides which is nationally scarce, and Phymatolithon calcareum. Over 50 seaweed species and many animal species are associated with this bed, including many rarities.

Eelgrass ***Zostera marina*** beds, a nationally scarce habitat, occur near the mouth of the Fal and in channels of the rias. Eelgrass provides a habitat for plants and animals including anemones, swimming crabs, hermit and shore crabs, heart urchins, brittlestars, cuttlefish and more unusually, seahorses.

Mudflats and Sandflats Not Covered By Seawater at Low Tide

Intertidal mudflats and sandflats are submerged at high tide and exposed at low tide. Physically these intertidal flats can range from mobile coarse sand beaches on wave-exposed coast to stable, fine sediment mudflats in sheltered estuaries and embayments. Associated plant and animal communities vary according to the coarseness of the sediment, its stability and the salinity of the water.

The area supports sheltered intertidal mudflats and sandflats representative of the southwest of England which are important for their infaunal communities including amphipods, polychaete worms, the sea cucumber ***Leptopentacta elongata*** and bivalve molluscs. These in turn support wading bird populations.

Atlantic Salt Meadows

Atlantic salt meadows (***Glauco-Puccinellietalia***) occur in the North Sea, English Channel and Atlantic shores where halophytic vegetation colonises sheltered soft intertidal sand and mud sediments, forming the middle and upper reaches of saltmarsh. Upper saltmarsh habitat types differ considerably in different parts of the UK with transitions to sand dune, coastal shingle, freshwater marshes or woodland. Many areas of upper saltmarsh have been destroyed by enclosure and remaining areas are considered particularly important. The SAC contains examples of saltmarsh vegetation typical of rias, a type restricted to the southwest of England and Wales. There is narrow saltmarsh zonation from pioneer to upper marsh, and transitions to woodland from the upper marsh are an unusual juxtaposition of vegetation in the UK.

24.2.2 Conservation Objectives

Under Regulation 33(2) of The Conservation (Natural Habitats &c.) Regulations 1994, Natural England has a duty to advise other relevant authorities as to the conservation objectives for the European marine site. Natural England's conservation objectives for the Fal and Helford marine SAC are as follows.

Large Shallow Inlets and Bays

Subject to natural change, maintain the large shallow inlets and bays in favourable condition (see Section 24.6), in particular:

- saltmarsh communities;
- rocky shore communities;
- intertidal mudflat and sandflat communities;
- subtidal rock and boulder communities;
- kelp forest communities;
- subtidal mud communities; and
- subtidal sandbank communities.

Sandbanks which are Slightly Covered by Sea Water all the Time

Subject to natural change, maintain the sandbanks which are slightly covered by water all the time in favourable condition (see Section 6), in particular:

- eelgrass bed communities;
- maerl bed communities;
- gravel and sand communities; and
- mixed sediment communities.

Mudflats and Sandflats Not Covered by Seawater at Low Tide

Subject to natural change, maintain the mudflats and sandflats not covered by seawater at low tide in favourable condition (see Section 24.6), in particular:

- sand and gravel communities;
- muddy sand communities; and
- mud communities.

Atlantic Salt Meadows

Subject to natural change, maintain Atlantic salt meadows in favourable condition (see Section 24.6), in particular:

- low marsh communities;
- mid-marsh communities; and
- upper marsh communities.

24.3 BASELINE ENVIRONMENTAL CONDITIONS

This section presents information on the existing environmental baseline conditions of the dredge area and the surrounding area. The information is provided so that potential impacts of the dredging works on the SAC can be identified and assessed. Data has been collated through desk study and consultation with Natural England.

The information in the following paragraph focuses on the maerl habitats. This is because Natural England has expressed concern about impacts associated with these habitats. In addition, information about coastal processes and sediment quality is provided, as these environmental parameters could affect the maerl habitats.

24.3.1 Maerl Habitats

In 2007, Gardline and Mojo Maritime were contracted to collect sediment data using vibrocores from Falmouth Harbour to inform the EIA process for the proposed Falmouth Cruise Project. The location of the polygons defined by the vibrocores is illustrated in Figure 24-1 below. Table 24-1 details the sediments that were present for each vibrocore at their respective depths. Each core was assumed to be representative of the surrounding area within the polygon.

The polygons were then used to estimate the area in hectares (see Table 24-2) of the various substrates present at differing depths and post-dredge (these values are gross predictions only as the boundaries are only indicative based on available data). The net loss and gain of each substrate within the dredge area was then calculated, including the maerl and maerl matrix which provided a viable habitat (i.e. the same substrate to at least 1.0m in depth) (see Figure 24-1 and Tables 23-2 and 23-3).

Table 23-1 Sediments Present in the Proposed New Navigation Channel at Various Depths (Guardline and Mojo Maritime, 2007)

Vibrocore Area	Bed Level 0m	Bed Level 0.5m	Bed Level 1m	Bed Level After Dredge	Bed Level After Over Dredge	Bed Level 0.5m Below Over Dredge	Bed Level 1.0m Below Over Dredge
1	Clay Freq Maerl	Clay	Clay	Clay	Clay	Clay	Clay
2	Clay	Clay	Clay	Clay	Clay	Clay	Clay
3	Clay	Clay	Clay	Clay	Clay	Clay	Clay
4	Clay	Clay	Clay Freq Maerl	Clay Freq Maerl	Clay Freq Maerl	Clay Freq Maerl	Clay Freq Maerl
5	Mud Freq Maerl	Mud Freq Maerl	Mud	Mud Freq Maerl	Mud/Clay	Mud/Clay	Clay
6	Clay	Clay	Rock	Rock	Rock	Rock	Rock
7	Clay	Clay	Clay	Clay	Clay	Clay	Clay
8	Clay	Rock	Rock	Rock	Rock	Rock	Rock
9	Maerl	Clay	Clay	Clay	Clay	Clay	Clay
10	Sand Freq Maerl	Sand Freq Maerl	Sand Freq Maerl	Clay	Clay	Clay	Clay
11	Maerl	Maerl	Maerl	Maerl	Maerl	Maerl	Maerl
12	Clay Freq Maerl	Clay Freq Maerl	Clay Freq Maerl	Clay Freq Maerl	Clay Freq Maerl	Clay	Clay
13	Sand	Sand Freq Maerl	Sand Freq Maerl	Sand Freq Maerl	Sand Freq Maerl	Sand Freq Maerl	Sand Freq Maerl
14	Clay Freq Maerl	Clay Freq Maerl	Clay Freq Maerl	Clay Freq Maerl	Clay Freq Maerl	Clay Freq Maerl	Clay Freq Maerl
15	Sand/Gravel & Maerl	Sand/Gravel & Maerl	Sand/Gravel & Maerl	Clay	Clay	Clay	Clay
16	Clay Freq Maerl	Clay Freq Maerl	Clay Freq Maerl	Clay Freq Maerl	Clay Freq Maerl	Clay Freq Maerl	Clay Freq Maerl
17	Sand Freq Maerl	Sand Freq Maerl	Sand Freq Maerl	Sand Freq Maerl	Clay	Clay	Clay
18	Sand Freq Maerl	Sand	Sand	Sand	Sand	Sand	Sand
19	Maerl	Maerl	Clay Freq Maerl	Maerl	Maerl	Maerl	Maerl
20	Sand	Clay Freq Maerl	Clay	Clay	Clay	Clay	Clay
21	Maerl	Clay Freq Maerl	Clay Freq Maerl	Clay Freq Maerl	Clay Freq Maerl	Clay	Clay

Figure 23-1 Polygon Areas showing Maerl and Maerl Matrix Pre-Dredge (top) and Post-Dredge (bottom)

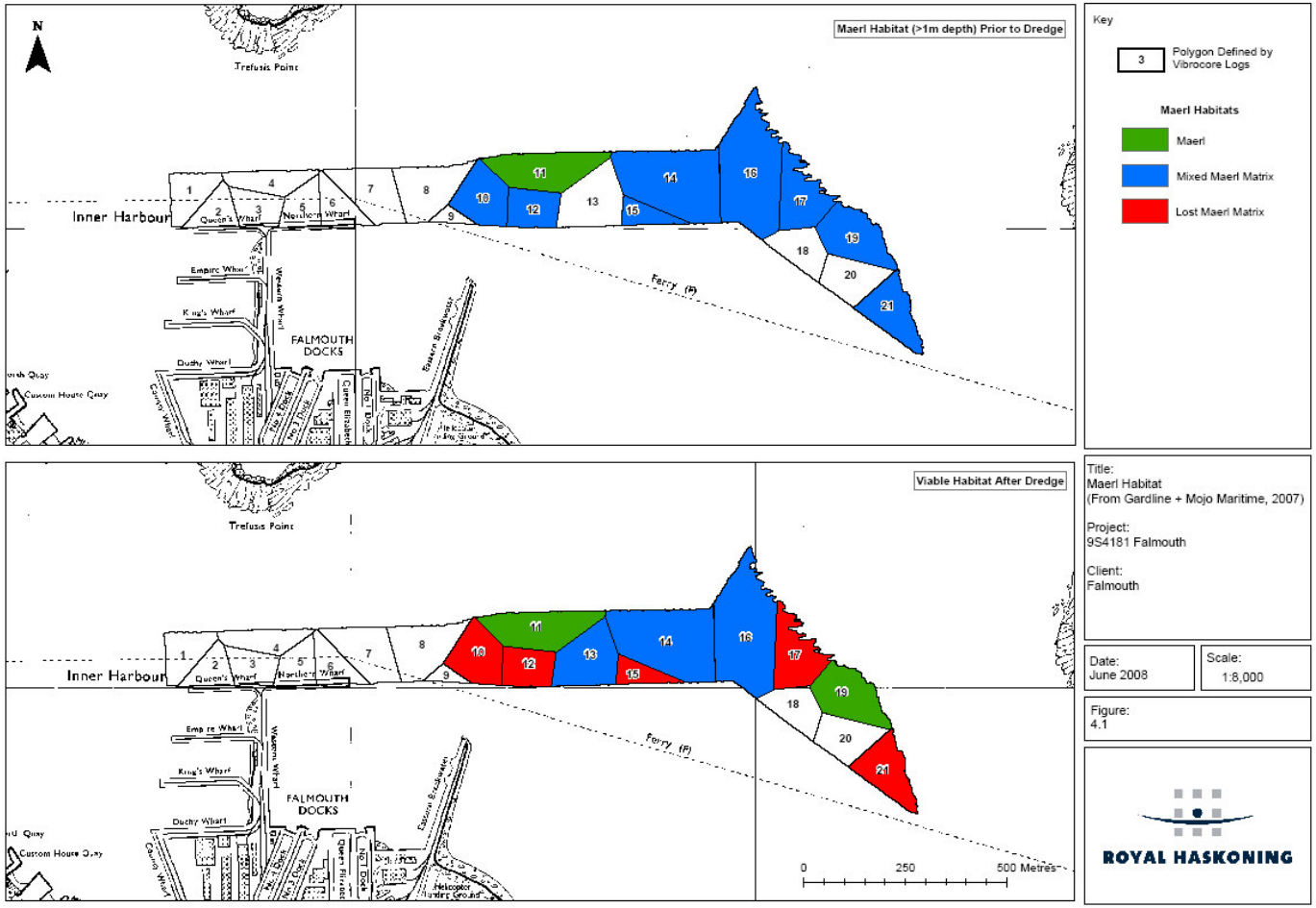


Table 23-2 Substrate Areas in the New Navigation Channel (all data in hectares)

Substrate	Existing Area	Bed Level 0.5m	Bed Level 1.0m	Bed Level After Dredge	Bed Level After Over Dredge	Bed Level 0.5m Below Over Dredge	Bed Level 1.0m Below Over Dredge
Clay	7.49	7.05	6.38	9.19	10.92	13.67	14.00
Clay With Frequent Maerl	10.28	12.09	13.72	11.80	11.80	9.05	9.05
Maerl	5.93	4.08	2.16	4.08	4.08	4.08	4.08
Mud With Frequent Maerl	0.95	0.95	0.00	0.33	0.00	0.00	0.00
Sand	3.32	1.21	1.21	1.21	1.21	1.21	1.21
Sand With Frequent Maerl	4.51	5.26	5.26	3.69	1.96	1.96	1.96
Sand / Gravel With Maerl	0.66	0.66	0.66	0.00	0.00	0.00	0.00
Rock	0.00	1.84	2.81	2.85	2.85	2.85	2.85
Mud	0.00	0.00	0.95	0.00	0.33	0.33	0.00

Table 24-3 illustrates the changes in areas of viable (i.e. over 1m depth) maerl habitats that are currently present and those that will exist post-dredge. [Note: these values are gross predictions as the boundaries are indicative, based on available data.]

Table 23-3 Maerl Habitat Area Changes Pre-Dredge and Post-Dredge (all areas in hectares)

Maerl Habitat Type	Pre-Dredge	Post-Dredge	Change In Area
Pure Maerl	2	4	+2
Mixed Maerl	17	11	-6
Total Maerl	19	15	-4

24.3.2 Associated Species / Communities

Survey work was undertaken (by SeaStar Survey) in order to characterise the communities within the affected area and also in the surrounding areas to determine the potential for recovery of any affected communities. This work, including the methodology and results, is reported in detail in the Environmental Statement associated with this project (Royal Haskoning, 2008).

The majority of the following text is taken from the findings of the SeaStar Survey report (Axelsson ***et al***., 2008). Marine ecological survey work undertaken by SeaStar Survey in 2007, revealed that of the habitats investigated within the study area, in all stations, except for CS08, dead maerl was common, while live maerl and algae were patchy, both being most abundant at stations CS03 and CS09.

Ecological surveys undertaken in 2004 found the benthic communities to be very diverse, containing a high number of species (Royal Haskoning, 2004). The fauna was dominated by the polychaete worms of the genus Sphaerosyllis and Mediomastus and crustaceans of the order Harpacticoida.

Subsequent ecological surveys undertaken in 2007 found the macrofaunal community to be relatively consistent across the study area, relatively diverse with a high species richness, except towards the inner harbour. The dominant species were peracarid crustaceans, notably the amphipods Leptocheirus pectinatus, Caprella linearis, Gammarella fucicola, Parametaphoxus fultoni and Socarnes erythrophthalmus, as well as the isopod Janira maculosa. Other dominant species included the brittle-star Amphipholis squamata, the gastropod Cerithiopsis tuberculatus and the amphipod Megamphopus cornutus. These are mainly species of coarse substrata, exploiting the interstices of gravels, shell-breccia and maerl present within the study area.

Multivariate analysis (Bray-Curtis similarity) of the data produced three main clusters.
At 50% similarity, two stations, CS07 and CS03, are isolated, as are two station-pairs, stations CS09 and CS10 (cluster A) and CS01 and CS02 (cluster C); The remaining ten of the stations form a main cluster (B), subdividing at 53% similarity into subclusters B1 and B2, which largely separate CS stations from RPT stations. These associations do not reflect well the proximate spatial relationship of stations other than the southern cluster of RPT stations (1 to 3) and the inner-harbour couplet of the cluster C stations, although the eastern CS stations CS04 to CS08 are associated. The dominant clusters and taxa are illustrated in Figures 23-2 and 23-3 and Table 24-4.

Figure 24-2 Dendrogram based on Bray-Curtis similarity (%;log-transformed data) for All Stations, with Clusters Distinguished at 50% Similarity Indicated (source: Axelsson et al., 2008)

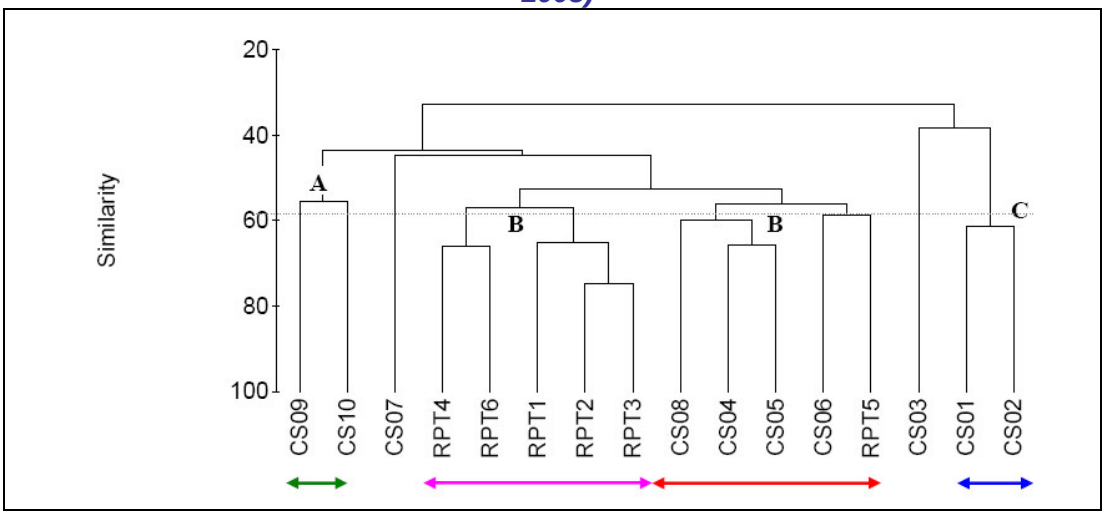
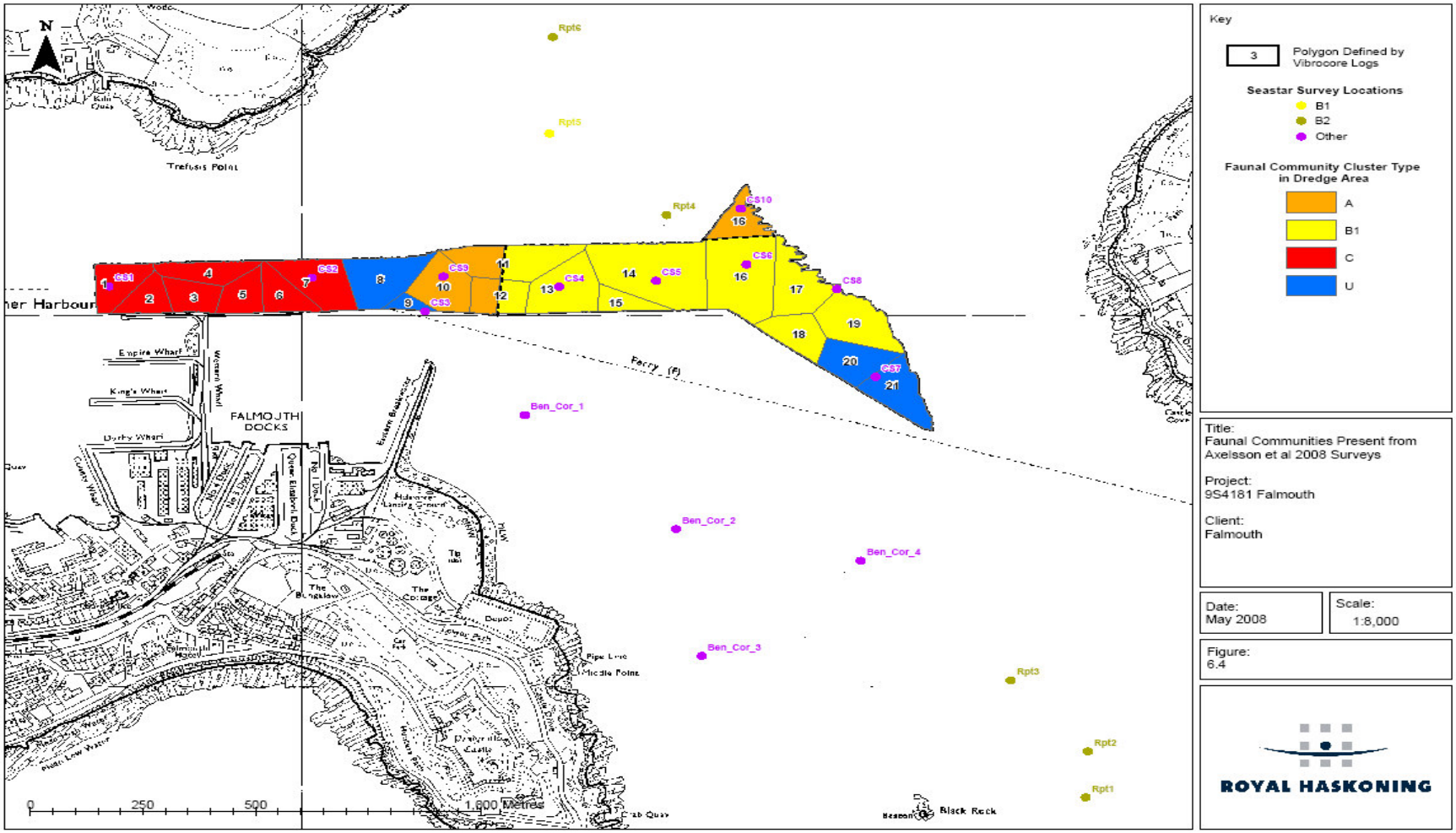


Figure 24-3 Distribution of Faunal Community Types



The community of cluster B reflects the general amphipod dominated structure described above. Subcluster B1 is distinguished by the greater densities of some infaunal taxa, notably the polychaete Exogone verugera. The distinction between the two sub-clusters is regarded as minor variations on the same theme. These communities are found to be present on a wide range of habitat types as shown by the results of the vibrocore data and the diver transect surveys, ranging from clay with frequent maerl to sand/gravel and maerl.

Table 24-4 Dominant Taxa per Major Cluster (source: Axelsson et al., 2008)

A	B1	B2	C
Caprella linearis	***Leptocheirus pectinatus***		***Cerithiopsis tubercularis***
Leptocheirus pectinatus	***Caprella linearis***		***Mediomastus fragilis***
Janira maculosa	***Exogone verugera***	***Socarnes erythrophthalmus***	***Chaetozone christei***
Gammarella fucicola	***Amphipholis squamata***	***Parametaphoxus fultoni***	***Chaetozone gibber***
Ericthonius sp.	***Socarnes erythrophthalmus***	***Janira maculosa***	***Cirratulus filiformis***
Socarnes erythrophthalmus	***Cumella pygmaea***	***Apseudes latreilli***	***Tubificoides insularis***
Bathyporeia sp.	***Nannastacus unguiculatus***	***Gammarella fucicola***	***Leptocheirus pectinatus***
	Typhlotanais brevicornis	***Megamphopus cornutus***	
Mean no. of individuals			
413	293	328	213
Mean biomass, g			
2.36	0.70	0.78	2.84

Cluster A stations, spatially more widely separated, represent a greater variation on the basic community illustrated by cluster B, largely distinguished by the absence of some species common to cluster B, namely the brittle-star ***Amphipholis squamata*** and the cumaceans ***Cumella pygmaea*** and Nannastacus unguiculatus, and the presence of two scarcely recorded amphipods. These stations are again regarded as minor variants of cluster B.

The two stations of cluster C supported a number of species associated with organic loading in the sediment, including cirratulid polychaetes, capitellids and oligochaetes. The gastropod ***Cerithiopsis tubercularis*** is normally associated with sponges, however it also feeds on epiphytic or epizootic detritus where abundant. The dominant amphipods were sparse at these stations, likely due to the poor opportunity for burrowing caused by the presence of fine sediments at these stations.

The isolated stations CS03 and CS07 were markedly impoverished, with sparse numbers of pericarid crustaceans, typical of the other stations and low overall species diversity.

The analysis of vibrocore data taken from polygons 1-8 showed the substratum to be mainly fine materials, comprising clays and mud with sparse areas of frequent maerl

mixed with clay and mud, in the surface of the bed material. Macrofaunal analysis of cores taken from the corresponding Seastar stations CS01 and CS02 showed a community reflecting a greater fine fraction to the sediment, and potentially higher organic loading, dominated by infaunal annelids (cluster C).

At Seastar station CS03 (polygon 8) the fauna was found to be severely impoverished and uncharacterised in comparison with the surrounding stations (cluster U). This impoverished community may be due in part to the sediments found at this station, with core data showing the area to be rock from a depth of 0.5m with overlaying mud.

Stations CS09 and CS10 (cluster A), corresponds to polygon 10, an area of sand with frequent maerl (down to at least 1m substrate depth) and the northernmost section of polygon 16, clay with frequent maerl (down to at least 1m substrate depth) respectively. These areas, both with fragments of live-maerl, supported a denser community of peracarid crustaceans of low species richness and with a lower presence of infaunal species.

Station CS07 (polygons 20 and 21), has an impoverished community, and despite the presence of maerl (at the surface of polygon 21) has a smaller coarse fraction. According to the surveys by Seastar there was no other apparent environmental cause for this impoverishment, however, the low species diversity may be accounted for by the shallow depth of maerl at this site. Polygon 21 shows live maerl present only in the bed material, with a clay and maerl mix present at 0.5m substrate depth.

The remaining surveyed stations (CS04, CS05, CS06, CS08, cluster B1) support a relatively consistent and diverse community, dominated by species which are consistent with a habitat of gravel, shell breccia and maerl. These stations are represented by the polygons 11, 12, 14, 15 and 19 respectively and the high species diversity at these stations is consistent with the established maerl cover and mixed sediments present at these stations, reaching a depth of over 1.0m.

Polygons 13, 17 and 18 were not sampled as part of the Seastar macrofaunal sampling, the sediment cores found these polygons to comprise of sand and sand with frequent maerl. Consequently, it is anticipated that the communities present at these stations would be broadly similar to those present at other areas of sandy sediments. Similar areas that were sampled for macrofauna, such as those found at polygon 10, were found to have communities of peracarid crustaceans of low species richness and with a lower presence of infaunal species compared to cluster C (cluster A).

No scheduled or otherwise conservation-significant species were recorded, other than the maerl itself. One notable species, previously rarely recorded, but present across the area at cluster B stations, was the tanaidacean Leptognathia paramanca, currently being considered for statutory conservation-protection.

24.3.3 Sediment Quality

Data on the quality of the sediments in Falmouth Docks has been obtained from surveys conducted in 2004 and 2007. Sediment quality has not been raised as an issue by Natural England in respect of the SAC features. However, sediment quality has been investigated as part of the EIA process and is discussed in Section 6 and summarised in Section 24.5.

24.3.4 Coastal Processes

Coastal processes have been investigated in respect of the proposed changes to the existing conditions that could arise as a result of the proposed works. The results of the modelling studies and investigation are discussed fully in Section 5. Potential impacts on the SAC features are discussed in Section 24.5.

24.3.5 Ecological Resource

The dredge area is situated in the main channel area at the mouth of the Penryn River. According to English Nature's map of interest features within the Fal Estuary (see Figures 23.4 and 23.5), the dredge area lies in an area classified as sublittoral mud with bedrock outcrops. Surrounding the channel area is an area designated as sublittoral muddy gravel.

Figure 24-4 Distribution of SAC Interest Features within the Fal Estuary (source: English Nature, 2000)

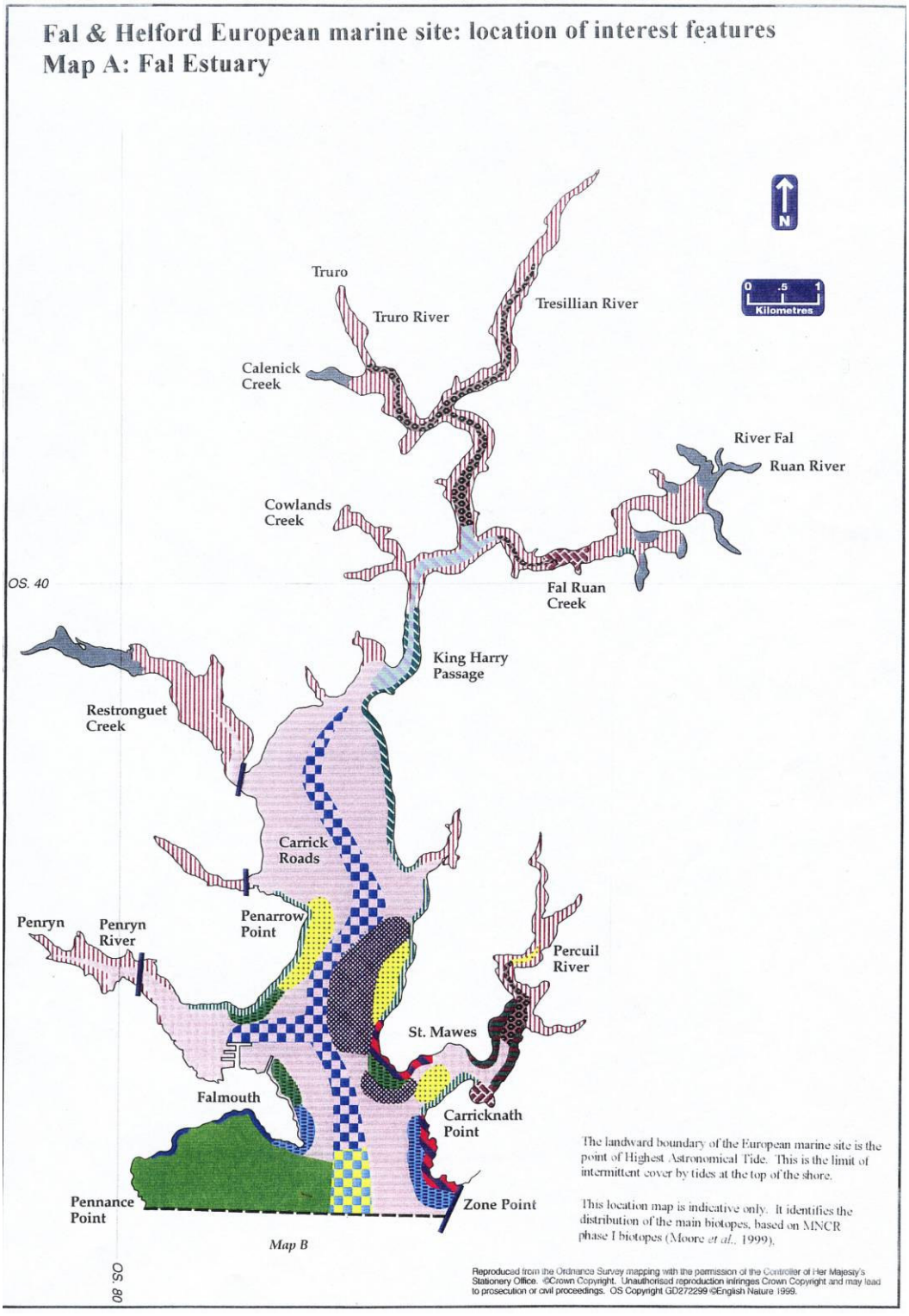
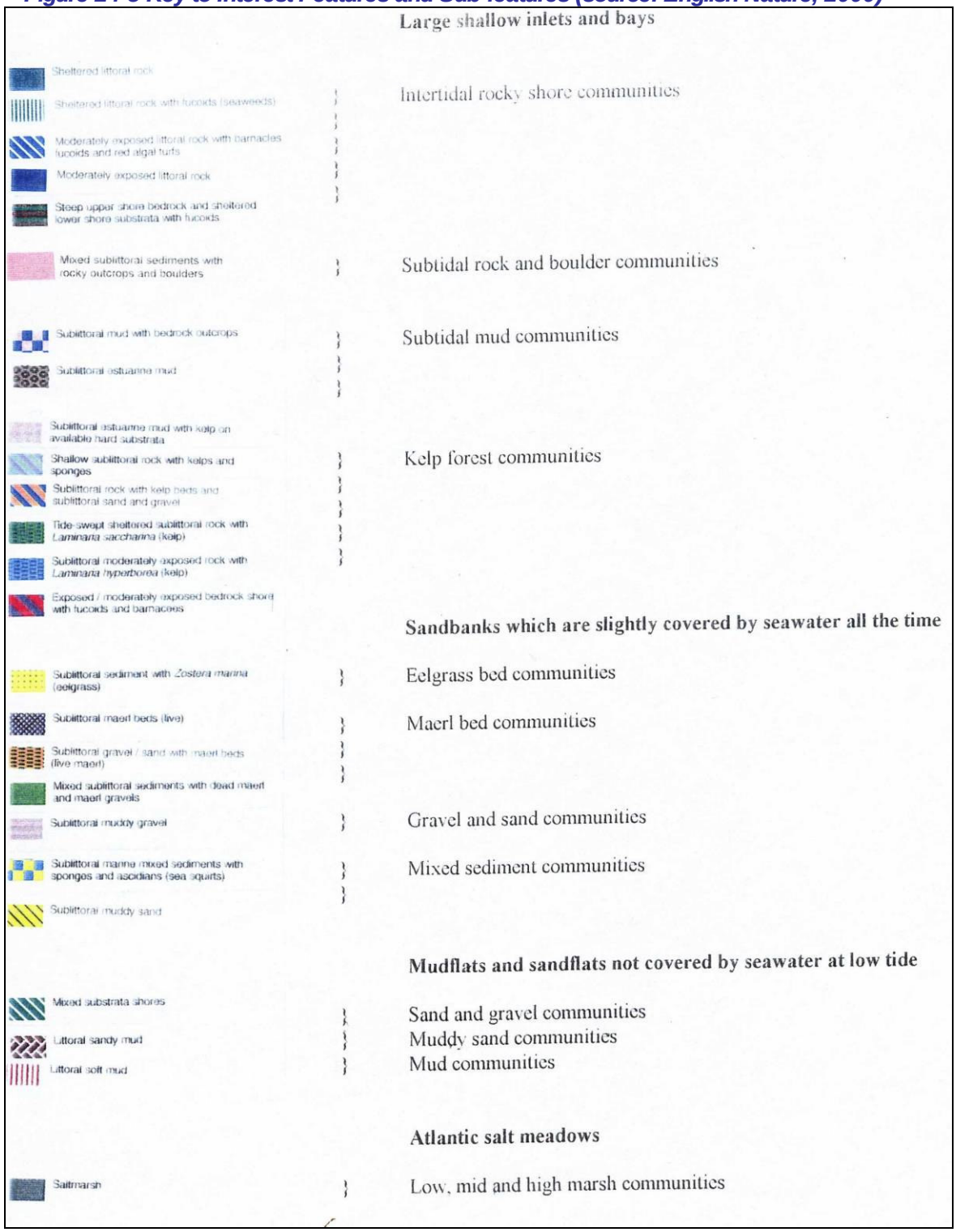


Figure 24-5 Key to Interest Features and Sub-features (source: English Nature, 2000)



24.4 POTENTIAL IMPACTS ON THE INTEREST FEATURES OF THE SAC

This section identifies and assesses the likely impacts of the dredging works on the SAC. The impacts of the dredging have been identified as the following:

- removal of habitats during the dredging activity; and
- removal of species/communities during the dredging activity.

No other potentially significant effects on the SAC have been identified.

24.4.1 Removal of Habitats due to Capital Dredging

In order to define the effects of the proposed dredge for the Falmouth Cruise Project on the maerl communities it is necessary to define the depth of maerl bed that is required to ensure that the full range of species can colonise the habitat remaining, following dredging.

Hall-Spencer and Atkinson (1999) determined the depth distribution of species within a live maerl bed in the Clyde Sea. They used airlift techniques to excavate six 1m2 quadrats at 4cm intervals to give depth-stratified samples to 72cm below the surface of the deposit in June-July 1996. This was undertaken at two sites, one which had been previously impacted by scallop dredging and one which had not. Six species were recorded as being present below 40cm with the deepest species recorded at 68cm. Although this data was obtained from a live maerl bed, it is the only available data on which to base this assessment. It should be noted that the study only excavated to 72cm and therefore it is possible some species could be present below this depth. Therefore, a conservative value of 1m of maerl has been defined as the minimum depth required for a viable community.

In order to calculate the predicted changes in area (in ha) of viable (i.e. enabling a full range of species to colonise the habitat) maerl habitat (both mixed communities and maerl only), pre-dredge areas of maerl communities to a depth of 1m were compared to areas of maerl habitat to a depth of 1m that would be present post-dredge. Table 24-5 illustrates the changes in areas of viable (i.e. over 1m depth) maerl habitats that are currently present and those that will exist post-dredge.

Table 24-5 Viable Maerl Area Changes Pre-Dredge and Post-Dredge (all areas in hectares)

Maerl Habitat Type	Pre-Dredge	Post-Dredge	Change In Area
Pure Maerl	2	4	+2
Mixed Maerl	17	11	-6
Total Maerl	19	15	-4

Overall, the area of viable pure maerl habitat appears to increase by c.2ha, while the area of viable mixed maerl habitat appears to reduce by c.6ha, giving a net loss of maerl habitat of c.4ha.

Mitigation

In order to mitigate this impact and ensure that the extent of the maerl matrix habitat is not reduced, it is possible to overdredge specific areas and place mixed maerl habitat

back onto the seabed to ensure that a viable habitat remains (i.e. a habitat of substrate depth of at least 1m).

By undertaking habitat mitigation, the total area of maerl and mixed maerl habitats may be returned to that of the pre-dredge area of 18.8ha.

The areas that are identified as suitable for mitigation are polygons 17, 18, 20 and 21, giving an area of c.6ha that could be replaced as viable mixed maerl habitat. Other potential areas to mitigate could be polygons 15, 12 and 10, although these are closer to the inner channel areas that have existing communities of lower value.

24.4.2 Removal of Species / Communities due to Capital Dredging

Potential Changes following Dredging

Following dredging, the polygons of the inner harbour (1-9), are likely to revert to a similar status to that present before the dredge (fine sediments with species poor communities, cluster C) as opposed to a succession into a species rich community such as those present at the outer polygons (cluster B1). This is mainly due to the substrate types at depth in these areas which are very similar to those currently at seabed level. Dredging will, however, expose rock in two of these sites and this may serve to increase local species diversity by reducing the homogenous nature of the substratum.

The maerl habitat present at polygon 9 (which is only present as a surface layer of maerl and not a viable maerl habitat) will be completely removed by the dredge. This community is represented by cluster group C which is of low species diversity.

Mixed maerl communities that will not be present (even at a seabed level) following the dredge includes polygons 1, 10, 15 and 18. Following dredging, the remaining sediments in these areas will be mainly homogenous and fine, comprising of clay or sand. Recruitment to these areas and re-establishment of a varied community is likely to be a slower process. Primarily the communities that will become established are likely to be broadly similar to those found in the inner harbour; typical of fine sediment, dominated by infaunal annelids with low species diversity (cluster C). However, over time, there may be a succession towards the more species rich communities of cluster B1, as coarse fractions in the sediments may increase due to movement of maerl into the dredged areas and colonisation occurring from surrounding communities. Mitigation of these sites is discussed in Section 24.5.1 and could be provided by placing maerl onto the seabed following dredging. This would involve overdredging to approximately 1m and filling with maerl dredged from elsewhere and stored on a barge. It is unlikely that this would be beneficial for polygon 1 due to the impoverished nature of the existing communities. The sites which may benefit are 10, 15 and 18 where the placing of maerl could encourage recolonisation to a more diverse community and the presence of coarser material would stabilise the seabed and reduce the risk of erosion of fines.

Polygons which currently support a habitat which contains maerl at a depth of at least 1m, but are unlikely to recover to a similar community even though the same seabed habitat will remain are 12, 17 and 21. This is because following the dredge, the depth of habitat is not viable for burrowing species. The maerl mix habitat is only present at the seabed level (polygon 17 loses the maerl matrix just with the overdredge). The enhancement measure discussed above could be used at these sites in order to improve chances of recovery.

At certain locations the established maerl and mixed maerl communities (those of polygons 11, 14, 16 and 19) are likely to recover, as the same habitat occurs at the dredge depth (and beyond to a depth of at least 1m) (see Figure 24-3 which shows the habitats at depth following dredging). Recovery at these established communities and those surrounding them is therefore expected to be to a similar state to that of pre-dredge, although longer-lived sessile taxa and their associated epifauna are likely to take longer to recover. As such, it is likely that, assuming no requirement for maintenance dredging in these areas, these communities will return to a relatively consistent and diverse community, dominated by species, which are consistent with a habitat of gravel, shell breccia and maerl (cluster B1). The same community cluster group occurs outside of the proposed dredged area (as shown in Figure 24-3) which will provide a source of species for recolonisation (recovery potential is further discussed later in this section). This community cluster group and the similar B2 sub-group are found on a variety of substrate types and are not considered to be habitat specific other than requiring coarse substrate.

There are two polygons which indicate that following dredging a habitat that includes maerl will be exposed which is deep enough to support burrowing species. These are site 4, which is currently clay and will expose a habitat of clay with frequent maerl, and 13, which currently has a seabed comprising of sand and will expose a sand with frequent maerl habitat. Site 13 could support a community more similar to type B as it is surrounded by community types B. Polygon 4 is unlikely to improve in its community composition due to the lack of water movement and proximity to the impoverished sites close to the harbour.

One remaining polygon (20) changes from a surface substrate of sand to clay following dredging. This area contains survey sample CS07 which is characterised by an impoverished fauna which is dissimilar to other samples taken during the survey work in 2007.

Recovery Potential

There have been numerous studies investigating impacts and recovery of maerl beds and coarse sediment substrates following different activities (mainly dredging for aggregates, maerl extraction and scallop dredging). In order to accurately predict the impacts these documents have been cited and the results have been reviewed in the context of this study.

Definition of Recovery

It is important to determine what is considered to be ‘recovery’. In terms of meeting the targets for the SAC attributes it is necessary to ensure that the presence and abundance of composite species should not deviate significantly from an established baseline, subject to natural change. The attribute affected by dredging works is the species composition of the characteristic biotope for the mixed sediments, which in this case is likely to be a relatively consistent and diverse community, dominated by species which are consistent with a habitat of gravel, shell breccia and maerl. The dominant species were peracarid crustaceans, notably the amphipods ***Leptocheirus pectinatus***, ***Caprella linearis***, ***Gammarella fucicola***, ***Parametaphoxus fultoni*** and ***Socarnes erythrophthalmus***, as well as the isopod ***Janira maculosa***. Other dominant species included the brittle-star

Amphipholis squamata, the gastropod ***Cerithiopsis tuberculatus*** and the amphipod ***Megamphopus cornutus***.

McCauley ***et al***. (1977, cited from De Grave and Whitaker 1999) in a review of the effects of maintenance dredging on benthic infauna, proposed that the term 'recovery' should not be employed when studying re-colonisation processes after cessation of dredging, as 'recovery' implies a return to prior abundance levels, and a return to ecological pathways which may have taken years to develop. Drastic changes induced by dredging or maerl extraction may alter these pathways significantly, and although the resulting community may return to its pre-dredging abundance levels, if sedimentary or hydrodynamic conditions have changed, or the site is subject to ongoing regular maintenance dredging, it may never return to its pre-dredging structure and internal integrity.

A practical approach to defining recovery has also been referred to in relevant scientific papers and has been discussed in Newell ***et al*** (1998) as the recognition of the establishment of a community that is capable of maintaining itself and in which at least 80% of the species diversity and biomass has been restored. A Cefas technical report (no. 130 Cooper ***et al***, 2005) defines recovery in practical terms (for the specific study) as the establishment of a community that is virtually indistinguishable (determined using both uni- and multi-variate analysis techniques) from surrounding, non-impacted reference sites.

Previous Studies of Recovery

Hall-Spencer and Moore (2000) in studies investigating the impacts of scallop dredging on live maerl communities found that dredging led to a greater than 70% reduction of live maerl thalli, which showed no sign of recovery in four years of monitoring. Studies by Hall-Spencer (1995) in the Firth of Clyde found that the scallop dredger's teeth penetrated 10 cm into the maerl, crushing maerl fragments and killing them by burial. Four months after scallop dredging there were less than half as many live maerl thalli as in control un-dredged areas. There was evidence that the community structure was altered in favour of opportunistic species such as scavengers. Overall, the impact of scallop dredging on maerl beds was high, with the effects on living maerl affecting habitat integrity and future recovery.

With regard to the above studies and their relevance to the proposed Falmouth Cruise Project, it should be noted that the studies carried out by Hall-Spencer looked at previously un-dredged live maerl communities where the high initial losses and low rates of recovery were attributable to the inability of the live maerl to photosynthesise again due to smothering. The habitat and communities present in the proposed new navigation channel at Falmouth comprise mainly abundant dead maerl. Live maerl communities were recorded as rare at the majority of stations and occasional at four stations (CS01, CS07, CS10 and RPT5), with only two stations recorded as abundant (CS03 and CS09).

Grall and Glémarec (1997) compared various indices of biological health for exploited and control maerl beds at the isles of Glénan, and found few significant differences except for a reduction in the number of individuals of each species counted in samples. In a review of the environmental effects of commercial maerl extraction in the Fal Estuary, Royal Haskoning (2004) found the benthic communities to be diverse, containing a high number of species and with no significant difference in the mean number of taxa in the infaunal community of maerl beds in extraction areas to those in

reference areas. The study did however identify that the number of individuals per core was significantly lower in the area of high extraction.

The references for recovery for live maerl beds show low rates of recovery mainly due to the high intensity of extraction, the status of the community prior to dredging and the inability of the live maerl to photosynthesise following disturbance. The habitats and communities affected by the proposed dredging works in Falmouth are mostly a dead maerl matrix comprising varying amounts of live maerl (mostly recorded as rare but reaching levels of abundant at two stations (CS03 and CS09)) (recorded by diver survey along transects)) mixed with clay, mud, sand and gravel. The community types found within these habitats have been described as those typical of coarse substrata, exploiting the interstices of gravels, shell-breccia and maerl present within the study area (Axelsson ***et al***., 2008).

Populations of benthic communities have been widely studied in investigations of the integrated effects of disturbance from a variety of natural and other sources (Newell ***et al.***, 1998). Newell ***et al***. (1998) reviewed a number of these studies relating to the impact of dredging works in coastal waters which included recovery of biological resources on the seabed. Their review suggested that marine communities conform with well-established principles of ecological succession and that this allows some realistic predictions on the likely recovery of benthic communities following the cessation of dredging (Newell ***et al.***, 1998). Their extensive review confirmed that biological community composition reflects changes in sediment composition but is also in equilibrium with seabed disturbance from tidal currents and wave action. A review of recovery in various habitats from many different sources revealed that a realistic recovery time for gravels and sands would be between 2-4 years but that this time may increase to more than 5 years in coarser deposits, including coral reefs. It is concluded from the above review that biological communities are controlled by more than just sediment type and that other factors are important in determining the species composition mainly mobility of the sediment.

Within the Fal Estuary the proposed works are predicted to have a minimal effect on hydrodynamics and therefore on sedimentary conditions. The current movement within the Fal Estuary is already very small, so any changes will have a negligible effect on the community development. In terms of mobility of sediment, the coarse nature of the material is such that, the mobility of the placed material would not change from the mobility levels already experienced. There is a low level of disturbance in the estuary at present due to its sheltered nature. Coupled with the low levels of suspended sediment concentrations, any sedimentation within the site will be very low, such that there is not expected to be any requirement for maintenance dredging. Therefore there is not expected to be any further disturbance of the area in order to maintain the channel. The only predicted disturbance would be due to propeller wash and this is not expected to change from the existing situation.

Long-term monitoring studies by Cefas have shown similar results which confirm that recovery is possible following dredging activity, but that sediment composition is an important factor in the potential for recovery and the rate at which recovery occurs. The surveys undertaken by Cefas (Cooper ***et al***., 2005) were monitoring for recovery following different intensities of aggregate extraction. Monitoring at a low intensity dredge site which was left, post dredging, with the same habitats as the reference sites has shown substantive ‘recovery’ (i.e. were largely indistinguishable from reference conditions).

Recovery has also been investigated by Phua ***et al***. (undated) in previous studies of aggregate dredging sites who found that species abundance generally recovers in 2 years; however, recovery to the previous population structure took 4 years.

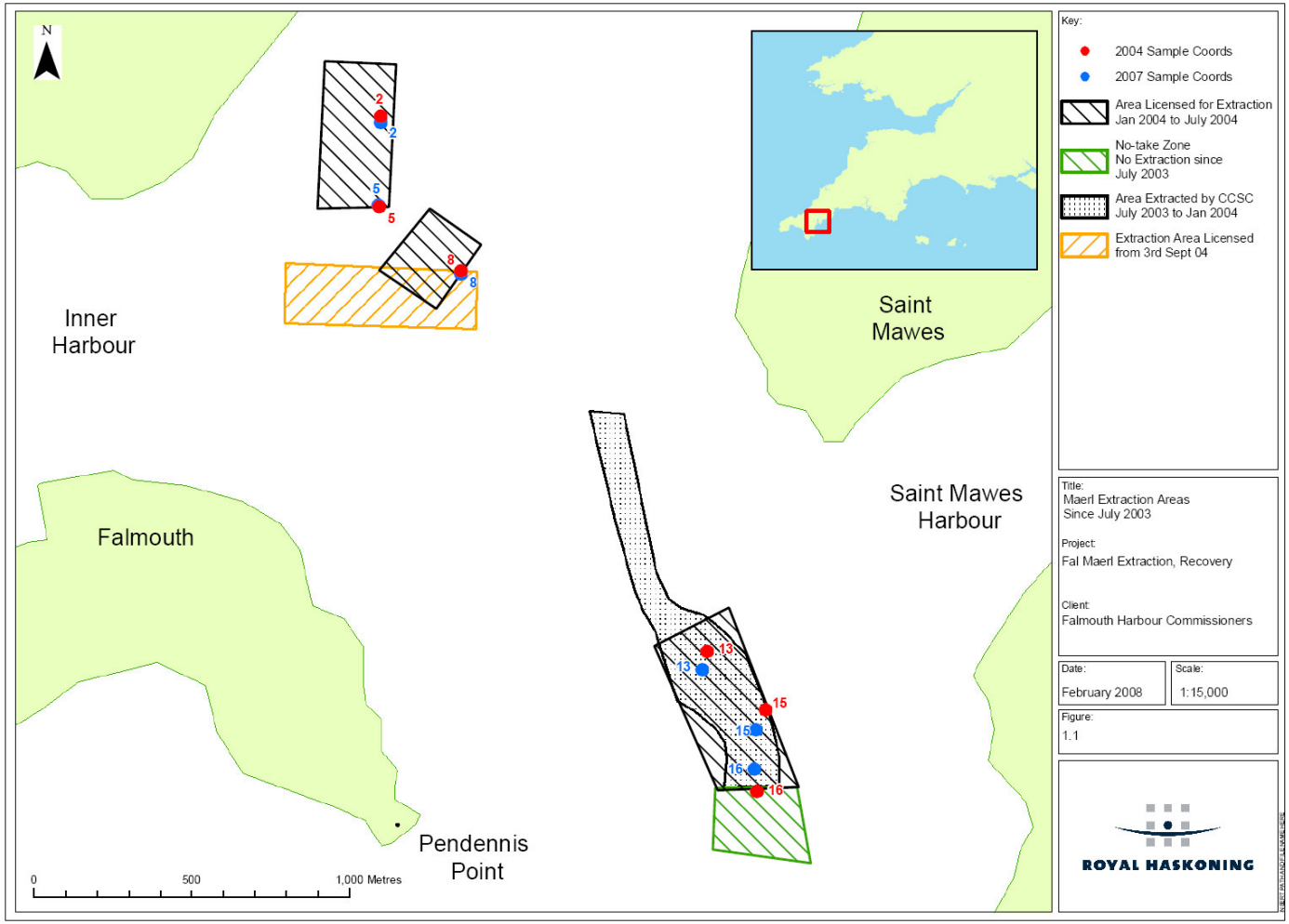
Rehabilitation Survey within the Fal Estuary

In terms of recovery potential specifically within the Fal Estuary, the survey work undertaken in 2007 included samples selected to investigate 'recovery' of previously dredged areas. The study involved repeat sampling in 2007 of macrofaunal monitoring sites which were previously sampled in 2003 (Figure 24-6). Survey sites were selected to assess recovery since dredging, which had ceased over different time periods. Locations of the monitored sampling sites and the dredge areas are shown in Figure 24.6 as Rpt sites 1-6. These sites correspond with the 2003 sites 16, 15, 13, 8, 5 and 2 respectively.

Axelsson ***et al*** (2008) concluded from this survey that "the evidence from the repeat stations is that recovery has been successful to the point that distinctions in the infaunal community are minor and insignificant. A similar response may therefore be expected at the outer proposed-dredged-area stations on dredge transects 4 to 7. However, the longer lived taxa of the epibiota are clearly taking longer to recover, and, as a result, so are their associated epizooite species".

Although there were limited data available for quantitative analysis statistical analysis of the results has been undertaken to investigate the similarities, differences and trends in community structure between the sites surveyed (a detailed account of the sampling techniques and analysis performed is available (Royal Haskoning briefing note 'Results of analysis on maerl recovery rates', 2008). The results of the multi-dimensional scaling analysis show a stress value of 0.15, which indicates that the statistical community type analysis is considered to be within the range of 'good' to 'useable, but misleading'.

Figure 24-6 Sample Sites for Recovery Monitoring



The infauna communities sampled in 2003 and 2007 were significantly different in terms of the number of individuals and number of taxa recorded. In 2007 a much higher total number of individuals were recorded with the average per core increasing from 90 to 265. Interestingly the total number of taxa recorded decreased by 23 in 2007, although in contrast the average per core increased by over 30%.

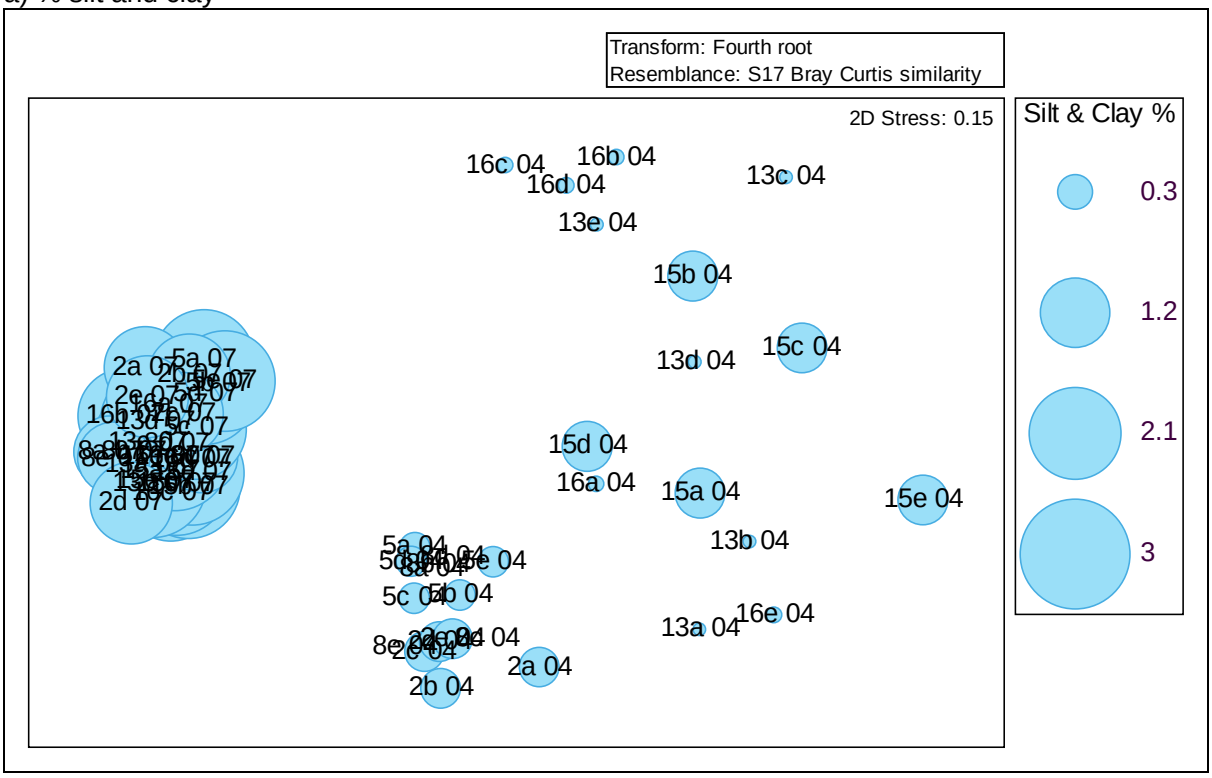
Diversity (measured using the Shannon-Wiener index) was generally high across the sites surveyed, sites 2, 5 and 8 having high values in both 2003 and 2007. The lowest Shannon-Wiener values were from sites 16, 15 and 13 in 2003. In 2007, this diversity measure increased substantially at these sites, making them as diverse as the northern sites in both 2003 and 2007

Multivariate analysis identified a clear separation of sample areas within 2003 and 2007. In 2003 northern sites 2, 5 and 8 were similar in community composition whereas southern sites 16, 15 and 13 were different from the north and also more varied amongst themselves. In 2007 the community composition shifted so that all sites were very similar to each other as compared to the communities previously sampled in 2003. In addition, the MDS and cluster analysis indicated that all communities sampled in 2007 were different (in varying degrees of difference) from those communities sampled in 2003. The conclusions made by Axellson ***et al*** (2008) would indicate that although there are differences in the community types, these differences are not statistically significant.

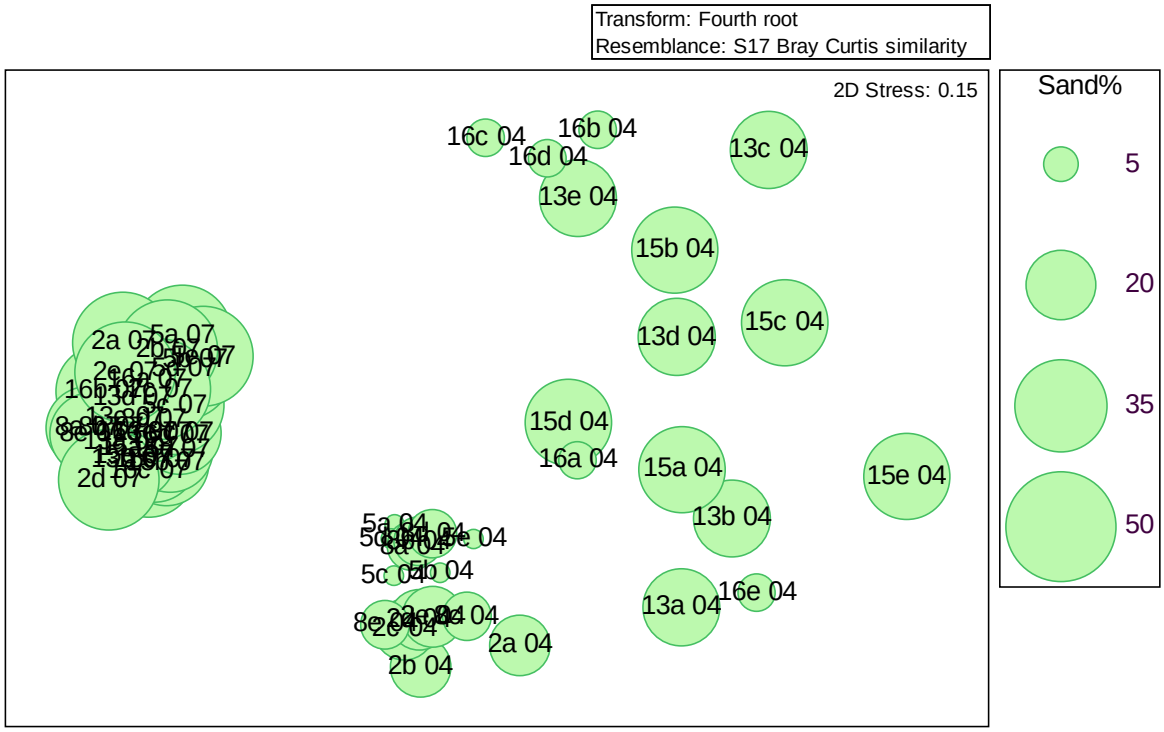
Figure 24-7 shows the MDS plot with the clearly distinct community types from the 2003 and 2007 surveys and the influence of sediment type overlain onto the MDS plot. The sediment composition does appear to be an influential factor in the lack of recovery to similar community types. The sediment types also seem to be an influential factor on community types between the different communities found during the 2003 survey. It would appear that the loss of granular material contributed to the low recovery rate to similar communities experienced between the two sites.

Figure 24-7 MDS Plot with Sediment Type Overlain as a Bubble Plot

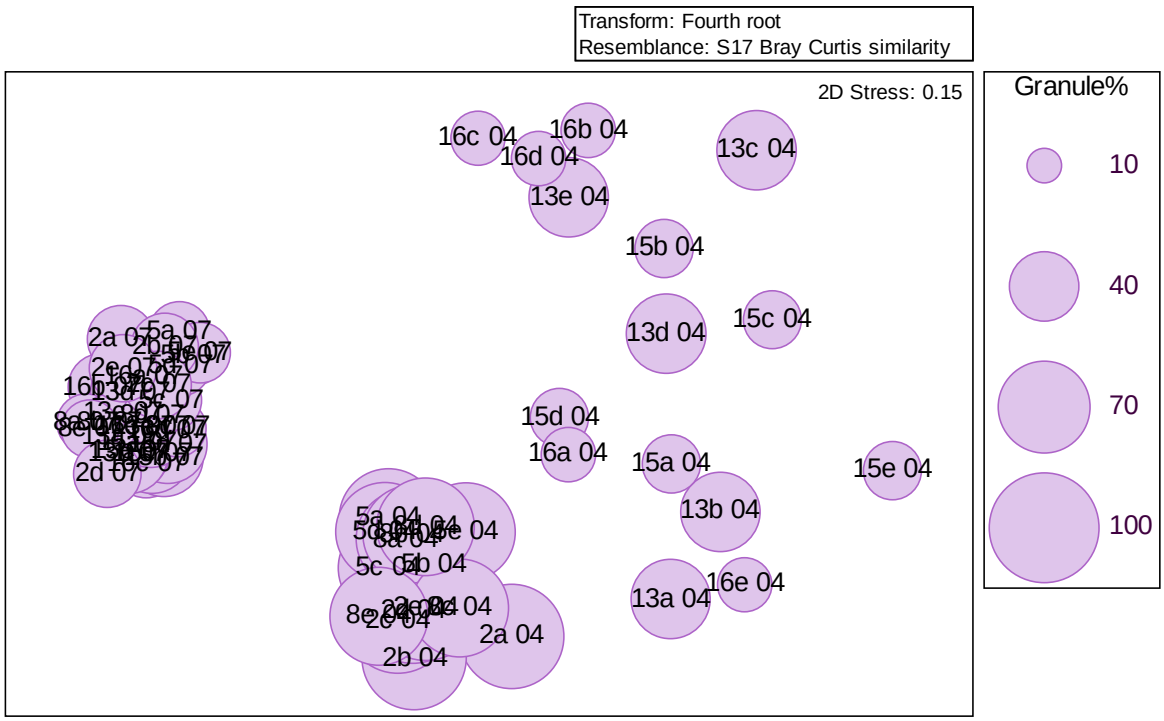
a) % silt and clay



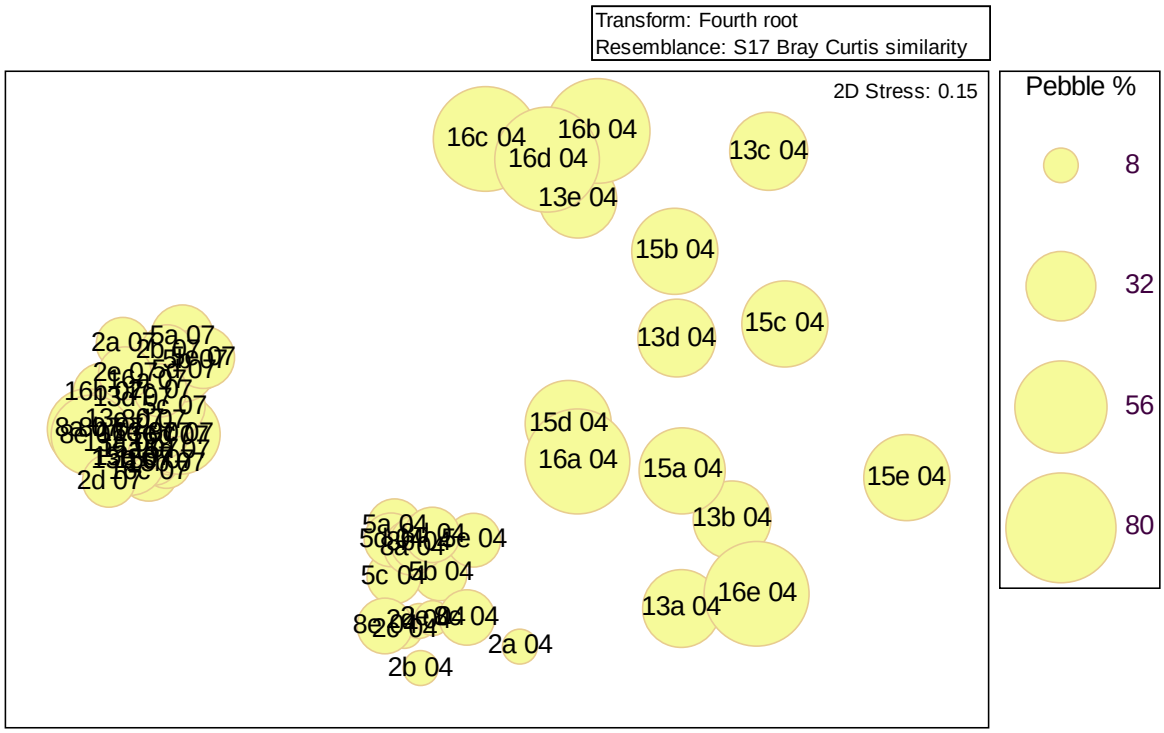
b) % sand



c) % granule



d) % pebble



K-dominance Curves

Figures 23.8 and 23.9 present the k-dominance curves for each site surveyed. These plots illustrate the cumulative ranked abundances of infauna plotted against the species rank. The curves are formulated from both a richness measure (species rank) and an evenness measure (% cumulative dominance), the least elevated curve having the highest evenness and the longest reaching curve having the highest number of taxa. As evenness and species number are together measures of diversity the plots suggest the southern sites to be less diverse than the northern, particularly in 2003. The K-dominance curves show that within three years the communities had recovered to a similar evenness of distribution to those that were present prior to the dredging activity (which occurred within 2004). The community that has developed in these areas is the B community, consisting of both variants B1 and B2. This shows that this community type, which is present within the dredge area is capable of recolonising a disturbed site within a space of three years.

Figure 24-8 K-dominance Curves for Samples in 2003 and 2007

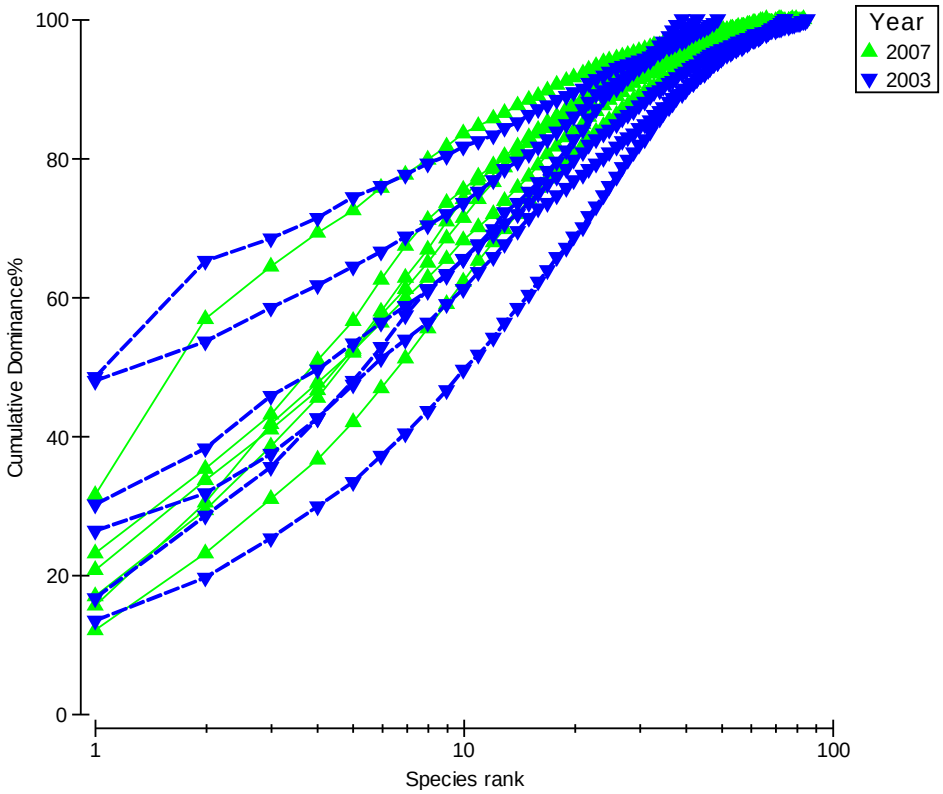
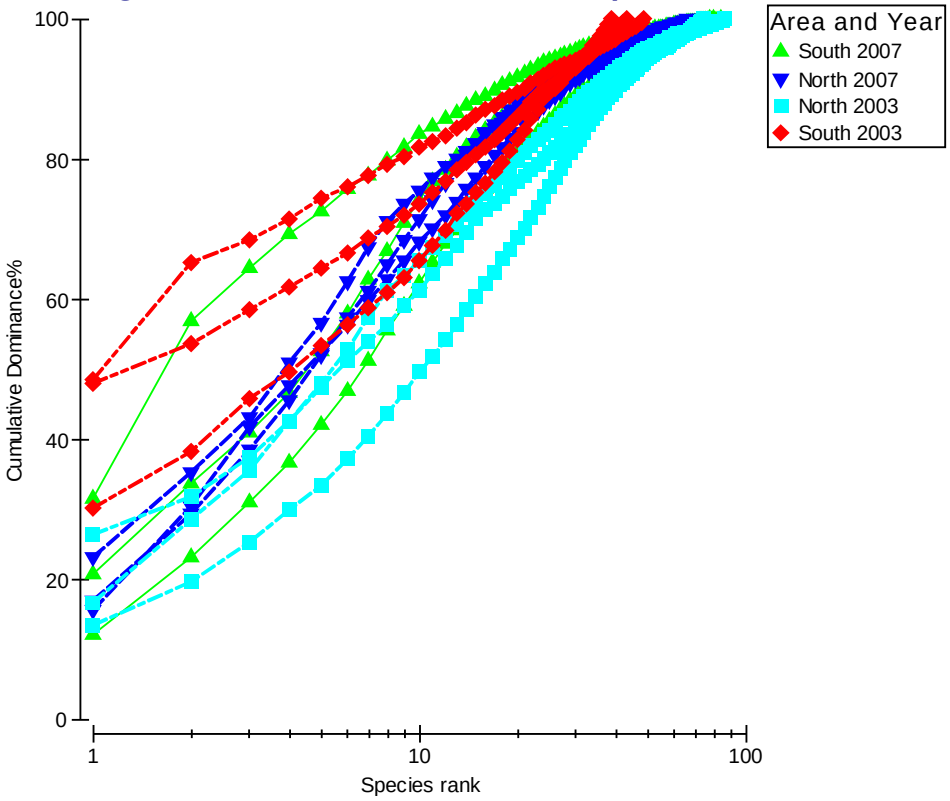


Figure 24-9 K-dominance Curves for Samples in 2003 and 2007 with Area



Given the above investigations and the conditions at the site it is therefore anticipated that with the recommended mitigation measures in place there would be a very high probability of the communities recovering (to a very similar community) within 2-5 years.

24.4.3 Potential Changes to Hydrodynamics due to Capital Dredging

A computational model of the area was setup to demonstrate the effect of the works on tidal flows, waves and sediment transport. The full report is provided in Appendix A. In summary, the predicted effects of the completed dredge were:

- a small reduction in tidal currents local to the dredge;
- no general change to the magnitude of wave conditions - some small increase in wave energy on the southern edge of the dredged channel and towards the west of Falmouth Inner Harbour;
- no general effect on mud transport - a small amount of accretion in the dredged area was predicted but insufficient to suggest regular maintenance dredging will be required; and
- no change to sand transport fluxes in the area - a potential accretion rate of sands of 5,500 m3/yr was predicted, mostly on the south side of the eastern end of the dredged channel. This value is insufficient to require regular maintenance dredging but suggests monitoring of the southern side of the channel should be considered during the early stages following the completion of the dredge.

Disposal of the whole dredged amount (600,000m3) in the existing disposal site was shown to lead to a build up of 0.1 – 0.5m within the disposal area and 0.01 – 0.05m within 800m of the limit of the disposal area.

24.4.4 Potential Impacts relating to Sediment Quality due to Capital Dredging

Survey work and data review was undertaken in order to characterise the sediments within the proposed dredge area. The results of this work indicate that the surface sediment of the western part of the navigation channel including the cruise berth contains concentrations of organo-tins (TBT and DBT), some metals (As, Cu, Hg, Pb and Zn), PAHs and total PCBs that are generally elevated above the Cefas Action Levels 1 or 2 and the Canadian TEL or PEL. The sub-surface sediment of the western part of the navigation channel including the cruise berth and the surface and sub-surface sediment of the eastern navigation channel contain concentrations of organo-tins, metals, PAHs, total PCBs and OCPs that are generally much lower, below the Cefas Action Level 1 and the Canadian TEL.

Capital dredging will remove large quantities of chemical contaminants from the seabed and the Fal estuary environment. The predicted magnitude of reduced chemical contaminant concentrations (and associated sediment toxicity) in relation to the receptor sensitivities (as defined by the assessment criteria) are predicted to cause an overall beneficial impact of moderate to major significance to sediment quality in the capital dredge area.

24.4.5 Potential Impacts relating to Water Quality due to Capital Dredging

Contaminant Release

The fate of sediment released during the capital dredge and disposal operations were modelled with special reference to the portion of the sediment to be dredged that is known to contain contaminants. The extent of the sediment plume from the dredging was predicted to be dominated by the exchange of flow between Inner Falmouth Harbour and Falmouth Bay with the plume remaining to the western side of Carrick Roads. Some excess concentrations larger than those experienced in the area typically were predicted in the area of the dredger.

Modelling for water quality effects was undertaken as part of the EIA. As a result of this work capital dredging is predicted to:

- increase concentrations of TBT to the extent that water quality requirements will be breached for the EQSs required under the DSD; and
- not increase concentrations of the other indicator contaminants to the extent that water quality requirements will be breached for the EQSs required under the DSD.

The scale of the impact on TBT concentrations will be limited in space (i.e. largely around Falmouth Docks and the harbour area) and time (i.e. over the duration of the capital dredge for contaminated sediment – 50% of the dredging programme of c.26 weeks). Overall, capital dredging is predicted to cause a temporary moderate adverse impact on water quality with regard to TBT concentrations. Normally, a high impact magnitude and high impact sensitivity would lead to a major adverse impact being predicted, but in this case the impact is put into the context of the baseline conditions where TBT is already present at concentrations exceeding the EQS.

The impact is temporary and reversible (i.e. baseline conditions will return following the cessation of capital dredging). Like the baseline conditions, the conditions after dredging will remain above the EQS for TBT. No mitigation measures are proposed, but it is

recommended that the adverse nature of this impact be considered against the long-term, permanent benefits to water quality that are predicted to occur due to the removal of some of the TBT from the estuarine system.

Plume Generation and Settlement

Some of the fine sediment portion (such as clay and mud) from the dredge area will be mobilised into the water column by the proposed dredging activities. These sediments would be transported in the currents as a sediment plume. Such sediment plumes can reduce the light penetration in the water column and thus potentially inhibit the growth of photosynthetic species, including maerl and other algal species. The sediment is subsequently deposited in low energy areas, or at slack tide, resulting in a fine layer of sediment which has the potential to impact benthic organisms by smothering feeding/respiratory organs. Mobile epifauna and active burrowers in the area are least likely to be affected by smothering, with sessile organisms such as filter feeding bivalves more sensitive.

As detailed above, live maerl communities were recorded as rare at the majority of stations and occasional at four stations (CS01, CS07, CS10 and RPT5), with only two stations recorded as abundant (CS03 and CS09). Live maerl is present as only a thin layer over deeper dead deposits; this layer will be removed during dredging from within the dredge footprint and consequently no longer present to be impacted by the localised effects of increased turbidity. However, the dredge plume and settlement would affect the surrounding areas and there are live maerl communities present within Falmouth harbour that may be impacted by the increased turbidity associated with the sediment plume.

Release rates of fine sediments from the type of dredger proposed (backhoe dredger) are generally low, and it is estimated that a maximum of 6,200 tonnes of material would be released into suspension during the duration of dredging work. Near the dredge, peak concentrations of up to 20mg/l above ambient levels are predicted (background concentrations of 5-10mg/l are observed (HR Wallingford, 1985) although the seasonal variation and concentrations during storm events is not known).

An illustration of the type of plume resulting from the dredging on the most dispersive tide is given in Figures 5-9 to 5-14.

Given that the main area of deposition would be immediately surrounding the dredge area, the main effects of sedimentation, should be limited to those within this region. The use of a backhoe dredger should minimise the amounts of silt entering the water column and based on this methodology, impacts associated with sedimentations should be reduced. The predicted level of deposition throughout the whole dredge campaign ranges from 0.5mm to 1.7mm. The rate of deposition is very small as this total would be spread over a period of up to 6 months.

On this basis and given the localised and temporary nature of the impacts, it is considered that the potential residual impact on the subtidal areas from sediment plume generation and sedimentation would be of minor adverse significance.

24.5 RECOMMENDED MONITORING

24.5.1 Requirement for Monitoring

The suggested mitigation measures and recovery potential for the habitats affected by the capital dredging will require monitoring to record the habitat distribution and the recolonisation patterns. The monitoring will have the objective of checking that the site does recolonise as expected. The detailed monitoring plan will need to be agreed with Natural England in advance of any works.

Within other estuaries within the UK, where dredging schemes have taken place within designated marine sites, monitoring has been undertaken for determining the effect on benthic organisms. For example within the Stour and Orwell Estuaries a long-term monitoring study investigates changes as a result of a 19Mm3 capital dredge. Maintenance dredging is required within the estuaries so recovery in the dredge areas is not likely to occur to pre-dredge levels. Extensive monitoring was initially undertaken every five years and has recently changed to less intensive annual surveys. For the Felixstowe South Reconfiguration project (capital dredge to remove 3.86Mm3 of material) benthic monitoring will be undertaken to determine any changes to the community types, but again this site will be subject to regular maintenance dredging. The monitoring results for these schemes are discussed at an annual regulators meeting together with results of physical surveys and bird counts. Although these are much larger schemes, the objective for monitoring will be similar to that proposed here, in that they are investigating change against an agreed baseline.

24.5.2 Monitoring Plan

A baseline should be established prior to the capital dredging works which will select sampling sites based on the previous surveys and the proposed mitigation works.

Habitat Monitoring

Monitoring of habitat types should be undertaken immediately after dredging to record the effectiveness of the habitat mitigation. This should be undertaken by suction pipe sampling and analysis to record the depths of sediment present within the channel area.

Monitoring should also be undertaken of the areas surrounding the dredge zone to ensure that the plume created during dredging does not affect any sensitive habitats. The modelling has shown that the plume created is predicted to remain to the west of the channel area and should therefore not affect the live maerl bed and the seagrass beds to the east and north of the channel area. However, it is recommended that these habitats are monitored following the dredging activity to ensure no impacts. This would include the seagrass beds on the shallow sandbanks between Trefusis and Penarrow Points.

Community Monitoring

Sampling will follow the methodology used for the previous surveys, namely diver core samples and transects across the channel areas. The monitoring will be quantitative to enable statistical analysis to be undertaken to determine changes in community types over time. The monitoring will be undertaken at annual intervals at the same time as the baseline is established (ideally this will be undertaken in summer) for a duration of at least five years. Annual reports will be produced which would be discussed at a

regulators meeting where any actions necessary will be agreed amongst the Regulatory group.

Threshold Levels for Action

Threshold levels for action will need to be determined prior to monitoring together with the necessary actions if monitoring shows the thresholds to be exceeded. This could include monitoring of the sediment plume to provide information on the suspended sediment concentration which can also be linked to the potential level of contaminants.

24.6 IMPLICATIONS FOR INTEGRITY OF THE SAC

24.6.1 Summary of Impacts

As discussed in Section 24.4, the main way in which the SAC features could be affected is through removal of habitats and communities from the SAC during the capital dredging works. The effects of this on SAC favourable condition targets are presented in Table 24.6.

From Table 24.6 it can be seen that the favourable condition targets are predicted to be affected beyond a temporary change in habitat until mitigation replaces the lost habitat and a longer term change in community types until recolonisation occurs. It is, therefore, considered that the dredging associated with the cruise terminal facilities will not have a long term effect on the integrity of the SAC.

This conclusion is reached for the following reasons:

- The communities that have returned to the areas subject to maerl extraction in 2004 are the same community type as those that occur in the channel area;
- There is unlikely to be a requirement for regular maintenance dredging, particularly in the outer channel area where the mitigation is proposed;
- The predicted effects on the hydrodynamic regime are minimal, causing small, localised changes in tidal currents and wave energy;
- The communities that occur in the channel also occur on a variety of substrate types and, as such, are not specific to narrow habitat requirements;
- The sedimentary characteristics of the site can, through the implementation of mitigation measures, be returned to pre-dredge conditions during the dredge activity;
- Recovery of species within other areas of the estuary has occurred within three years to similar community dominance structures although to different community types thought to be due to the change in sediment types;
- Recovery of coarse sediment communities has been well studied in the past and studies have shown success at recovery to similar communities;
- Studies on community succession have enabled accurate predictions to be made on the ability of communities to recover; and
- The recovered communities should continue to make the same contribution to the favourable status of the interest features as they did when the site was designated.

24.6.2 Recommendations

It is recommended that the mitigation measures outlined in Section 24.5 are implemented. In addition, it is recommended that Natural England is consulted on the method statement for the works and a draft version sent to them for their approval.

It is also recommended that the monitoring plan discussed in Section 24.5.2 is implemented in order to record the recovery process.

Table 23-6 Impacts on Favourable Conditions

Sub-feature	Attribute	Target	Potential construction impact	Preventative measures	Significance of residual impact	Effect on designated site
Large shallow inlet and bay						
	Extent	No decrease in extent from an established baseline.	No impact on extent of shallow inlet and bay	N/A	N/A	No change from existing situation
	Water clarity	Average light attenuation should not deviate significantly from the established baseline, subject to natural change.	Small increase in SSC during works	Type of material and the selection of a backhoe dredge will reduce the potential for a significant sediment plume	N/A	Temporary change of minor significance
	Nutrient status – phytoplankton concentration	No significant increase in phytoplankton concentration from the established baseline, subject to natural change.	No impact on phytoplankton concentration	N/A	N/A	No change from existing situation
Rocky shore communities	Distribution of characteristic rocky shore communities	No decrease in littoral extent of range of rocky shore communities from an established baseline value (intertidal biotope mapping survey 1998), subject to natural change.	No route for impact on extent of rocky shores.	N/A	N/A	No change from existing situation
	Species composition of low-shore boulder communities	Presence and abundance of composite species (biotope MLR.Fse.Bo.) should not deviate significantly from established baseline,	No route for impact on extent of rocky shores.	N/A	N/A	No change from existing situation

Sub-feature	Attribute	Target	Potential construction impact	Preventative measures	Significance of residual impact	Effect on designated site
		subject to natural change				
	Species composition of rockpool communities	Presence and abundance of composite species should not deviate significantly from established baseline, subject to natural change. Average percentage cover of ***Sargassum muticum*** (Japweed) should not increase from the established baseline.	No route for impact on extent on rockpool communities.	N/A	N/A	No change from existing situation
Kelp forest communities	Algal species composition	Presence and abundance of composite algal species should not deviate significantly from established baseline, subject to natural change.	No impact likely on kelp beds – the proposed works will only affect the area around the dredge zone. There were no kelp beds found within the direct dredge zone and surrounding area. Any increases in SSC will be temporary and settlement of material will be minimal and close to the dredge zone.	N/A	N/A	No change from existing situation

Sub-feature	Attribute	Target	Potential construction impact	Preventative measures	Significance of residual impact	Effect on designated site
	Characteristic species – ***Laminaria hyperborea & L. ochroleuca*** population size	Average ratio ***of Laminaria hyperborea: L. ochroleuca*** should not deviate significantly from an established baseline, subject to natural change. Average density of each species should not deviate significantly from an established baseline, subject to natural change.	No impact likely on kelp beds – the proposed works will only affect the area around the dredge zone. There are no indications of kelp communities within the direct dredge zone and surrounding area. Any increases in SSC will be temporary and settlement of material will be minimal and close to the dredge zone.	N/A	N/A	No change from existing situation
	Characteristic species – ***Distomus variolosus*** population size	Average percentage cover should not deviate significantly from an established baseline, subject to natural change.	No impact likely on kelp beds – the proposed works will only affect the area around the dredge zone. There are no indications of kelp communities within the direct dredge zone and any increases in SSC will be temporary and settlement of material will be minimal and close to the dredge zone.	N/A	N/A	No change from existing situation
Subtidal rock and boulder communities	Species composition of characteristic biotopes MCR.ErSEun	Presence and abundance of composite species should not deviate significantly from an established baseline,	No impact – the proposed works will not impact on these community types.	N/A	N/A	No change from existing situation

Sub-feature	Attribute	Target	Potential construction impact	Preventative measures	Significance of residual impact	Effect on designated site
	and ECR.AlcMas	subject to natural change.				
Subtidal mud communities	Species composition of characteristic biotopes	Presence and abundance of composite species should not deviate significantly from an established baseline, subject to natural change.	The capital dredge will remove communities associated with the clay habitats in the inner harbour area. The habitat remaining after the dredge will be the same as that which is there prior to the dredge and it is anticipated that the same communities will recolonise the clay habitats.	N/A	Negligible	No significant effect
Subtidal sandbanks						
	Extent	No decrease in extent from an established baseline, subject to natural change.	No change in extent of subtidal sandbanks	N/A	N/A	No change from existing situation
	Sediment character	Average PSA parameters should not deviate significantly from an established baseline, subject to natural change.	Removal of mixed maerl habitat through capital dredge	Replacement of viable habitat to ensure no net loss of mixed maerl habitat within the SAC.	Negligible	No change from existing extent given mitigation measure
	Topography	Depth distribution should not deviate significantly from an established baseline, subject to natural change.	Capital dredge will increase the depth within the navigation channel to accommodate vessels	N/A	N/A	Navigation channel will be deeper than existing channel
	Water density	Average temperature/salinity should	No impact anticipated	N/A	N/A	No change from existing situation

Sub-feature	Attribute	Target	Potential construction impact	Preventative measures	Significance of residual impact	Effect on designated site
		not deviate significantly from an established baseline, subject to natural change.				
Eelgrass bed communities	Extent	No decrease in extent from an established baseline, subject to natural change.	No impact – the proposed works will only affect the immediate area around the dredge zone and jetty area therefore no eelgrass habitats will be impacted.	N/A	N/A	No change from existing situation
	Characteristic epiphytic species – ***Zostera marina***	Average density should not deviate significantly from an established baseline, subject to natural change.	No impact – the proposed works will only affect the immediate area around the dredge zone and jetty and therefore no eelgrass habitats will be impacted.	N/A	N/A	No change from existing situation
	Characteristic species – Epiphytic community	Presence and abundance of epiphytic species should not deviate significantly from an established baseline, subject to natural change.	No impact – the proposed works will only affect the immediate area around the dredge zone and jetty and therefore no eelgrass habitats will be impacted.	N/A	N/A	No change from existing situation
	Nutrient status – green algal mats	No increase in extent of green algal mats from an established baseline, subject to natural change.	No impact – the proposed works will only affect the immediate area around the dredge zone and jetty and therefore no eelgrass habitats will be impacted.	N/A	N/A	No change from existing situation

Sub-feature	Attribute	Target	Potential construction impact	Preventative measures	Significance of residual impact	Effect on designated site
Maerl bed communities	Extent	No decrease in extent of maerl as a whole, or of either dead or live maerl, mats from an established baseline, subject to natural change.	Capital dredge will remove maerl and mixed maerl habitat (only small fragments of live maerl) from the navigation channel	Replace lost habitat by overdredging and replacing with mixed maerl substrate dredged during same campaign	Minor impact but temporary	No significant adverse effect given mitigation measure
	Distribution of maerl bed communities	Distribution of maerl bed communities should not deviate significantly from an established baseline, subject to natural change.	Capital dredge will remove mixed maerl communities from the navigation channel	Replace lost habitat by overdredging and replacing with mixed maerl substrate dredged during same campaign to promote recolonisation with similar community	Moderate impact but localised and temporary	No significant adverse effect given mitigation measure
	Species composition of maerl bed communities	Presence and abundance of composite species should not deviate significantly from an established baseline, subject to natural change.	Capital dredge will remove species associated with mixed maerl habitats	Habitat replacement and presence of the same species/communities close to the dredge area will promote recolonisation with same or similar species composition	Moderate impact but localised and temporary	Temporary effect on designated site until area recolonises.
	Nutrient status – green algal mats	No increase in extent of green algal mats from an established baseline, subject to natural change.	No anticipated impact	N/A	N/A	No change from existing situation
Gravel and	Species	Presence and abundance	Capital dredge will remove	Habitat replacement	Temporary,	Temporary effect

Sub-feature	Attribute	Target	Potential construction impact	Preventative measures	Significance of residual impact	Effect on designated site
sand communities	composition of characteristic biotopes	of composite species should not deviate significantly from an established baseline, subject to natural change.	communities associated with gravel and sand habitats	and presence of the same communities close to the dredge area will ensure recolonisation occurs	localised impact	on designated site until area recolonises.
Mixed sediment communities	Species composition of characteristic biotopes	Presence and abundance of composite species should not deviate significantly from an established baseline, subject to natural change.	Capital dredge will remove communities associated with mixed sediment habitats	Habitat replacement and presence of the same communities close to the dredge area will ensure recolonisation occurs	Temporary, localised impact	Temporary effect on designated site until area recolonises.
Intertidal mudflats and sandflats						
	Extent	No decrease in extent from an established baseline, subject to natural change.	No impact – the proposed works will only affect the immediate area around the dredge zone and jetty and therefore no intertidal habitats will be impacted.	N/A	N/A	No change from existing situation
	Sediment character	Particle size parameters and sediment penetrability should not deviate significantly from an established baseline, subject to natural change.	No impact – the proposed works will only affect the immediate area around the dredge zone and jetty and therefore no intertidal habitats will be impacted.	N/A	N/A	No change from existing situation
Mud communities	Extent and distribution of characteristic biotopes	Extent and distribution of the biotopes should not deviate significantly from an established baseline,	No impact – the proposed works will only affect the immediate area around the dredge zone and jetty and	N/A	N/A	No change from existing situation

Sub-feature	Attribute	Target	Potential construction impact	Preventative measures	Significance of residual impact	Effect on designated site
		subject to natural change.	therefore no intertidal habitats will be impacted.			
	Topography	Shore profile measurements should not deviate significantly from an established baseline, subject to natural change.	No impact – the proposed works will only affect the immediate area around the dredge zone and jetty and therefore no intertidal habitats will be impacted.	N/A	N/A	No change from existing situation
	Nutrient status – green algal mats	Extent of green algal mats should not increase from an established baseline, subject to natural change.	No impact – the proposed works will only affect the immediate area around the dredge zone and jetty and therefore no intertidal habitats will be impacted.	N/A	N/A	No change from existing situation
Sand and gravel communities	Extent and distribution of characteristic biotopes	Extent and distribution of the biotopes should not deviate significantly from an established baseline, subject to natural change.	No impact – the proposed works will only affect the immediate area around the dredge zone and jetty and therefore no intertidal habitats will be impacted.	N/A	N/A	No change from existing situation
Muddy sand communities	Extent and distribution of characteristic biotopes	Extent and distribution of the biotopes should not deviate significantly from an established baseline, subject to natural change.	No impact – the proposed works will only affect the immediate area around the dredge zone and jetty and therefore no intertidal habitats will be impacted.	N/A	N/A	No change from existing situation

Sub-feature	Attribute	Target	Potential construction impact	Preventative measures	Significance of residual impact	Effect on designated site
Atlantic salt meadows						
	Extent	No decrease in extent of Atlantic salt meadows from an established baseline, subject to natural change.	No impact – the proposed works will only affect the immediate area around the dredge zone and jetty and therefore no salt marsh habitats will be impacted.	N/A	N/A	No change from existing situation
	Creek patterns	No significant alteration of creek patterns from an established baseline, subject to natural change.	No impact – the proposed works will only affect the immediate area around the dredge zone and jetty and therefore no salt marsh habitats will be impacted.	N/A	N/A	No change from existing situation
	Range and distribution of characteristic NVC communities	Range and distribution of characteristic saltmarsh communities should not deviate significantly from an established baseline, subject to natural change.	No impact – the proposed works will only affect the immediate area around the dredge zone and jetty and therefore no salt marsh habitats will be impacted..	N/A	N/A	No change from existing situation
	Vegetation structure	Vegetation structure should not deviate significantly from an established baseline, subject to natural change.	No impact – the proposed works will only affect the immediate area around the dredge zone and jetty and therefore no salt marsh habitats will be impacted.	N/A	N/A	No change from existing situation

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25 PROPOSALS FOR MONITORING

25.1 CHANGES TO SUSPENDED SEDIMENT AND CONTAMINANT CONCENTRATIONS IN THE FAL ESTUARY DURING CAPTIAL DREDGING

It is anticipated that water quality monitoring will need to take place during the capital dredging to record the changes to suspended sediment (as TSS) and a range of chemical contaminants. This will allow the changes to be compared to the water quality requirements of the relevant EC Directives.

A monitoring plan will need to be agreed with the Environment Agency. It is anticipated that a baseline will not need to be established prior to the capital dredging works since the Environment Agency already monitor water quality in the estuary. Sampling sites will have to be agreed with the Environment Agency, and it may be most suitable to use the sites already used to monitor water quality (e.g. for shellfish waters in Carrick Roads, Penryn River and Percuil River).

It is anticipated that monitoring may have to take place on a real time basis. Therefore, it may be appropriate to install turbidity metres that record and send data at regular intervals (e.g. 15 or 30 minutes). In order to provide real time results for TSS and chemical contaminants, the turbidity data would need to be calibrated against measured TSS concentrations and translated into chemical contaminant concentrations using the TSS concentrations and partition coefficients.

25.2 CHANGES TO BATHYMETRY AND MARINE ECOLOGY IN FALMOUTH BAY DUE TO DISPOSAL OF DREDGED MATERIAL

It is anticipated that bathymetry and marine ecology monitoring will need to take place after the disposal of dredged material to record the changes to bathymetry and benthic communities in and around the Falmouth Bay disposal site.

A monitoring plan will need to be agreed with the MFA and Cefas. It is anticipated that a baseline may need to be established prior to the disposal activities. It is anticipated that monitoring will include a pre- and post-disposal bathymetric survey, and at least a post-disposal survey of benthic communities.

25.3 RECOVERY OF MAERL HABITAT AND COMMUNITIES DUE TO SEABED HABITAT MITIGATION

The suggested mitigation measures and recovery potential for the habitats in the SAC affected by the capital dredging will require monitoring to record the habitat distribution and the recolonisation patterns. The monitoring will have the objective of checking that the site does recolonise as expected. The detailed monitoring plan will need to be agreed with Natural England in advance of any works.

A monitoring plan will need to be agreed with Natural England. It is anticipated that a baseline will need to be established prior to the capital dredging works, with sampling sites selected based on the previous surveys and the proposed mitigation works.

25.3.1 Habitat Monitoring

It is anticipated that monitoring of habitat types will need to be undertaken immediately after dredging to record the effectiveness of the habitat mitigation. This should be undertaken by suction pipe sampling and analysis to record the depths of sediment present within the new navigation channel.

It is anticipated that monitoring will need to be undertaken in the areas surrounding the new navigation channel to ensure that the sediment plume created during dredging does not deposit and hereby affect any sensitive habitats. Computational modelling predicts that the plume should remain to the west of the channel area and should therefore not affect the live maerl bed and the seagrass beds to the east and north of the channel area. However, it is recommended that these habitats are monitored following the dredging activity to ensure that no impacts have occurred due to sediment deposition. This monitoring would include the seagrass beds on the shallow sandbanks between Trefusis and Penarrow Points.

25.3.2 Community Monitoring

Sampling will follow the methodology used for the previous surveys, namely diver core samples and transects across the channel areas. The monitoring will be quantitative to enable statistical analysis to be undertaken to determine changes in community types over time. The monitoring will be undertaken at annual intervals at the same time as the baseline is established (ideally this will be undertaken in summer) for a duration of at least five years. Annual reports will be produced which would be discussed at a regulators meeting where any actions necessary will be agreed.

25.4 MARINE MAMMAL OBSERVATION

It may be necessary to employ a MMO to reduce the risk of piling related noise impacts on marine mammals. Consultation with the relevant bodies (notably Natural England) will establish if it may also be necessary to employ a MMO to ensure that marine mammals are not present in the near vicinity of the piling.

If necessary, it is expected that the MMO will undertake a search for marine mammals 30 minutes prior to the start of pile driving, as recommended by JNCC (2008). A safety zone around piling activity would be implemented by the MMO, with the distance based on consultation with Natural England. The MMO must be confident that no marine mammals are present within the safety zone before the initial piling works commence. If a marine mammal is sighted within the safety zone, then pile driving activities should be delayed by at least 30 minutes, until it has left the safety zone.

25.5 ARCHAEOLOGICAL WATCHING BRIEF AND RECORDING OF FINDS DURING CAPITAL DREDGING

Mitigation for a number of potential impacts on archaeology includes monitoring activities to be undertaken according to an Archaeological Protocol and Written Scheme of Investigation (WSI).

The Archaeological Protocol will include monitoring in the form of an archaeological watching brief during capital dredging of the new navigation channel, with provision for

intervention if archaeological material of maritime interest is identified during this process. It would not be practicable or productive for an archaeologist to be on site constantly during the dredging and a pragmatic approach to the watching brief should be adopted. For example, the project archaeologist could visit the site on the first day of dredging to inspect the method of working and the potential for archaeological screening and to liaise with the appointed contractor's staff with regard to the identification of artefactual material. Subsequently, the watching brief would operate on a call out basis, with the appointed contractor contacting the project archaeologist in the event of anything out of the ordinary being dredged up and the archaeologist making a weekly visit to inspect the work in progress.

A system for reporting finds of archaeological interest could be adopted, closely following the British Marine Aggregate Producers Association and English Heritage Protocol (Wessex Archaeology, 2005). The appointed contractor would nominate one of their staff as a Site Champion for archaeology that would be issued with a flow chart setting out the actions to be taken when they are told about a discovery. The Site Champion would fill in a pro forma Preliminary Record sheet for each find, and would inform the Project Archaeologist. The Project Archaeologist should be present when the areas of selected targets such as GT 31 and GT 40/41 are dredged with a view to recovering at least one of these objects to enable a positive identification to be made.

The monitoring will allow for any features or wreckage to be preserved by record, and could potentially add additional information to our knowledge and understanding of the site and the historical development of Falmouth.

25.6 GAS MONITORING FOR DETAILED RISK ASSESSMENT

As already stated, a site investigation has been carried out on the site. It is considered that the number of window samples provided a sufficient spatial coverage for a preliminary assessment. However, of the boreholes constructed only two dual monitoring wells were installed for ground gas and groundwater sampling. Since ground gases have been identified at the site, it is recommended that further gas monitoring wells are installed to fully assess the risks associated with the presence of ground gas at the site and delineate the areas affected by the ground gases. These further boreholes may also provide additional information on groundwater quality and flow regime.

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Appendix A
Hydrodynamics

Appendix B
Sediment Quality

Appendix C
Marine Ecology

Appendix D
Terrestrial Ecology

Appendix E
Archaeology

Appendix F
Noise

Appendix G
Landscape and Visual Impact Assessment

Appendix H
Contaminated Land