g) Assess the ability of the landscape and visual resource to absorb the proposed development.

14.2 Methodology

14.2.1 Introduction

Methods used in this assessment have been developed by RPS Planning & Environment and are derived from the DoEHLG “Landscape and Landscape Assessment” (June 2000) and ‘Guidelines for Landscape and Visual Impact Assessment’ (GLVIA) by The Landscape Institute and Institute of Environmental Management and Assessment (2002). These documents recommend baseline studies to describe, classify and evaluate the existing landscape and visual resource focusing on its sensitivity and ability to accommodate change. The guidelines are not intended as a prescriptive set of rules but rather offer best practice methods and techniques of LVIA. The existing landscape and visual context of the study area was established through a process of desktop study, site survey work (March 2011) and photographic surveys. The proposal was then applied to the baseline conditions to allow the identification of potential impacts, prediction of their magnitude and assessment of their significance. Mitigation can then be identified to reduce as far as possible any residual potential landscape and visual impacts.

Landscape Assessment Criteria and Terminology

The following section describes the criteria and terminology used during the landscape assessment: -

Landscape Quality

For the purpose of this assessment, landscape quality is categorised as:

- *Exceptional Quality* - Areas of especially high quality acknowledged through designation as Areas of Outstanding Natural Beauty or other landscape based sensitive areas. A landscape that is significant within the wider region or at a national level;

- *High Quality* - Areas that have a very strong positive character with valued and consistent distinctive features that gives the landscape unity, richness and harmony. A landscape that is significant within the district;

- *Medium Quality* - Areas that exhibit positive character but which may have evidence of alteration/degradation or erosion of features resulting in a less distinctive landscape. May be of some local landscape significance with some positive recognisable structure; and

- *Low Quality* - Areas that are generally negative in character, degraded and in poor condition. No distinctive positive characteristics and with little or no structure. Scope for positive enhancement.

Landscape Sensitivity

Landscape sensitivity to the type of development proposed is defined as follows:

- *High Sensitivity*: High visual quality landscape with highly valued or unique characteristics susceptible to relatively small changes.

- *Medium Sensitivity*: Medium visual quality landscape with moderately valued characteristics reasonably tolerant of changes.

- *Low Sensitivity*: Low visual quality landscape with common characteristics capable of absorbing substantial change.

Magnitude of Landscape Resource Change

Direct resource changes on the landscape character of the study area are brought about by the introduction of the proposal and its effects on the key landscape characteristics. The following categories and criteria have been used:

- *High magnitude*: Total loss or alteration to key elements of the landscape character which result in fundamental and / or permanent long-term change.
- *Medium magnitude*: Partial or noticeable loss of elements of the landscape character and / or medium-term change.
- *Low magnitude*: Minor alteration to elements of the landscape character and / or short-term/ temporary change.
- *No Change:* No change to landscape character.

Significance of Landscape Impact

The level of significance of effect on landscape is a product of landscape sensitivity and the magnitude of alteration in landscape resource. Where landscape sensitivity has been predicted as high and the magnitude of change as high or medium the resultant impact will be significant in terms of EIA Regulations. This is illustrated in Table 14.1 below.

Table 14.1 Significance of Landscape Impact

Magnitude of	Landscape Sensitivity

Landscape resource change	Low	Medium	High
No change	No change	No change	No change
Low	Slight	Slight / moderate	Moderate
Medium	Slight / moderate	Moderate	Moderate / Substantial
High	Moderate	Moderate /Substantial	Substantial

Landscape Assessment Definitions

- *Landscape Resource*: The combination of elements that contribute to landscape context, character and value.
- *Landscape Value:* The relative value or importance attached to a landscape that expresses national or local consensus because of intrinsic characteristics.
- *Landscape Character*: The distinct and homogenous pattern that occurs in the landscape reflecting geology, landform, soils, vegetation and man's impact

14.2.2 Visual Assessment Criteria and Terminology

The following text describes the key criteria and terminology used in the visual assessment.

Viewer Sensitivity

Viewer sensitivity is a combination of the sensitivity of the human receptor (i.e. resident; commuter, tourist; walker; recreationist, or worker) and viewpoint type or location (i.e. house, workplace, leisure venue, local beauty spot, scenic viewpoint, commuter route, tourist route or walkers' route). Sensitivity can be defined as follows:

- *High sensitivity:* e.g. users of an outdoor recreation feature which focuses on the landscape; valued views enjoyed by the community; tourist visitors to scenic viewpoint.
- *Medium sensitivity:* e.g. users of outdoor sport or recreation which does not offer or focus attention on landscape; tourist travellers.
- *Low sensitivity:* e.g. regular commuters, people at place of work (excluding outdoor recreation).

Magnitude of Visual Resource Change

The magnitude of alteration in visual resource or amenity results from the scale of change in the view with respect to the loss or addition of features in the view and changes in the view composition, including proportion of the view occupied by the proposed development. Distance and duration of view must be considered. Other vertical features in the landscape and the backdrop to the development will all influence the magnitude of visual resource change. This can be defined as follows:

- *High magnitude:* Where changes to the view significantly alter (negative or beneficial) the overall scene or cause some alteration to the view for a significant length of time.
- *Medium magnitude:* Where some changes occur (negative or beneficial) in the view, but not for a substantial part of the view and/or for a substantial length of time.
- *Low magnitude*: Where only a minor alteration to the view occurs (negative or beneficial) and/or not for a significant length of time.
- *No change:* No discernible deterioration or improvement in the existing view.

Significance of Visual Impact

Significance of visual impact is defined on a project by project basis. The principal criteria for determining significance are magnitude and sensitivity of the receptor. A higher level of significance is generally attached to large scale or substantial effects on sensitive receptors.

Where visual sensitivity has been predicted as high or medium, and the magnitude of change as high, the resultant impact will be significant. Where the magnitude of change has been predicted as high and the visual sensitivity has been predicted as high or medium then the resultant impact will be significant in terms of EIA Regulations.

Table 14.2 illustrates significance of visual impact as a correlation between viewer sensitivity and visual resource change magnitude.

Table 14.2 Significance of Visual Impact

Visual resource change magnitude	Visual Sensitivity		
	Low	**Medium**	**High**
No change	No change	No change	No change
Low	Slight	Slight / moderate	Moderate
Medium	Slight / moderate	Moderate	Moderate / Substantial
High	Moderate	Moderate/ Substantial	Substantial

Positive effects upon receptors may also result from a change to the view. These may be through the removal of negative features or visual detractors, or through the addition of well designed elements, which add to the visual experience in a complementary, positive and stimulating manner.

Visual Assessment Definitions

Visual Quality: Although the interpretation of viewers' experience can have preferential and subjective components, there is generally clear public agreement that the visual resources of certain landscapes have high visual quality. The visual quality of a landscape will reflect the physical state of the repair of individual features or elements.

Visual Resources: The visual resources of the landscape are the stimuli upon which actual visual experience is based. They are a combination of visual character and visual quality.

Visual Character: When a viewer experiences the visual environment, it is not observed as one aspect at a time, but rather as an integrated whole. The viewer's visual understanding of an area is based on the visual character of elements and aspects and the relationships between them.

Zone of Visual Influence (ZVI)

The ZVI is the area within which views of the site and/or the development can be obtained. The extent of the ZVI is determined primarily by the topography of the area. The ZVI is then refined by field studies to indicate where relevant forestry, woodlands, hedges or other local features obscure visibility from the main roads, local viewpoints/landmarks and/or significant settlements.

Using terrain-modelling techniques combined with the proposed development specification, a map is created to show areas from where the proposed development would theoretically be seen. A worst case scenario is taken in line with Landscape Institute guidelines.

The actual visual impacts within the ZVI have been described in later sections of this chapter. The ZVI for the proposal is illustrated in Figure 14.1.

Photographs & Photomontages

Photographs and photomontages have been prepared for selected representative viewpoints throughout the study area as indicated in Figure 14.2.

Viewpoints are chosen to give a typical representative sample of views of the proposal within the landscape using the parameters of distance and direction of view. Viewpoints frequented by members of the public such as public rights of way, car parks and popular viewpoints are usually chosen, along with views from nearby settlements.

Photographs from each viewpoint location are taken covering an arc of view matching that of the visual extent of the development.

14.3 Receiving Environment

14.3.1 Scale and Character

Bantry town is situated 55 miles west of Cork City and is located at the head of Bantry Bay which is 25 miles long. It is one of the larger towns in West Cork with a population of approximately 4000. Bantry Bay forms a sheltered harbour which is surrounded by low mountains. Within the bay there are two large islands namely Bear and Whiddy Islands with smaller islands such as Chapel Island scattered along the shore. Whiddy Island has a large petroleum terminal located on its shores and is located approximately 2km from Bantry. Mari-culture activities take place in the bay and are visible over a wide area from the shore and surrounding hills.

Bantry town functions as a market town for a wide hinterland in West Cork and is a well known tourist destination. Bantry House and Gardens is one such tourist draw and it sits just outside the town centre to the southwest and has panoramic views across the bay as far as Caha Mountains. The gardens contain seven terraces and the house is located on the third terrace.

Bantry town is centred on a main square (Wolf Tone Square) and inner harbour. The square is surrounded on three sides by built form but open on its western aspect with views across the inner harbour and towards the bay. The inner harbour area is similarly enclosed and on all sides by built development and hills with the exception of the western aspect. A series of existing jetties and piers allow access for boats to the water and vantage points for views along the shoreline and across the bay.
The landscape character of the study area can be described by use of the following distinctive landscape character areas:

Bantry Harbour Urban Landscape:

This landscape character area covers the built development of Bantry town and the inner harbour area. The inner harbour is an integral part of the town and the town has historically developed around the harbour. The town is centred on Wolf Tone Square and is surrounded on its north, east and south sides by mostly three storey development backed by rising hills. The built form of the town is predominantly painted rendered finish with the slate roofs but occasional stone buildings of historic importance are found. The stone spire of the Church of Ireland church is a notable landmark. The main square is open and wide. The streets off the main square in contrast are tight and narrow with a mixture of Georgian and Victorian buildings. The topography rises to the north, east and south of the town centre where residential development is prominent and from where elevated views across the harbour towards the bay are available. The inner harbour has busy car parks and roadside car parking both located adjacent that overlook the harbour with cars parked between the water's edge and adjacent buildings generally detracting from the quality of the townscape. Footpaths and stone walls surround the inner harbour leading to two stone piers on the north and south side of the harbour. Small boats are a feature of the harbour area. Much of the town centre (including Wolf Tone Square) is included within an Architectural Conservation Area designation in the Cork County Development Plan 2009. The N71 passes through the town centre and extends along the south side of the inner harbour.

The Bantry Harbour Urban Landscape Character Area has a medium sensitivity to change.

Bantry Bay Rounded Hills and Farmland

Beyond the built development of Bantry town and harbour to the north at Reerour and Newtown and to the southwest at Abbey and Seafield the landscape consists of coastline with prominent rounded hills that are covered by a combination of farmland and woodland. The woodland is predominantly located on the steeper slopes facing the bay. The farmland consists of pasture fields with tall tree lined hedgerows at the boundaries. The N71 is located within this landscape and follows the shoreline from Bantry Harbour to Abbey where it turns south and inland. There are few roads on the hills and public access is limited to lower lying ground between the hills. Housing is also infrequent and limited to the lower lying roadsides. Bantry House is a notable exception and is located on the steep side of a hill at Seafield with a northwest aspect. There is a large graveyard at Abbey that is a prominent feature on a rising hillside overlooking the bay. This landscape is important as it provides the backdrop for the harbour and bay creating a distinctive setting for Bantry.

Bantry Bay Rounded Hills and Farmland has a high landscape sensitivity to change.

14.3.2 Planning Designations

Cork County Development Plan 2009 – 2015

A review has taken place of the Cork County Development Plan 2009-2015 and related documents to establish if there are any relevant landscape designations that may influence the assessment within the study area.

Scenic Landscapes: The Plan states that Scenic Landscapes within the County are based on designations established by the previous development plans (e.g. 2003) and that they are currently under review. The Plan sets out in Volume 3 Map 13 designated Scenic Landscapes within the study area. The nearest designated landscape to the proposed site is located on the hills and shoreline immediately north and southwest of Bantry town.

Scenic Routes: The Plan sets out in Volume 3 Map 13 a number of Scenic Routes. The nearest route designated to the proposed site is; Plan ref S108 N71 that extends southwest from Bantry town at it's nearest immediately adjacent to the proposed site.

Landscape Character: the Plan has established a set of 76 landscape characters reflecting the complexity and diversity of the County (see Volume 2 of Development Plan). The character areas have been amalgamated into a set of 16 generic landscape types based on similarities evident in the various areas. The proposed site is located within the Landscape Character Type (LCT) 4 Rugged Ridge Peninsulas. The Type 4 LCT is extensive and covers most of West Cork and the Landscape Value and Sensitivity are stated as Very High. This LCT is also stated as of National Importance.

Bantry Local Area Plan 2011

A review has taken place of the Bantry Local Area Plan and related documents to establish if there are any relevant landscape designations that may influence the assessment within the study area.

The Bantry Local Area Plan has the same landscape designations as the Cork County Development Plan as described above.

14.4 Project Description

The proposed development is described in detail elsewhere in this EIS (see Project Description – Chapter 4). As such only a brief description is included within this report. .

The inner harbour area will be transformed into a marina and the pontoons will have the capacity for approximately 230 marina berths and the proposed layout of the marina is presented in Chapter 4.

For the purpose of the landscape and visual impact assessment the project has been assessed in its entirety rather than individual components as a worst case scenario. Where necessary the impact of individual components has been described.

14.5 Landscape and Visual Impacts

14.5.1 Landscape Character Area Impacts

As identified in the baseline assessment above the study area incorporates two landscape character areas:

- Bantry Harbour Urban Landscape; and
- Bantry Bay Rounded Hills and Farmland.

The landscape impacts of the proposed development is summarised in the following text.

Bantry Harbour Urban Landscape

The development proposed is located at three separate parts of Bantry Harbour and Bay. The proposed developments at Abbey and Cove/Beicin strand are not located within this landscape character area. The proposed marina and associated developments is located within this landscape character and will result in the introduction of a new breakwater, pier and wall improvements and leisure craft at new pontoon moorings within the inner harbour area. Such developments are not uncharacteristic of the inner harbour area. The creation of a marina will add liveliness to the harbour, creating activity and visual interest to the waterside as part of the regeneration of the inner harbour area. The influence of the new marina and associated improvements is very limited due to the enclosed nature of the urban landscape and the majority of the urban landscape will not be influenced by the development due to the low-lying nature of the proposals and intervening built development. The development will have a positive impact on the existing built form around the harbour through improvement and regeneration. Sympathetic materials are proposed to be used.

The landscape at this location is identified with a medium sensitivity to change. The predicted magnitude of change in landscape resource is low and the significance of the landscape impact is assessed as slight/moderate positive.

Bantry Bay Rounded Hills and Farmland

The proposed development is located within this landscape character at Abbey and Cove/Beicin Strand. Overall the proposed development will be an insignificant development within the wider Bantry Bay Rounded Hills and Farmland landscape due to the limited scale of these developments, their low-lying shoreline locations and the backdrop of hills and trees found at the proposed sites. The Abbey development is located beside an existing access road and jetty and although larger in scale to the existing facilities at this location the proposals are similar in character and will extend this existing use along the tree-lined shoreline. The backdrop of hills and shape of the coastline at Abbey assist the new development to blend well with its surroundings and the influence of the proposals are essentially directed towards the open water with reduced influence along the shoreline. The proposed beach renourishment at Cove/Beicin Strand will be a non-intrusive intervention that will have limited landscape impact on this part of the shoreline.

The Bantry Bay Rounded Hills and Farmland landscape is identified as high quality with a high sensitivity to change. Due to the limited influence over this landscape the proposal is predicted to have a magnitude of change in the landscape resource of low and therefore the predicted significance of landscape impact for this landscape character area is moderate negative.

14.5.2 Planning Policy Designation Impacts

Impacts on relevant designations contained within the Cork County Development Plan and Bantry Local Area Plan 2011– as referred to above in Section 14.3.2 – are assessed below.

<u>Cork County Development Plan 2009 – 2015</u>

Scenic Landscapes: The nearest designated landscapes to the proposed site are located on the hills and shoreline immediately north and west of Bantry town. The proposed beach renourishment works at Cove/Beicin Strand are located within a Scenic Landscape immediately north of Bantry town. The beach renourishment works will be non-intrusive and temporary in nature and will not therefore cause a significant landscape impact on the Scenic Landscape designation. The proposed development at Abbey is well located on a sheltered part of the coastline and with a good backdrop of woodland that prevents the influence of the development on the Scenic Landscape inland and further along the shoreline. While this section of the shore will change in character such boat activities are familiar along this shoreline and a jetty an access road already exist just north of the N71 at Abbey. Such factors will combine to reduce the potential impact on the Scenic Landscape at Abbey. Within the western part of the southern shore of the inner harbour the proposed development is located adjacent to a Scenic Landscape. The proposals are generally consistent with the harbour character at this location and will see the improvement of existing piers and walls. Overall the proposed developments will have a low impact on the designated Scenic Landscapes. The predicted significance of landscape impact is slight negative.

Scenic Routes: The nearest Scenic Route designated to the proposed site is; Plan ref S108 N71 that extends southwest from Bantry town at it's nearest immediately adjacent to the proposed site at the inner harbour and Abbey. All of the views from the Scenic Route will be maintained. Views of the Abbey reclamation area are very limited from the N71 due to intervening topography and trees and distance of views. It is not possible to view the beach renourishment at Cove/Beicin Strand from the N71 due to intervening topography. The inner harbour development will be directly visible from the N71. There will be no significant loss of view from the N71. While directly located within views from the N71 the new development visually blends with the existing inner harbour features. Although there will be increased levels of activity within the inner harbour such boating activities are not uncharacteristic of the harbour. The proposals will create a new focal point for views from the N71 without detracting from the quality of the view. Overall the proposed developments will have a low impact on the designated Scenic Route. The predicted significance of visual impact is slight negative.

Overall no significant visual impacts are predicted for Scenic Landscape and Scenic Routes designated in the Cork County Development Plan.

14.5.3 Zone of Visual Influence (ZVI)

The ZVI for the proposed development is illustrated in Figure 14.1. The ZVI has been used to identify the locations where potential visual impacts may occur. As viewer distance from the proposed site and existing harbour facility increases, the level of visibility decreases significantly. This is contributed to by the low lying nature of the coastal landscape within the study area and the nature of the undulating shoreline topography. As referred to previously, the nature of the development, the context of the site within a hilly backdrop and the relatively refined size and extent of the area will all combine to further negate potential views within the mapped ZVI.

The ZVI represents a worst case. In reality, views of the site will be entirely obscured from a number of locations within this area such as from within the Bantry urban area and undulating shoreline. At most locations within Bantry town, the enclosed nature of the existing streetscape will render views to the site either impossible or - where available – insignificant. It is really only from Wolf Tone Square and the roads north and south of the harbour (N71), that direct views of the proposal are available from the town.

Broadly the ZVI map indicates that the proposals are potentially visible across the bay as far as Whiddy Island, Chapel Island and Reenbeg Point at distances of 1-2km west and north from sites of the proposed developments. To the east, southwest and south the distinctive hills that extend along the shoreline restrict visibility in these directions to close proximity to the shoreline. In reality, as will be illustrated below, the visibility of the proposals at such long distances is very limited. Public access points are also limited to the inaccessibility of the steep hills and escarpments along the coast further limiting potential visual impact.

The following text describes the actual predicted visual impacts on visual receptors within the ZVI.

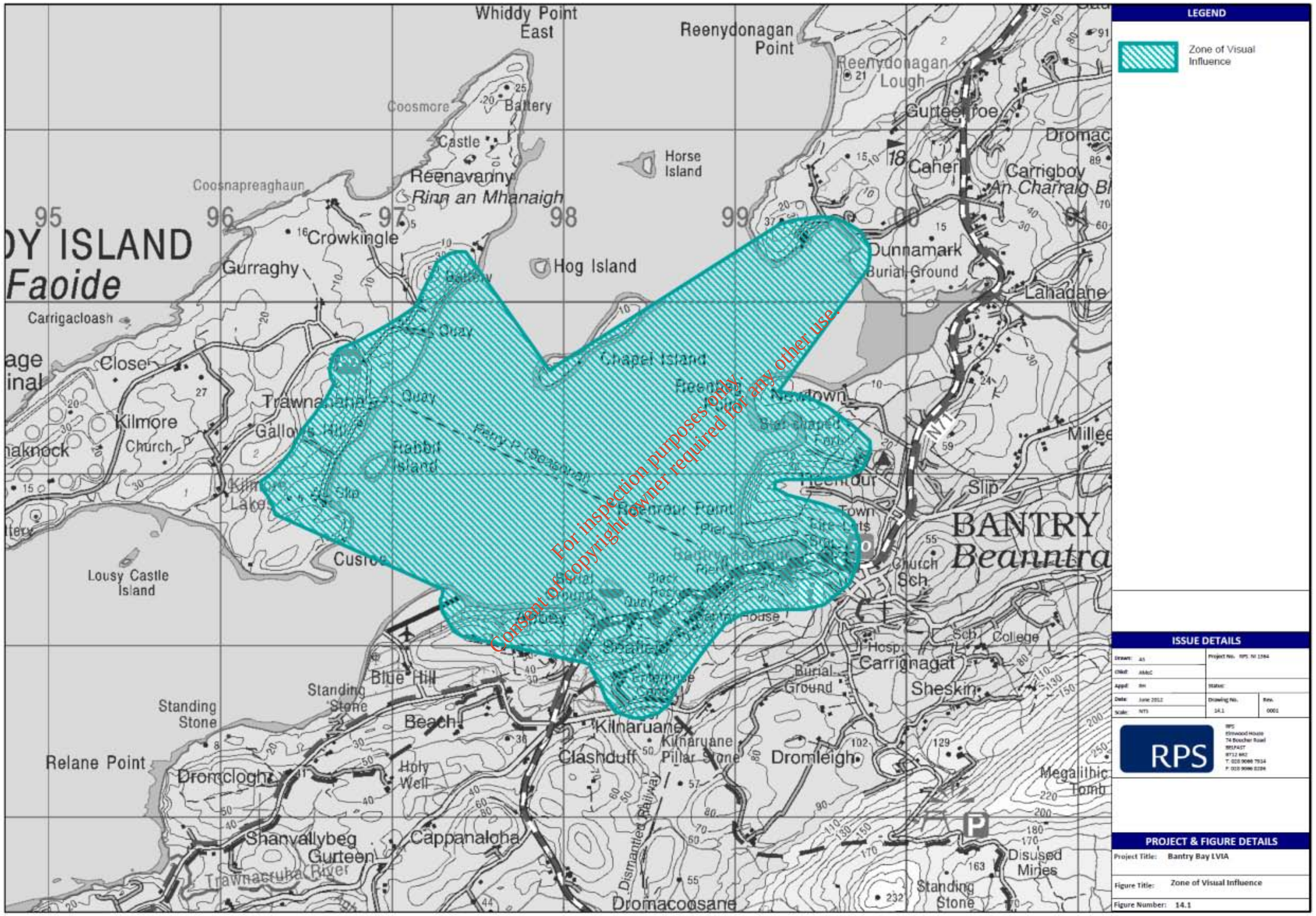

Figure 14.1 Zone of Visual Influence

14.5.1 Visual Impacts on Residential Properties

An assessment has occurred within the ZVI to determine the magnitude of visual impact of the proposed development on potential views from sensitive visual receptors including residential properties.

The majority of residential properties within the study area are located within the development limit of Bantry town. Because of the tight and dense built up nature of the townscape and low lying location of the proposals, views within Bantry town will be severely restricted. Dwellings beyond the harbour area are often grouped together in terraces – such as Marina Terrace and Marino Heights located north of Wolf Tone Square (see Viewpoint 2) – and where the topography and townscape allows elevated views towards the proposals the existing harbour facilities are an existing component of such views and combined with the distance of these views will restrict the significance of any visual impact associated with the proposal.

A series of properties are located on the north and south side of the inner harbour that include some residential buildings, bed and breakfast accommodation and the Maritime Hotel. Currently such properties look directly across the existing road network, car parks and inner harbour area. The proposal will not prevent similar views on completion. The proposal will in part enhance existing views and provide a new focal point of interest within the harbour particularly complementary to the view for visitors to the hotel and bed and breakfast accommodation. Overall the proposed marina infrastructure associated mooring boats, pier improvements, amenity areas and breakwater will not significantly impact on views from residential properties and at some locations there will be a slight improvement in views.

No residential properties within the ZVI will have been predicted as having significant visual impacts.

14.5.2 Viewpoint Assessment

A series of representative viewpoints have been selected from locations throughout the study area and subjected to specific assessment below. The location of all viewpoints can be found on Figure 14.2 while photomontages for Viewpoints 1-4 are provided in Appendix 6.

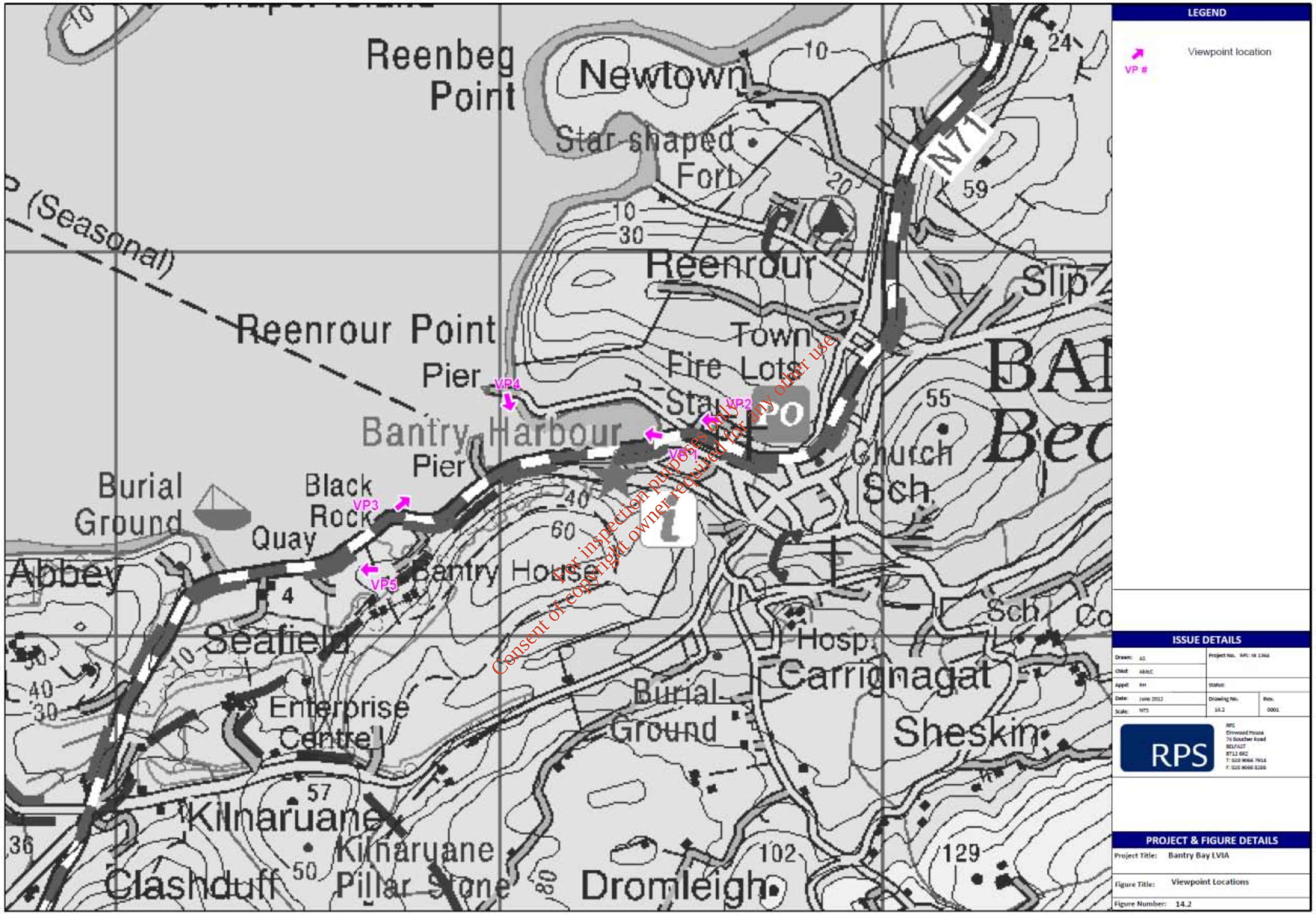

Figure 14.2 Viewpoint Locations

Viewpoint 1 – Wolf Tone Square looking west

Type and Sensitivity of receptor: This view is available from the N71 a Scenic Route designated in the Cork Development Plan and is predominantly available to the local community, tourists and day-trippers. The viewer sensitivity is medium.

Existing view: The view is enclosed by both topography and buildings to the left and right creating a vista that is directed towards Bantry Bay with the Caha Mountains visible in the distance. Whiddy Island is also partly visible to the rear of the existing pier. Parked cars at the roadside and in dedicated car parks detract from the view. The existing stone revetment on the north side of the inner harbour is visible.

Predicted view: The proposal will be located in the centre of this view for a direct view. The proposed pontoons and associated features with boats will be visible in the foreground. The new stone revetment on the northern side of the inner harbour will also be visible. The revetment, improved southern pier and breakwater will prevent views of Whiddy Island but the Caha Mountains will remain visible. Due to their proximity the proposals will occupy a high proportion of the view.

Magnitude of visual resource change: There will be a medium change in the visual resource.

Significance of visual impact: The predicted significance of visual impact is moderate.

Viewpoint 2 – Marino Heights looking west

Type and Sensitivity of receptor: This view is available to local residents at Marino Heights and adjacent Marina Terrace. The viewer sensitivity is medium.

Existing view: This view is available from a residential area on the north side of Wolf Tone Square. The view is elevated across the square and inner harbour area towards hills to the southwest and Bantry Bay. The Abbey area is visible in the centre left of the view. Whiddy Island is partly visible in the centre right of the view. Distant hills and mountains are visible beyond Whiddy Island.

Predicted view: The proposal will be in part visible from this viewpoint. The marina will be located in the inner harbour area in the centre of the view. The improved southern pier will be visible and a small section of the breakwater. The proposals are noticeable but not prominent. The boats visibly add interest to the view. Overall there is no loss of view with Abbey, Whiddy Island and distance mountains and hills still visible. Although located in this view direction, the proposed development at Abbey is not visible due to the distance of the view and the limited portion of the reclaimed land located within the view.

Magnitude of visual resource change: There will be a low change in the visual resource.

Significance of visual impact: The predicted significance of visual impact is slight/moderate

Viewpoint 3 – N71 at Bantry House looking northeast

Type and Sensitivity of receptor: This view is available from the N71 a Scenic Route designated in the Cork Development Plan at Bantry House and is predominantly available to the local community, tourists and day-trippers. The viewer sensitivity is high.

Existing view: The view is enclosed by topography and trees. Traffic on the N71 is apparent. The existing southern pier is visible in the centre of the view. Concrete coastal protection works are visible on the northern shoreline at the bottom of a steep escarpment. Properties in Bantry town are well screened with just the upper floors of some three storey buildings partly visible.

Predicted view: The proposal will be located in the centre of this view for a direct view. The proposed improved southern pier will be visible in a similar location to the existing pier with little change in visual resource. The breakwater and open piled quay structure on the northern side of the harbour will also be visible extending into the bay and partly obscuring a section of the shoreline. The marina development will not be visible. Although located within this view direction it will not be possible to view the beach renourishment at Cove/Beicin Strand. Overall the proposals will occupy a small proportion of the view.

Magnitude of visual resource change: There will be a low change in the visual resource.

Significance of visual impact: The predicted significance of visual impact is moderate.

Viewpoint 4 – Existing northern pier looking southeast

Type and Sensitivity of receptor: This view is available from the northern side of the inner harbour and is predominantly available to the local community, tourists and day-trippers. The viewer sensitivity is medium.

Existing view: The view is completely enclosed by both topography and buildings. The town centre is the main focal point including the stone spire at the Church of Ireland church on the main square. The existing stone revetment on the north side of the inner harbour is visible to the left of the view. To the right of the view the Maritime Hotel and a petrol station are prominent.

Predicted view: The proposal will be located in the centre of this view for a direct view. Due to their proximity the proposals will occupy a high proportion of the view. The proposed improvement to the revetment on the northern side of the inner harbour is clearly visible as are the pontoons and boats. The proposals appear to compliment their setting and overall do not detract from the view. Views to the town centre and surrounding buildings are maintained.

Magnitude of visual resource change: There will be a medium change in the visual resource.

Significance of visual impact: The predicted significance of visual impact is moderate.

Viewpoint 5 –Bantry House looking south to Abbey

Type and Sensitivity of receptor: This view is available from the gardens at Bantry House and is predominantly available to the local community, tourists and day-trippers. The viewer sensitivity is high.

Existing view: The view is available from the grounds of Bantry House and is elevated in nature allowing views over the N71 (that is not visible) towards Bantry Bay and Abbey. The graveyard at Abbey is visible along with the existing access road, revetment and jetty at the shoreline.

Predicted view: The proposed reclamation area at Abbey will be located in the centre of this view for a direct view. However due to intervening topography and the existing jetty the proposals are effectively screened with no apparent change in visual resource. The proposals will read as part of the existing jetty and revetment.

Magnitude of visual resource change: There will be no change in the visual resource.

Significance of visual impact: The predicted significance of visual impact is no change.

14.6 Construction Phase Impacts

During the construction phase potential impacts include:

(i) Site preparation/enabling works and operations;

(ii) Site infrastructure and access;

(iii) Vehicular and plant movements including dredging; and

(iv) Dust emissions

The construction phase is likely to be limited to 24 months and therefore visual impacts during the construction phase will be of a temporary nature. Works will be visible from within the ZVI during this location to a varied extent that will be related to the individual construction activity at any given time.

Due to distance and the broad scale of the landscape in Bantry Bay within which the works are located the change in landscape and visual resource will be low therefore the significance of landscape and visual impacts during the construction stage will be slight. There are limited residential dwellings in close proximity to the construction works at the inner harbour area where construction works are a common feature of the town centre and due to the temporary nature of the impacts no significant visual impacts are predicted at the construction stage as a result.

14.7 Mitigation measures

The design evolution of the proposed project has undertaken to enable incorporation of the following mitigation measures;
i) sensitive use of local materials for constructed elements;
ii) careful integration of constructed elements with existing elements such as existing jettys and revetments;
iii) general site housekeeping designed to minimise visual impact during construction stage.

Good site design, use of an environmental management plan during the construction phase and incorporation of mitigation measures identified above will effectively mitigate the impact of ancillary works.

14.8 Conclusions

The proposed development is located to the at the inner harbour area at Bantry Bay, Abbey and Cove/Beicin Strand. In landscape character terms the wider study area has been classified as:

- Bantry Harbour Urban Landscape; and
- Bantry Bay Rounded Hills and Farmland.

The proposal is located within both of these landscape character areas and because of the context within which the proposed revetment, breakwater and marina will be located at the inner harbour and its low lying nature, there will be no significant landscape impacts on the Bantry Harbour Urban Landscape. The proposed Abbey reclamation area and Cove/Beicin Strand beach renourishment have limited influence over the wider Bantry Bay Rounded Hills and Farmland Landscape due to their low-lying nature and limited scale and no significant landscape impacts are predicted for this landscape character area.

The theoretical ZVI has been established for the proposed development. The extent of the visibility of the proposal is limited by the hills and built development that provides the setting for the proposals. A series of five viewpoints have been assessed to give an accurate reflection of views to the sites from throughout the study area. No significant impacts are predicted for any viewpoints.

Bantry House and Gardens is an important tourist attraction in Bantry. Site survey and assessment has established that due to very restricted views and the low-lying nature of the proposals no significant visual impacts will occur for views from the house and gardens.

Existing clusters of housing within Bantry town constitute the nearest residential properties to the proposed development. The low lying nature of the proposal, intervening urban features, separation distances combine to ensure there are no residential dwellings within the ZVI predicted as being significantly impacted.

The current Cork County Development Plan and Bantry Local Area Plan have been examined. The proposal will have no significant impact on any relevant landscape designations.

Overall, therefore, when the landscape and visual impacts are considered the proposal is acceptable and the surrounding landscape and its visual resources have the ability to accommodate the changes of the type associated with this development.

15.0 COASTAL PROCESSES

15.1 Overview

The objective of this chapter of the Environmental Impact Statement (EIS) is to describe the existing coastal processes in the Bantry area and to assess the impact of the proposed development on these processes. The Bantry Inner Harbour Development Scheme aims to provide a sheltered harbour environment and marina with increased water depth and improved pier facilities to promote fishing and tourism activities in the Bantry area. There are four main components to this scheme which have been assessed in terms of their impact on coastal processes. They are as follows:

- Construction of Breakwaters
- Dredging of Inner and Outer Harbour
- Beach Renourishment at Cove
- Abbey Land Reclamation

The study has been undertaken using the MIKE 21 suite of coastal process modelling software developed at the Danish Hydraulic Institute (DHI). In addition, computational modelling was used to assist with the impact assessment of dredging of contaminated material on local aquaculture sites.

In all the above scenarios it is important to set out the current hydraulic conditions in and around the site before any impact assessment can be carried out. The same hydraulic conditions apply to all of the above and are described in section 15.2 of this chapter.

15.2 Existing Hydraulic Regime

15.2.1 Existing Information on Tide and Extreme Water Levels

Bantry is subject to semi-diurnal tides, meaning that there are generally two high waters and two low waters each day. The UK Admiralty tide tables give the tidal water levels at Bantry Harbour as shown in Table 15.1. The Mean Spring tidal range and Mean Neap tidal range are 2.9 metres and 1.5 metres respectively.

Table 15.1: Tidal Water Levels at Bantry Harbour

Tide	Water Level (m) Chart Datum	Water Level (m) MSL
MHWS	3.40	1.50
MHWN	2.60	0.70
MLWN	1.10	-0.80
MLWS	0.50	-1.40
MSL	1.90	-

A detailed study of extreme water levels along the south coast of Ireland from Carnsore Point to Bantry Bay has been undertaken by RPS on behalf of the Office of Public Works as part of the Irish Coastal Protection Strategy Study. The extreme water levels due to combinations of storm surges and tidal levels at a point near Bantry are predicted to be as shown in Table

15.2. The levels have an uncertainty value of +/- 150mm. The prediction point to which the levels refer is point S_6 as shown in Figure 15.1.

Table 15.2: Extreme Total Water Levels in Bantry Bay

Annual Exceedence Probability (AEP)	Water Level (m) OD Malin	Water Level (m) MSL
50%	2.14	2.34
20%	2.25	2.46
10%	2.33	2.54
5%	2.42	2.62
2%	2.52	2.73
1%	2.6	2.8
0.50%	2.68	2.88
0.10%	2.86	3.07

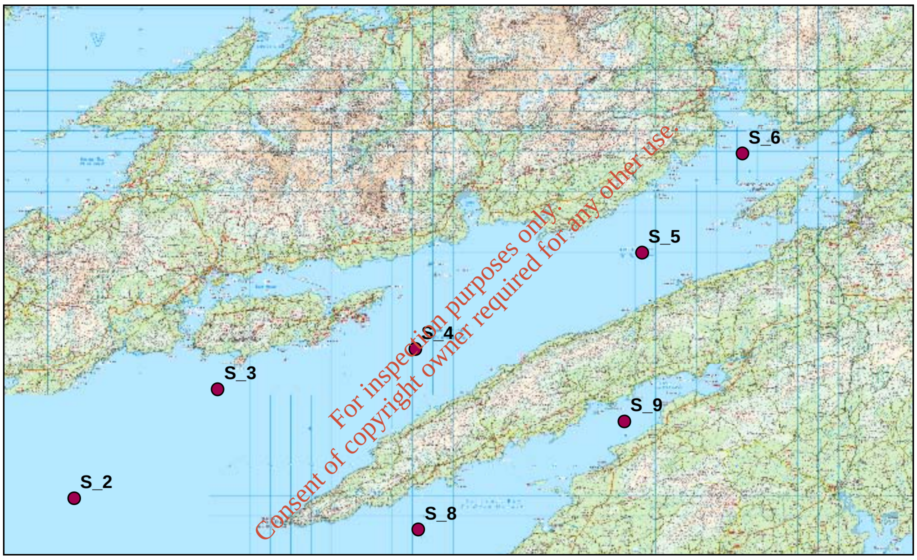

Figure 15.1: Location of ICPSS Prediction Points – Bantry S_6

Sea level rise due to global warming is currently expected to be 0.5m by 2100. There is some uncertainty about the actual figure but the upper bound value is currently assessed as being 1.0m. Thus at least 0.5m should be added to the extreme levels noted in Table 15.2 for the predicted water levels by 2100.

15.2.2 Tidal Flow Modelling

In order to gain a full insight into the hydrodynamics of the site, tidal flow modelling was undertaken for this study using the nested Mike21 HD model which is part of the Mike21 suite of coastal process software developed by the Danish Hydraulics Institute.

15.2.2.1 Model Construction

The model bathymetry was taken from digital chart data provided by C-Map of Norway. The area covered by the nested tidal model is shown in Figure 15.2. The outer area was covered by a 30m grid while the area around Bantry Harbour was modelled at a very fine resolution grid of 10m.

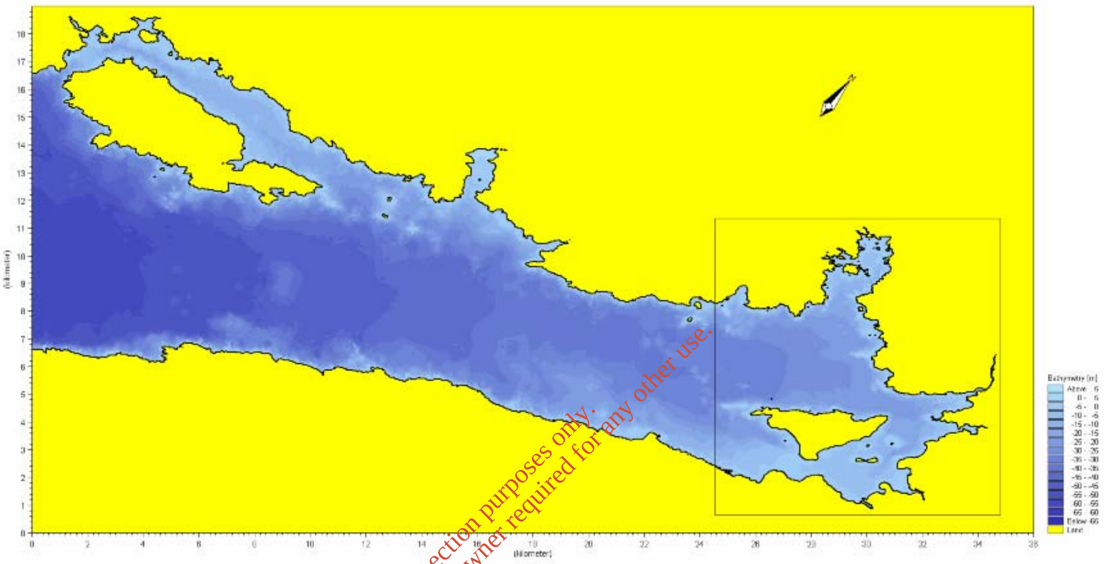

Figure 15.2: Nested 30m-10m Tidal Model Bathymetry of Bantry Bay

The boundary for the tidal model was taken from RPS storm surge tidal model of the North Atlantic and Irish waters.

15.2.2.2 Tidal Model Simulations

Tidal currents in the area are very low and are in the region of 0.0 – 0.2 m/s, with very little difference between neap and spring conditions, thus flow patterns are typically dominated by meteorological and wave induced conditions, incurring significant eddying. The model was run for a complete typical month of tides. Figure 15.3 and Figure 15.4 show the mean spring tidal flood and ebb flows for the area around Bantry Harbour and Whiddy Island. It will be seen from the diagrams that the tidal flow velocities around the entrance area of Bantry Harbour are very low.

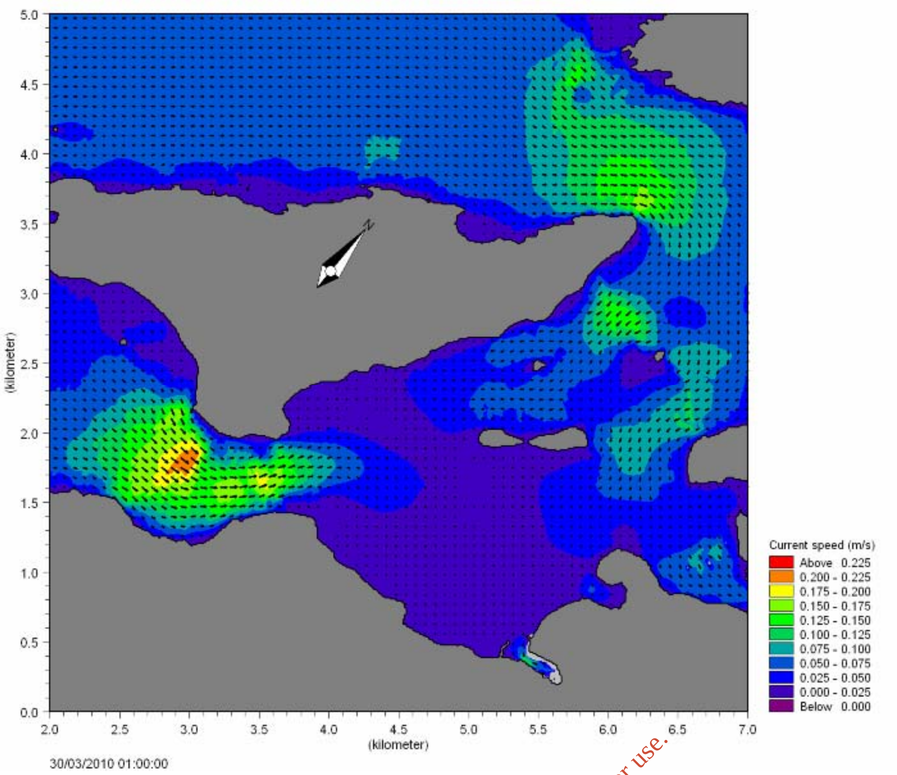

Figure 15.3: Typical flood tide flow patterns around Bantry and Whiddy Island

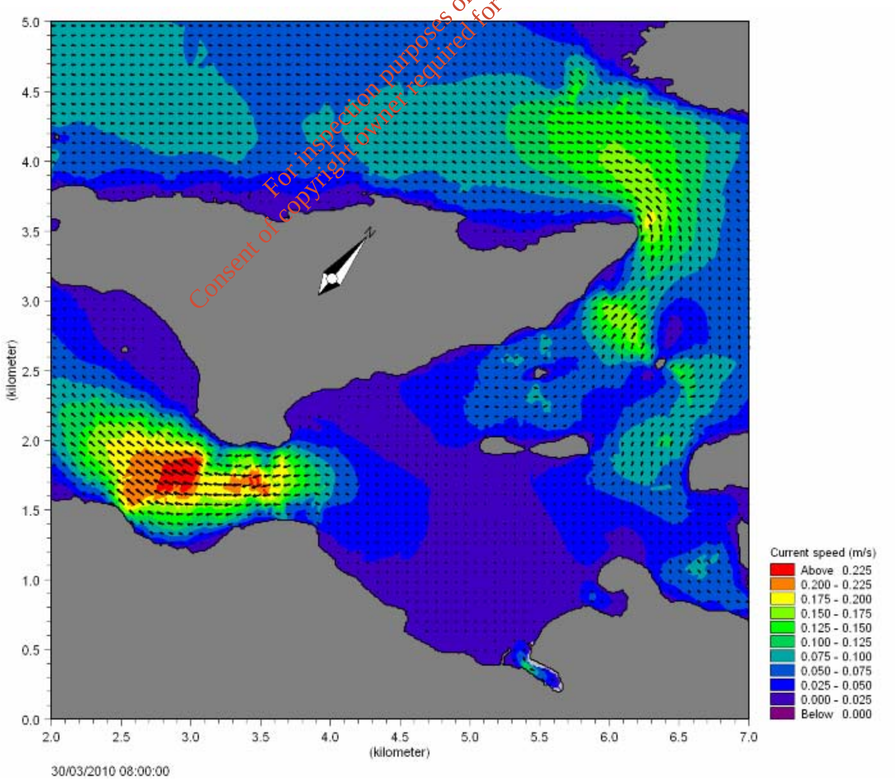

Figure 15.4: Typical ebb tide flow patterns around Bantry and Whiddy Island

15.2.3 Wind Data and Wave Modelling

<u>15.2.3.1</u> <u>Wind Data</u>

The wind data for the study was derived using information from two sources, one was 12 years of 3 hourly data derived from the European Centre for Medium Term Weather Forecast (ECMWF) for the point 51.5°, -10° and the other was from Met Eireann's map of extreme wind speeds over Ireland (development for use with the wind code CP3).

Figure 15.5 shows the wind roses for the area taken from the ECMWF data. The rose for all wind data is shown on the left while the rose for strong winds (gale and above) is shown on the right. It will be seen that the majority of strong winds come from the west and south west sectors.

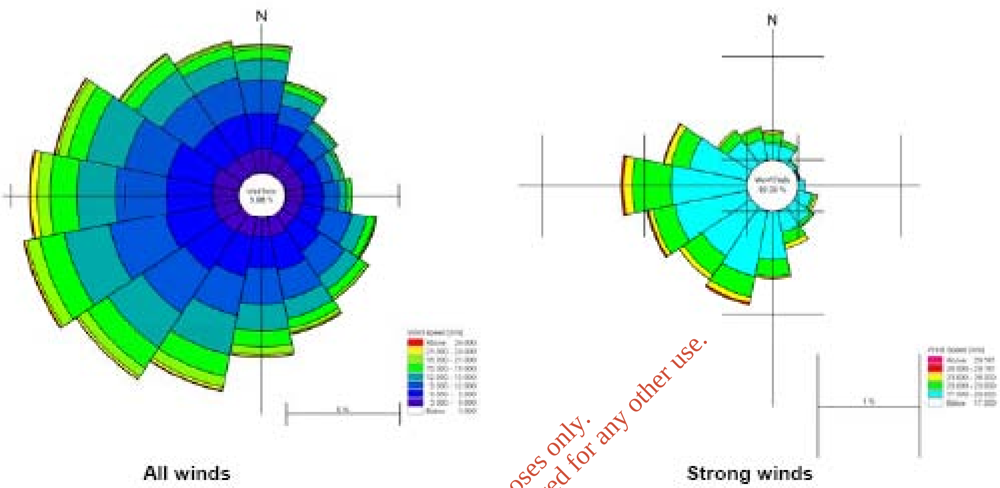

Figure 15.5: Wind Roses of the Bantry Bay Area

The analysis of the wind data sources indicated that the mean hourly wind speed during a typical gale from the south west, west and northwest sectors would be 27m/s, 27m/s and 25.3m/s respectively.

<u>15.2.3.2</u> <u>Wave Climate</u>

The analysis of the wave climate at Bantry Bay was undertaken by running wave model simulations for the penetration of Atlantic storm waves into Bantry Bay, the generation of storm waves within Bantry Bay itself and the generation of waves across the fetches from Whiddy Island.

An extreme valuation of the offshore wave climate indicates that wave heights of about 15 metres with peak wave periods of about 18 seconds will occur offshore of Bantry Bay during a 1 in 50 year return period event. These storm waves were transformed into Bantry Bay using the Mike21 NSW wave model. Figure 15.6 shows the significant wave heights and mean wave directions of 1 in 50 year event storm waves as they run into Bantry Bay from WSW. Figure 15.7 and Figure 15.8 show the way these long period storm waves are refracted onto the shore lines around the outer Bay and thus do not penetrate to any significant degree into the inner Bay behind Whiddy Island.

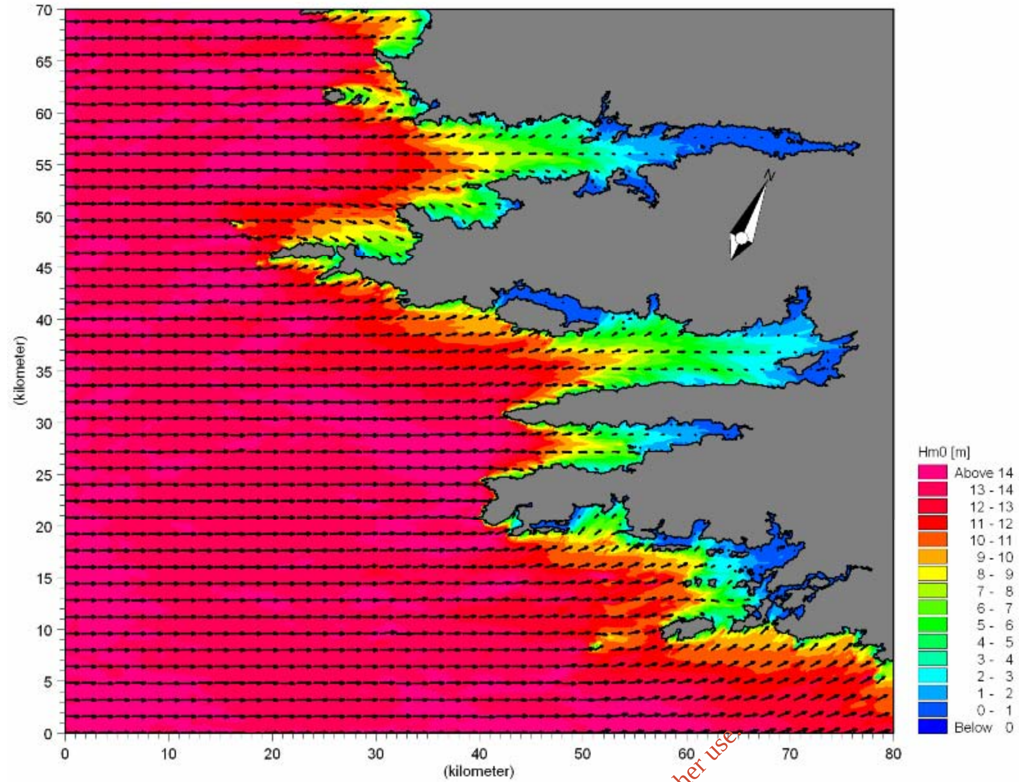

Figure 15.6: Significant Wave Height and Mean Wave Direction in Offshore Area 1 in 50 year return period event from 245°N

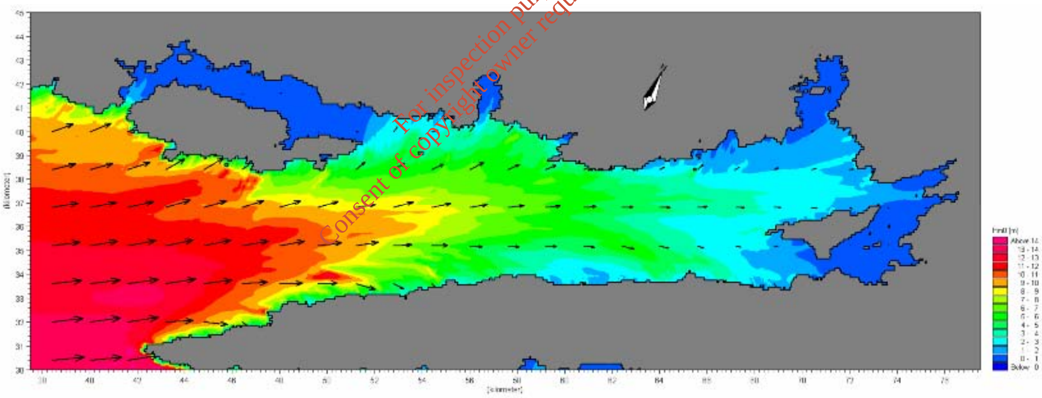

Figure 15.7: Significant Wave Height and Mean Wave Direction in Bantry Bay 1 in 50 year return period event from 245°N

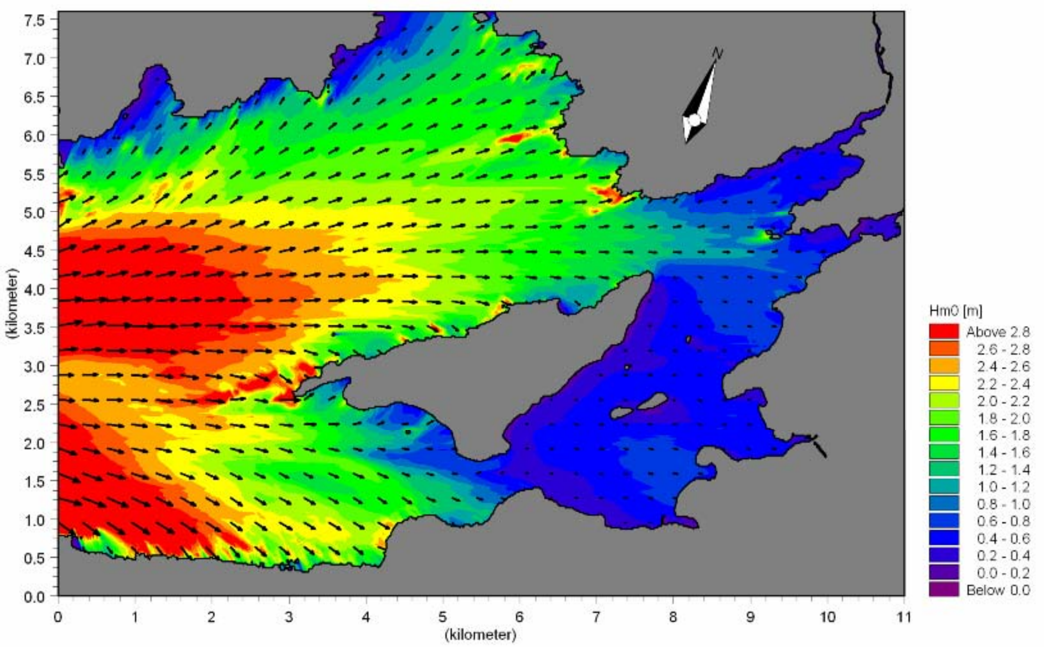

Figure 15.8: Signficant Wave Height and Mean Wave Direction in Inner Bantry Bay 1 in 50 year return period event from 245°N

Storm waves can also be generated by the action of strong winds across Bantry Bay itself. In this case the wave period will be shorter that the period of the Atlantic storm swells with periods of about 6 seconds. Figure 15.9 shows the transformation of these shorter period waves as they run in towards Whiddy Island and Bantry Harbour.

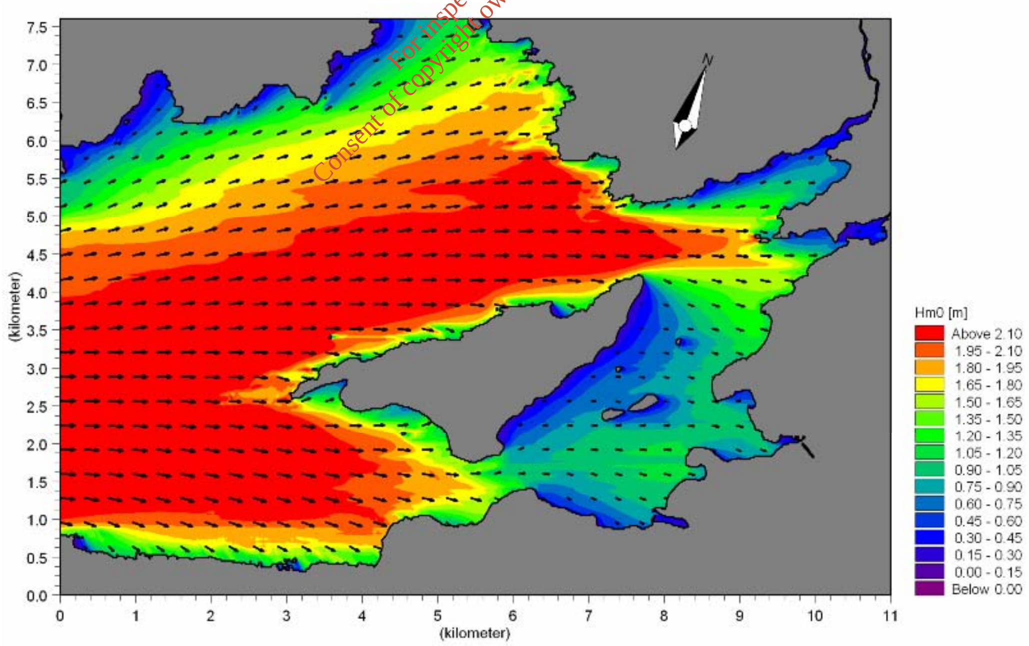

Figure 15.9: Significant Wave Height and Mean Wave Direction in Inner Bantry Bay 1 in 50 year return period event from 260°N within Bantry Bay

It will be seen from Figure 15.9 that there is not much penetration of wave energy through the sound to the south of Whiddy Island and that most of the wave energy arriving at Bantry

Harbour comes from the wave generation across the local fetch between Bantry Harbour and Whiddy Island.

Figure 15.10 shows the generation of waves across the local fetch from Whiddy Island during a 1 in 50 year storm from 280°N. The waves arriving at the entrance to Bantry during such an event will have spectral significant wave heights in excess of 1 metre with peak spectral wave periods of about 3 seconds. During 1 in 100 year events the significant wave heights approaching the harbour will be about 1.2 m while they will be about 0.75 m in height during a 1 in 1 year return period event.

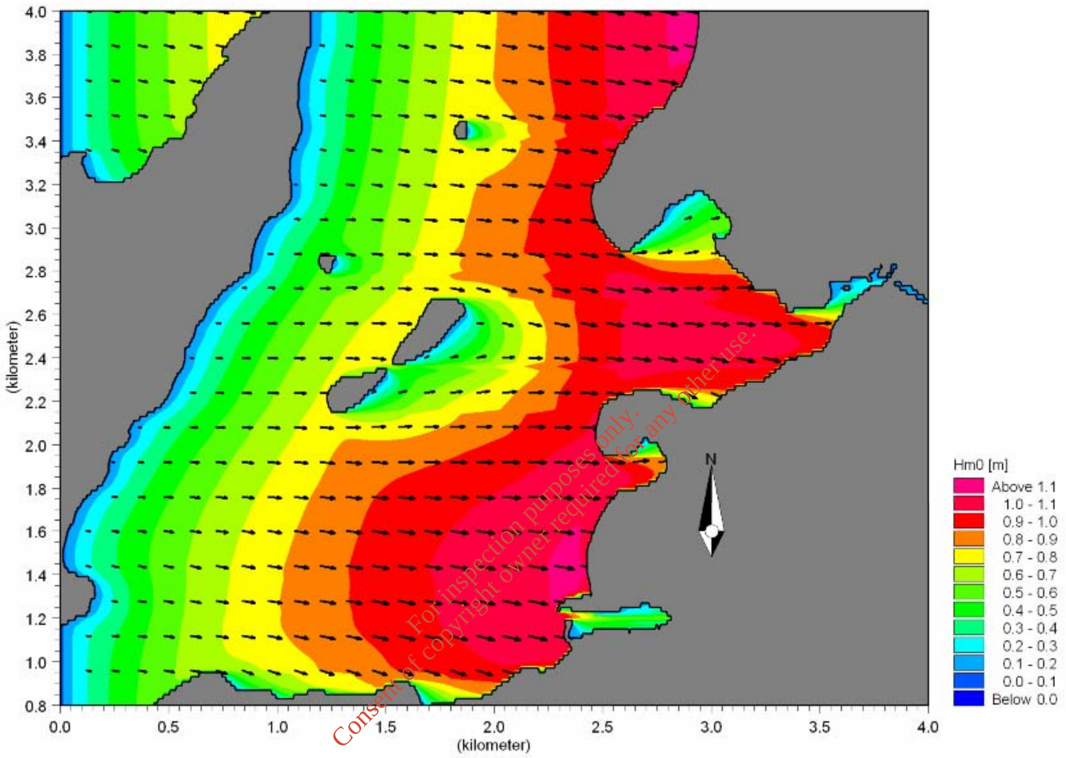

Figure 15.10: Significant Wave Height and Mean Wave Direction approaching Bantry Harbour for 1 in 50 year return period event from 280°N

As swell waves are predominantly blocked in the Bantry area by the presence of Whiddy Island, it is the locally generated wind waves that are of interest in this study. The length of fetch over which the waves are generated determines the time period for which winds must blow to fully develop the waves. For the waves generated across the relatively short fetches across Bantry Bay, a 45-50 minute wind speed was found to be required for maximum wave generation.

15.3 Harbour Layout Modelling

A key consideration in the development of the proposed scheme is to ensure that the enclosed harbour basin is adequately protected from prevailing weather and sea conditions. Computational modelling was used to assess the effectiveness of proposed breakwaters at the Harbour entrance.

15.3.1 Modelling Software and Breakwater Design

Harbour disturbance modelling was undertaken using the Mike21 Boussinesq model. The Boussinesq Wave model (MIKE 21 BW), is the state-of-the-art numerical model for calculation and analysis of short and long period waves in ports, harbours and coastal areas. As a 1 in 50 year storm is normally the design standard for harbours with pontoon berths, the simulations were undertaken using these conditions, i.e. incoming wave heights of 1.08m significant height.

The initial bathymetry for the harbour disturbance modelling is shown in Figure 15.11. The Boussinesq wave model can take account of the wave reflections from various different harbour structures. For this study the vertical walls were assumed to be largely reflective while the rock armour slopes were given a 50% reflective value. Combination of vertical and rubble sloped walls were assigned values of about 60% wave reflections.

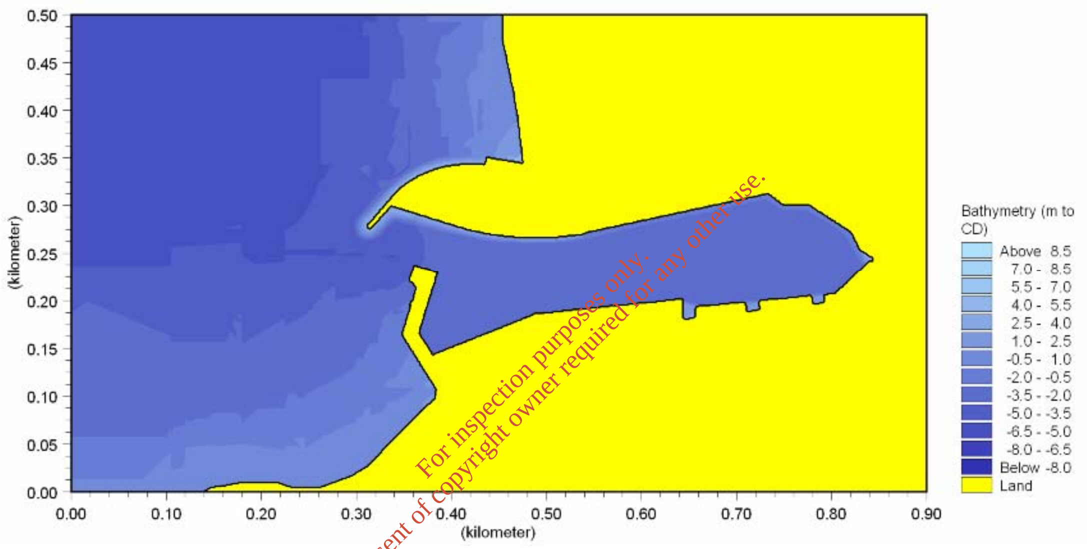

Figure 15.11: Proposed Harbour revised layout for disturbance tests

15.3.2 Harbour Disturbance Simulations

The harbour disturbance simulations were undertaken using a directional wave spectra input with a significant wave height of 1.08 metres. The surface elevation at the boundary of the model is shown in Figure 15.12. It will be seen that the model uses a random sea state to give a realistic combination of waves in a similar manner to the naturally generated wind sea.

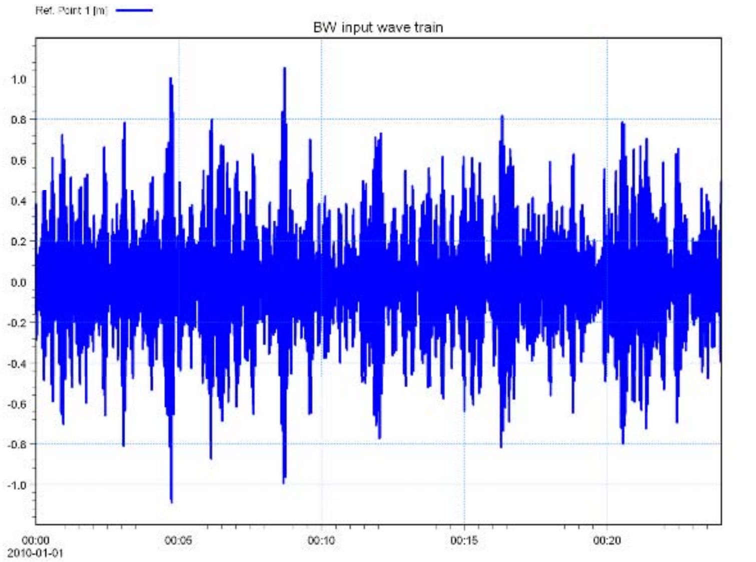

Figure 15.12: Boussinesq Harbour Disturbance model input wave train

Figure 15.13 shows a typical wave pattern taken during the simulation while Figure 15.14 shows the wave heights around the harbour during the 1 in 50 year storm from the west. It will be seen from these diagrams that storm waves can penetrate through the harbour entrance where they are reflected off the vertical walls along the southern side of the harbour.

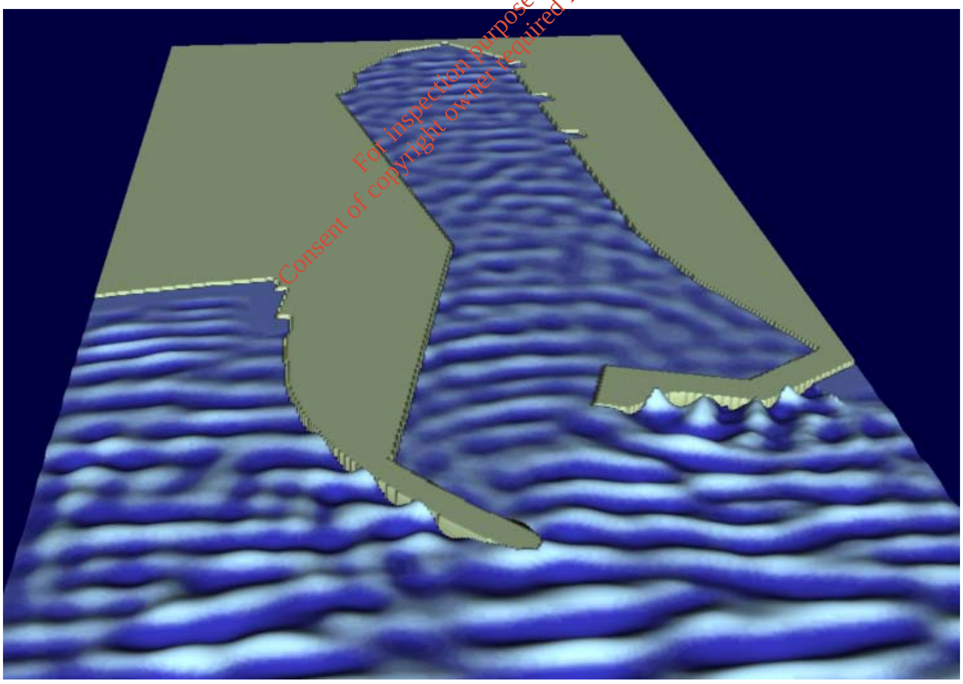

Figure 15.13: Typical wave disturbance pattern during 1 in 50 year storm

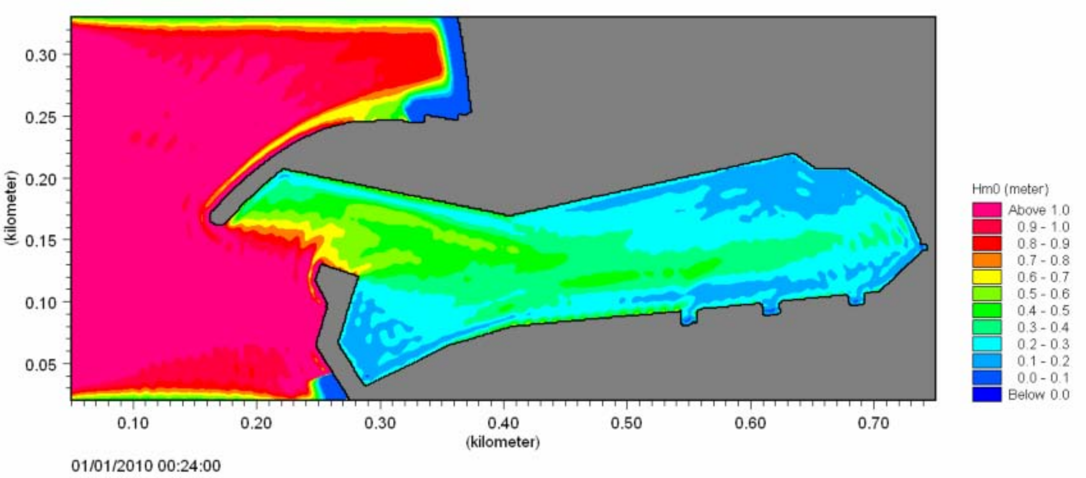

Figure 15.14: Wave heights in the harbour during 1 in 50 year storm

It will be seen from Figure 15.14 that a considerable amount of wave energy penetrates into the harbour such that the wave heights in the basin are above the recommended levels for safe pontoon berthing. Thus the outer breakwater was extended and further models tests undertaken to evaluate the performance of the harbour under storm conditions. It was found that a 20 metre extension to the breakwater would be sufficient to improve the wave characteristics within the basin to permit the use of pontoon berths. Figure 15.15 and Figure 15.16 show the typical wave disturbance patterns and the wave heights within the harbour with the extended breakwater.

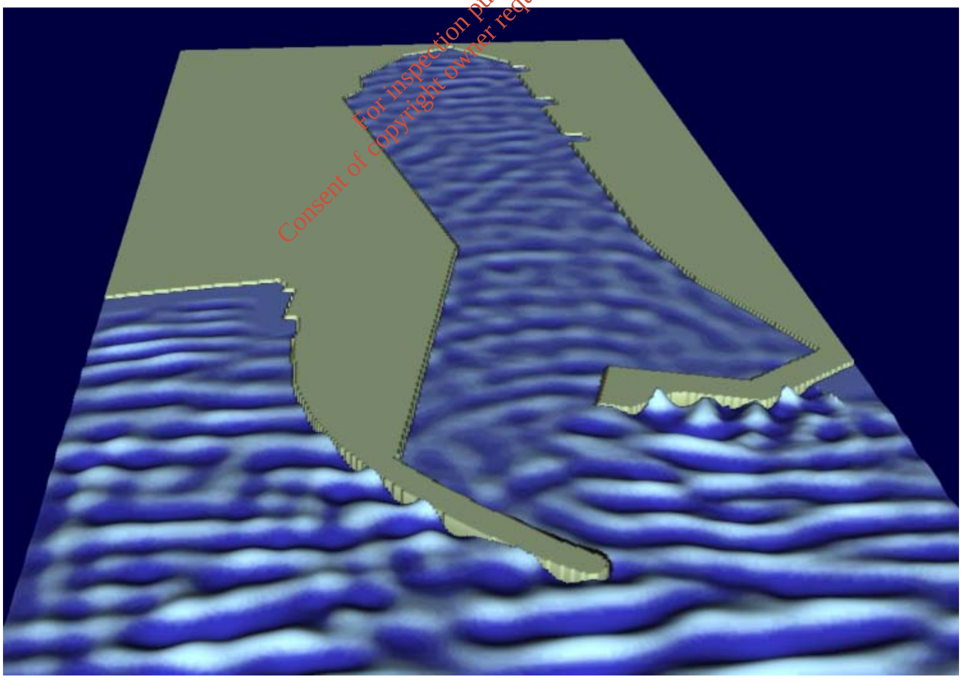

Figure 15.15: Typical wave disturbance pattern during 1 in 50 year storm in harbour with extended breakwater

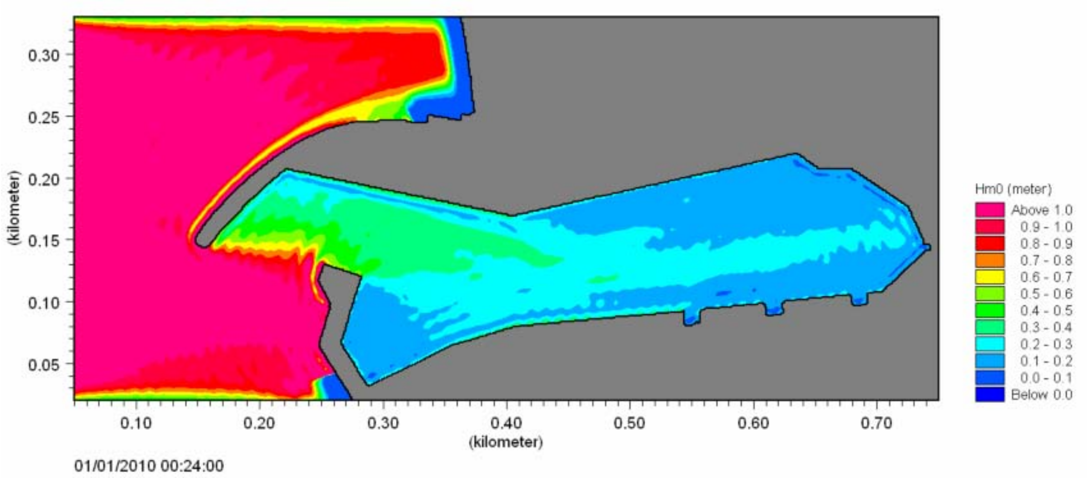

Figure 15.16: Wave heights in the harbour with extended breakwater during 1 in 50 year storm

Comparison of Figure 15.14 and Figure 15.16 shows that the 20m extension of the breakwater greatly improves the shelter within the harbour and thus it was decided that the longer breakwater be constructed for the scheme.

15.3.3 Sea Level Rise

The extreme tide levels are outlined already in Table 15.2. The analysis shows that a 1 in 200 year tidal level will be 4.78m to CD. Allowing for sea level rise of up to 0.5m by 2100 plus the uncertainty value of 0.15m and a freeboard allowance of 0.3m for waves within the harbour results in a crest level of 5.75m around the margins of the harbour for future flood defence.

The crest level for the breakwater will require to be designed to allow safe access along the breakwater for pedestrians during a 1 in 1 year return period event and to allow access for specialist or well trained and equipped personnel during a 1 in 50 year return period event. Allowing for sea level rise, the breakwater crest would require to be at least 0.9 m above the 1 in 50 year return period water level of 5.63 m CD, i.e. about 6.5m CD or +4.4 m OD Malin.

15.4 Modelling the Impact of Dredging Operations within and outside Bantry Harbour

The use of the inner harbour at Bantry is constrained by the available water depth. Dredging of the inner harbour will be required to provide sufficient water depth at low tides for the anticipated range of vessels using the harbour at present and in the future. The material to be dredged largely comprises sandy silty gravels, along with some clay and rock.

Contamination testing has indicated high levels of mercury and tributyltin (TBT) within the inner harbour, with elevated copper levels in the centre of the harbour basin. Sampling has shown that the contamination is limited to the upper 1m of the harbour sediments.

This inner harbour material will be treated and incorporated in the reclamation areas within the harbour, with only uncontaminated material being exported offsite to the Cove beach renourishment scheme.

Dredging will also be carried out in the area immediately outside of the harbour entrance. The top 1 metre of contaminated sediment will be removed and treated offsite as part of the Abbey reclamation.

15.4.1 Dredging Quantities

In order to achieve the design dredge levels throughout the harbour area, approximately 145,000m^3 of dredging is required, 120,000m^3 which will come from the inner harbour and a further 25,000m^3 from the outer harbour. The design dredge depth ranges from -5.0mCD in the outer harbour to -2.0mCD in the inner harbour, as shown in Figure 15.17.

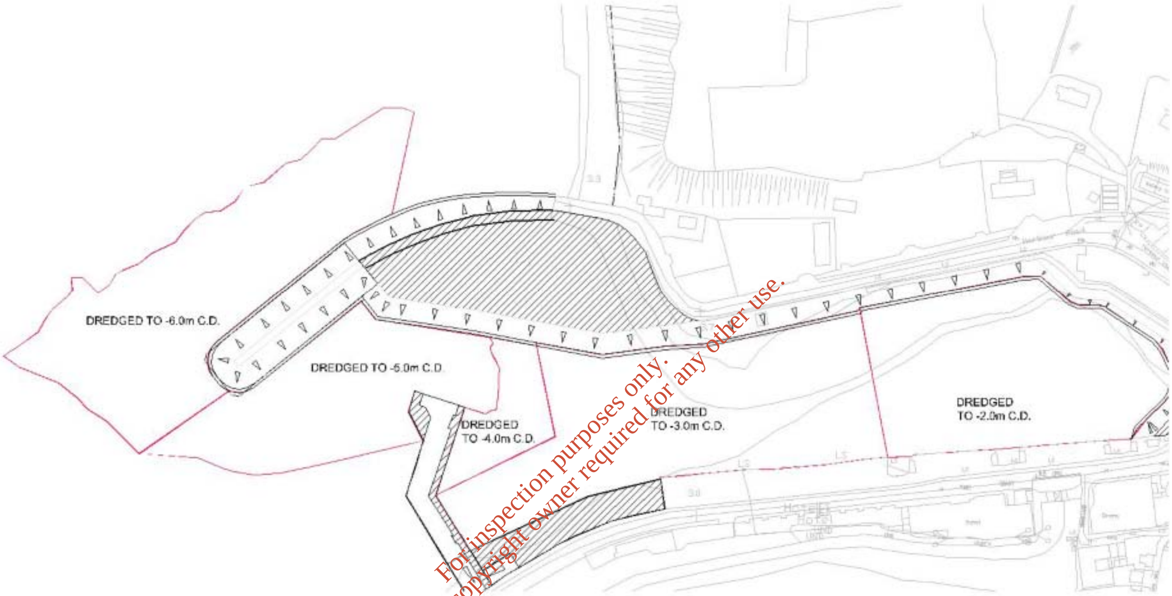

Figure 15.17: Dredging of Marine Basin at Bantry Harbour

The volumes of contaminated and uncontaminated material above the design dredge levels were calculated using the most recent bathymetric survey. The volumes of uncontaminated and contaminated materials are shown in Table 15.3.

Table 15.3: Volumetric Calculations

Item	Measure
Volume Uncontaminated Inner Harbour	81,500m^3
Volume Contaminated Inner Harbour	38,500m^3
Volume Contaminated Outer Harbour	25,000m^3
Total Dredge Volume	145,000m^3

The 38,500m^3 of contaminated material from the inner harbour will be treated and reused on site within the harbour, with the 81,500m^3 of uncontaminated material from the inner harbour to be exported offsite to Cove. The 25,000m^3 of contaminated material from the outer harbour will be exported and treated offsite as part of the Abbey reclamation.

15.4.2 Dredge Methodology

The process of dredging unavoidably causes a disturbance of sediment on the bed and a discharge of material through the water column from the dredger bucket or washout from the hopper barge depending on the mechanism used. These losses may have potential impacts on marine life in the form of a sediment plume within the water column. There is also the added complication in Bantry as some of the material to be dredged is contaminated with heavy metals so this must have a bearing on the choice of dredging method.

Three main methods of dredging equipment were considered for use at Bantry, grab dredging, backhoe dredging and suction dredging. Grab dredging can make use of special environmental buckets for the dredging of contaminated sediments. These closed 'environmental grabs' minimise spillage of sediment from the bucket as it is lifted out of the water. An 'environmental grab' would only be required for the removal of the upper 1m of material, thereafter a standard grab could be utilised. As with grab dredging, backhoe dredging can facilitate the use of several types of bucket, depending on the particular job requirements, and also make use of techniques for dredging contaminated sediments.

The rate of dredging using grab or backhoe dredgers is usually relatively low when compared to suction dredging. For suction dredging, water is generally allowed to overflow from the hopper during the dredging process to increase the solids ratio however in this case where contamination is present it could be expected that overflow may not be permitted in order to minimise the release of contaminants into the water column which may lead to dispersal. For Bantry, grab or backhoe dredging was deemed most appropriate.

15.4.2.1 Wet or Dry Dredging

Traditional dredging techniques are 'wet', i.e. the dredging is undertaken under water. This is the normal method for dredging and has many advantages, but does have some potential implications when contaminated sediments are present as these may be released into the water column.

Dredging in the dry is usually undertaken where there is the potential to fully isolate the dredge site and prevent the ingress of water. In the context of Bantry this would require the harbour mouth to be closed off, which would have implications for the flow of the river. Although practically more difficult than dredging in the wet, this option would usually be less environmentally sensitive as no contaminants/dredged material would be released into the water. However, further work was necessary to determine if wet dredging would be appropriate in this case.

Computational modeling was carried out to assess the implications of the dredging operation with respect to potential release of contaminants into the surrounding waters if the wet dredging technique were to be adopted. Details are provided in Section 15.4.3.

15.4.3 Dredging Plume Modelling

Dredging plume simulations were undertaken to investigate the fate of material spilled into the water column during dredging operations. In these simulations it was assumed that the dredger would be working in the wet with the tide going in and out of the harbour throughout the dredging operations. Due to restriction in the operating depth for the dredger, it was assumed that the machine would have to dig itself in by working in from the entrance towards the eastern end of the basin.

15.4.3.1 Model Simulations

The model simulations were undertaken using the Mike21 npa particle tracking model which used a typical month of tides generated by the tidal model as shown in Figure 15.18.

The model simulates the dispersion, settlement and the fate of the material lost to the water column during the dredging operations by releasing particles into the model flow regime and tracking them as they are carried by the currents and gradually settle out onto the bed. The source of the released particles follows the progress of the dredger as it gradually digs its way in from the entrance to the eastern end of the basin.

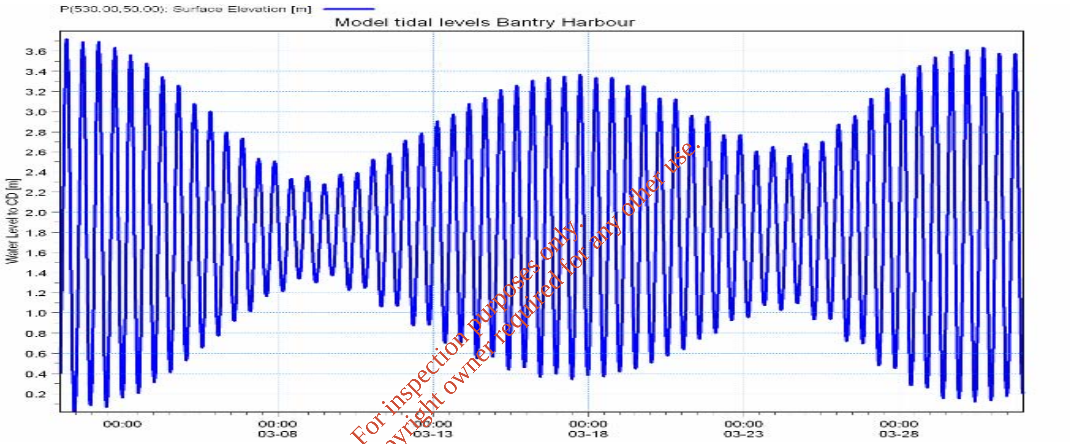

Figure 15.18: Typical month of tides used in dredging simulation

During dredging operations, losses to the water column are normally of the order of 3% of the quantity of material that is being dredged. The site investigation analysis has shown that the bed material at Bantry Harbour is composed of a mixture of gravel, sand and silt with a log linear grading from about 0.002mm to 20mm particle diameters. The most coarse one third of the material, i.e. the gravel and coarse sand, is so heavy that it will settle very quickly down to the bed thus the material which can potentially be carried away out of the harbour in the water column is approximately 2% of the finer fractions of the dredged material. In the simulation of the dredging at Bantry Harbour the losses were taken to be 2% of the rate of dredged material released at the surface with a grading as shown in Table 15.4. Some 2.5 million particles were released during the simulation with the distribution of the grain sizes of the released particles conforming to the grading shown in Table 15.4. The rate of dredging was assumed to be 1000 m^3/day, although the dredging process is now likely to be much slower than this, due to financial considerations. Therefore the results of the dredging simulations may be treated as the worst case scenario.

Table 15.4: Grain size distribution for released particles in dredging simulation

Grain diameter [mm]	Percentage
1.000	10

0.600	10
0.300	10
0.150	15
0.045	13
0.023	11
0.009	11
0.005	10
0.002	10

15.4.3.2 Model Results

Figure 15.19 shows the highest suspended concentration of sediment in the water column during the dredging operation. It will be seen that the values are very low outside the confines of the harbour. Figure 15.20 shows the deposition of sediment lost to the water column during the dredging operation. It will be noted that most of the material falls back onto the bed within the harbour area. This material would of course be picked up by the dredger during the final cleanup operation. The amount of material deposited outside the harbour is very small; the depth of the sedimentation in millimetres is approximately Kg/m^2/1.5.

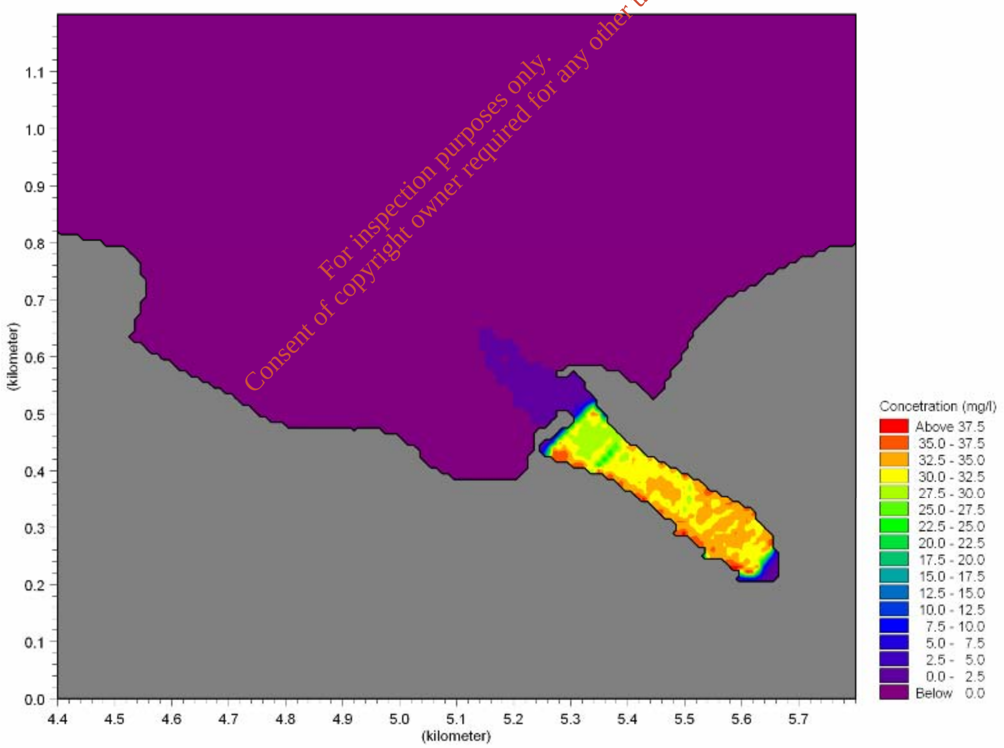

Figure 15.19: Maximum suspended sediment concentration in the water column during the dredging operations

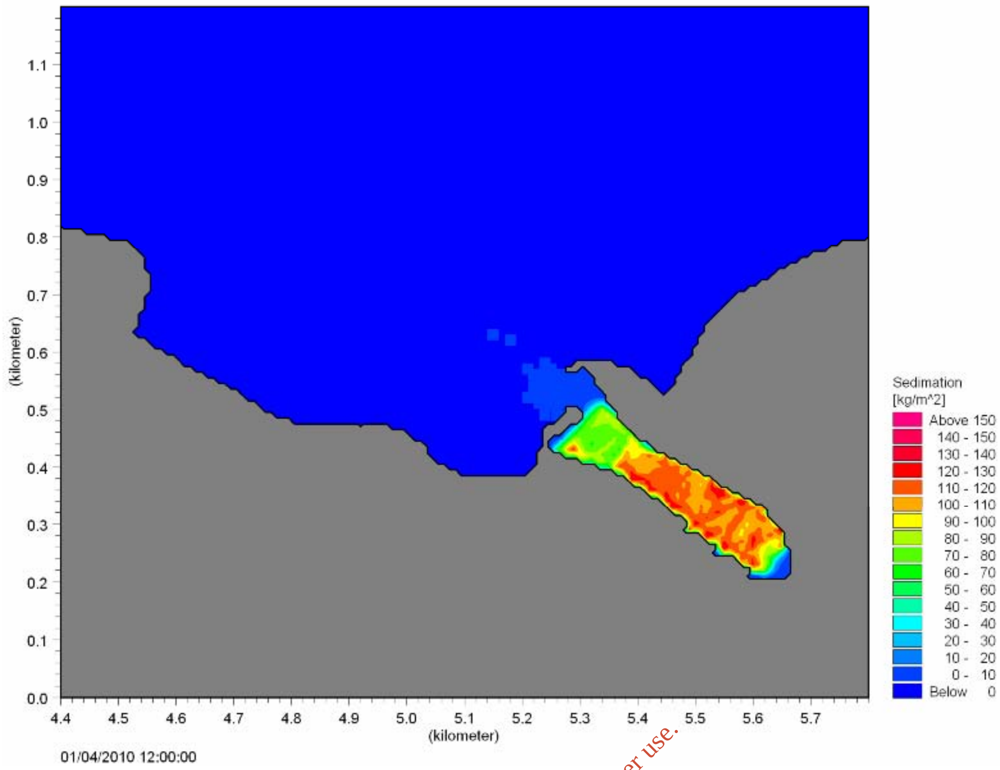

Figure 15.20: Sediment deposition on the seabed at the end of dredging operations

The dredging simulation shows that the impact of the proposed dredging in the harbour will be small and confined to the immediate area of the harbour. This is due to the low tidal velocities in the area and the relatively coarse nature of the material to be dredged. In the case when there are prolonged winds from the east then the sediment would expected to be carried further from the harbour entrance due to surface currents generated by the wind. However it is unlikely that such winds would occur for a large part of the four month dredging period assumed in the simulations. Thus it may be concluded that the dredging operations can be undertaken in the wet without a significant environmental impact away from the immediate area of the harbour and its entrance zone.

15.4.3.3 Conclusion

Dredging in the dry is unlikely to be an economic solution at Bantry and would also negate the use of the existing harbour facilities for the duration of the contract. Computational modelling has shown that the potential for the spread of contaminants if dredging in the wet is minimal and as such there would not appear to be any particular advantage to adopting a 'dry' dredging technique.

A semi-wet solution may be the most appropriate for Bantry. The Eastern end of the harbour dries out at low tide, therefore it will be possible at this location to effectively dredge in the dry by carrying out operations tidally. Bunds could be used in the deeper sections of the main harbour to allow land based excavation equipment to dredge without major tidal restrictions. In the vicinity of the fishing pier and harbour entrance, where the water depths are greatest, it may be necessary to use an excavator mounted on a floating pontoon.

Environmental risks associated with dredging in a wet or semi-wet environment should be manageable with the use of appropriate equipment and environmental monitoring of the dredging operation. Such monitoring measures may include the installation of monitoring buoys and regular sampling of turbidity and suspended solids. In some cases prevention measures such as a silt screen may also be beneficial, even though the results of the preliminary hydraulic modelling indicate that there will be limited movement of suspended sediments during the dredging operation.

15.4.4 Dredging of Contaminated Material

Due to the presence of mercury in the top 1m of the bed both inside and outside the harbour, specific dispersion modelling was carried out to determine the fate of the contaminant during and after dredging. Two dispersion scenarios were modelled, to ensure all possibilities were accounted for; one scenario assumed that the mercury was attached to the sediment and the other assumed the mercury dissolved in a solution. Both modelling scenarios were undertaken using a particle tracking model from the Mike Suite of software.

Sediment dispersion modelling was carried out both inside and outside the harbour, assuming the mercury was attached to the sediment particles, and thus were not separate particles. On output, the relative concentration of mercury could be derived. A south easterly wind was applied to the model inside the harbour, as a worst case scenario, and likewise a southerly wind was applied to the outer harbour. Figure 15.21 to Figure 15.24 show the results of the simulations. Figure 15.21 and Figure 15.22 show the maximum suspended sediment concentration envelop and maximum sedimentation depth envelop respectively during the dredging of the inner harbour. Figure 15.23 and Figure 15.24 show the same results for the dredging of the outer harbour.

According to the Water Framework Directive Surface Water Regs (S.I. No. 272 of 2009), the Priority Substance, Mercury and its compounds, should have a MAC EQS of 0.07µg/l in Surface Waters (Other Waters), which excludes inland waters but includes coastal and transitional waters. The model results show that the maximum sediment concentrations in the inner harbour and outer harbour are generally less than 0.04kg/m^3 and 0.025kg/m^3 respectively. Assuming the concentration of mercury is 0.198mg/kg as derived, the more critical 0.04kg/m^3 can be converted to an equivalent 0.0079µg/l, showing that concentrations for both the inner and outer harbour are well below the critical 0.07µg/l level.

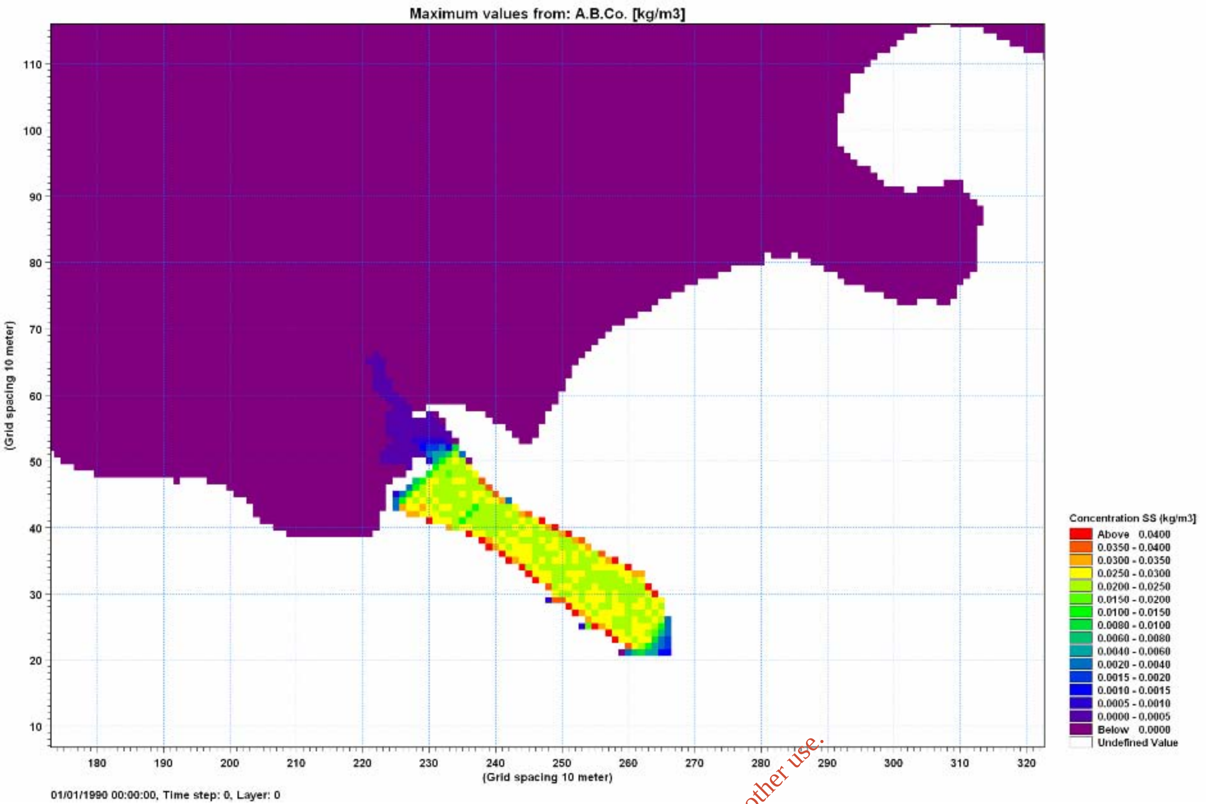

Figure 15.21: Maximum Suspended sediment concentration envelop during dredging of inner harbour with SE wind [5m/s]

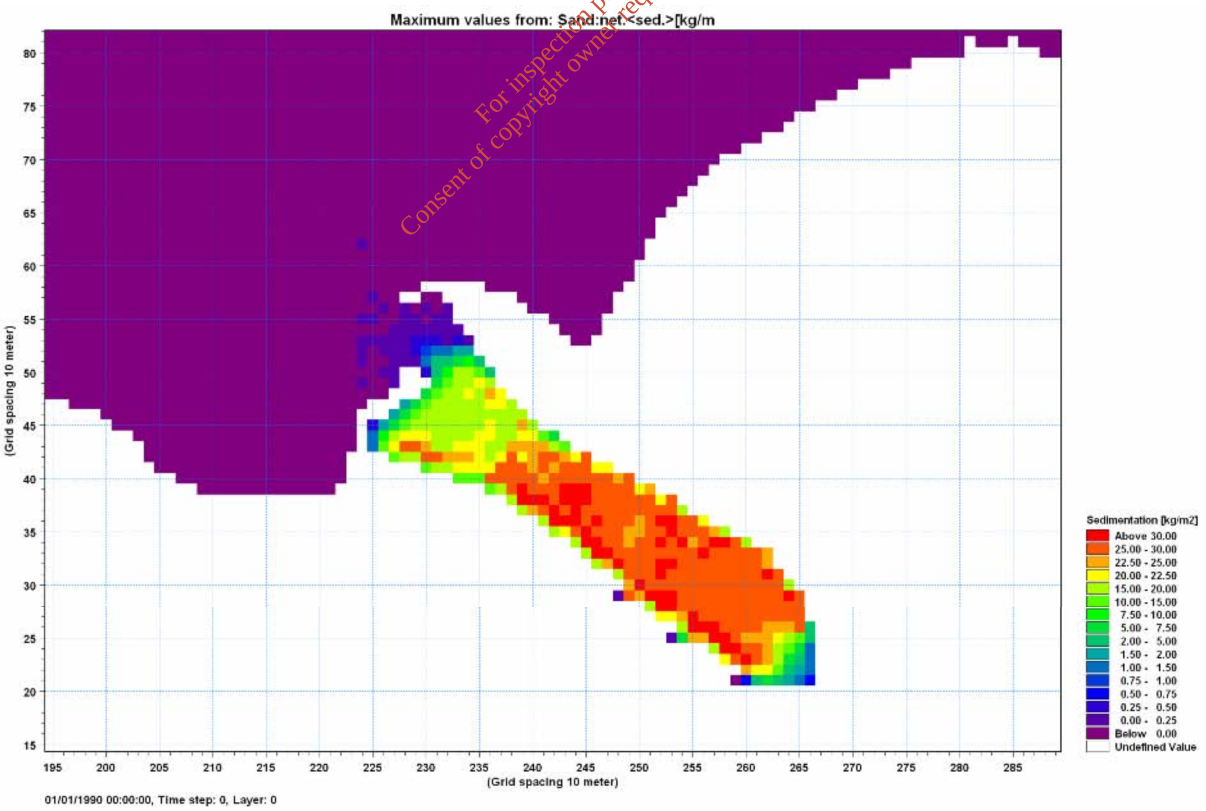

Figure 15.22: Maximum sedimentation depth envelop during dredging of inner harbour with SE wind [5m/s]

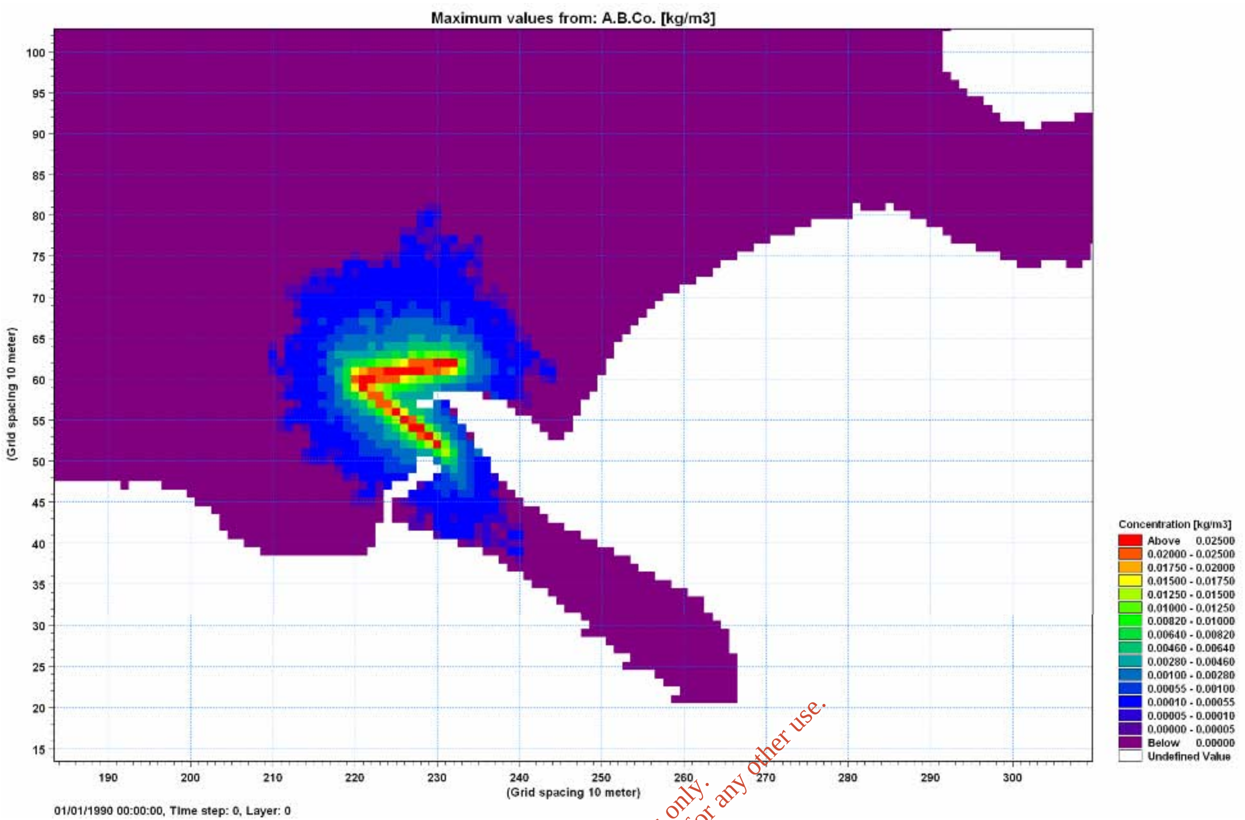

Figure 15.23: Maximum suspended sediment concentration envelop during dredging of outer harbour area with southerly wind [5m/s]

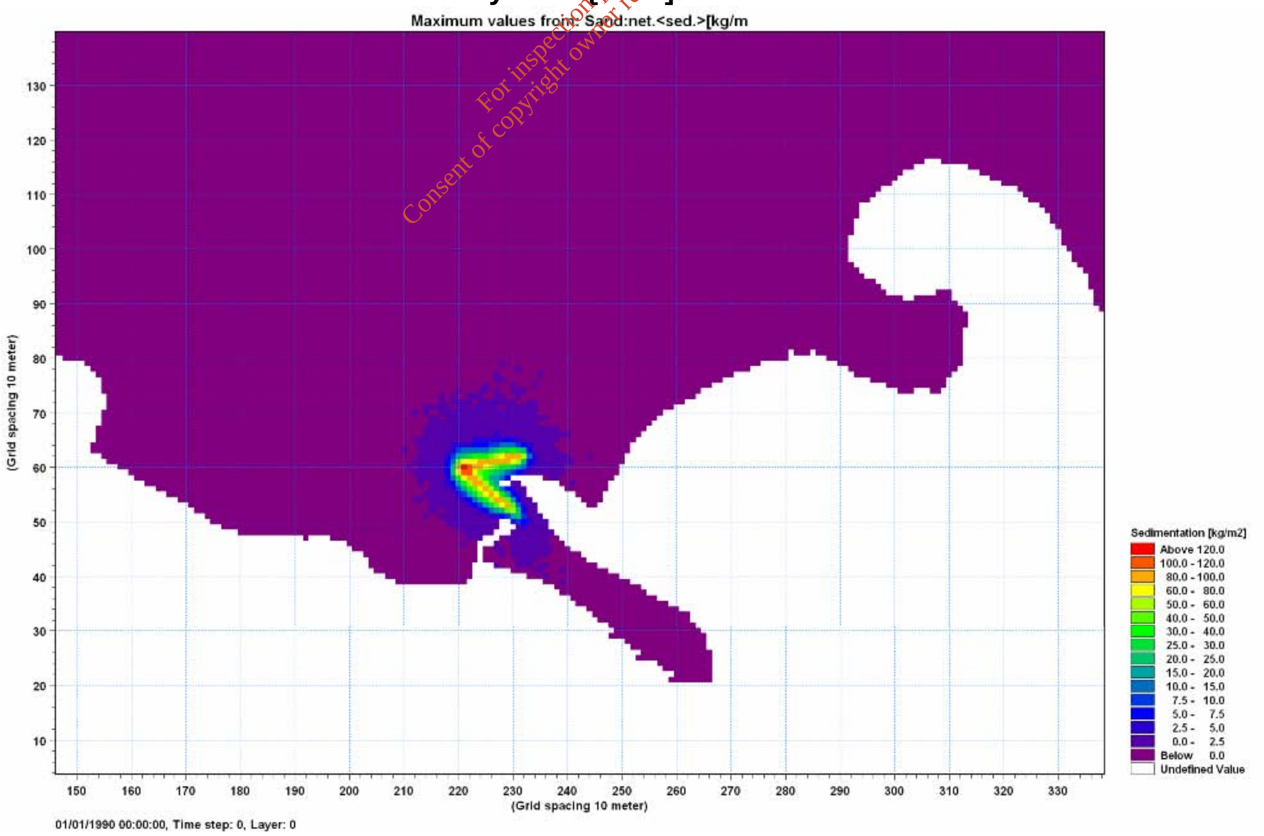

Figure 15.24: Maximum sedimentation depth envelop during the dredging of outer harbour area with southerly wind [5m/s]

The dissolved mercury modelling was undertaken for the outer harbour dredging only, as the sediment dispersion modelling showed that for the inner dredging, much less material and suspended solids reach outside the harbour compared to the outer dredging. Thus the levels of mercury which could reach the aquaculture sites will be even less than that for the outer harbour dredging. Therefore the worst case outer harbour modelling was taken forward for further modelling.

The dissolved mercury modelling was undertaken using a particle tracking model on the basis of a rate of $1000m^3$ per day which for the dredging outside the harbour was assumed to be 20 days continuous dredging with the dispersion modelling continuing for a further 10 days. This was based on a total dredge volume of $20,000m^3$ or 33,000,000kg.

The average mercury concentration in the area was taken as 0.198 mg/kg, resulting in a total mercury weight of 6.534kg. The quantity of mercury released during the dredging operation was calculated to be $1.13e^{-07}$ kg/sec and it was assumed that this would be carried in solution. The dredging simulations were undertaken using a figure of 3% losses to the water column. This is a normal loss figure for backhoe dredging which does not require silt curtains.

Figure 15.25 shows the maximum mercury concentration envelop during the dredging of the outer harbour, assuming all mercury disturbed by the dredging is carried in solution. The maximum concentration envelop shows the maximum value that occurs in each grid cell of the model at any time during the simulation. Thus the plot shows the peak value that occurs at each point in the model, even if it only occurs for a very short time. As for the previous simulations the mercury concentration is well below the critical level of 0.07µg/l.

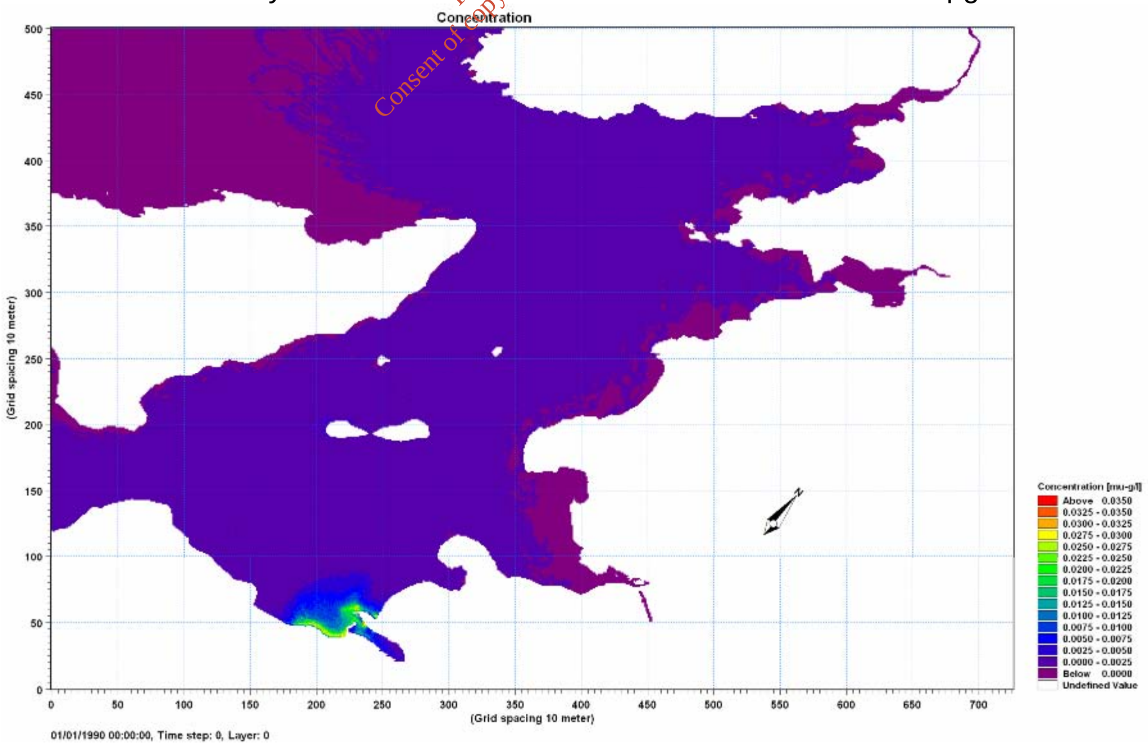

Figure 15.25: Maximum concentration envelop for Hg during dredging of outer harbour assuming all Hg disturbed by dredging is carried in solution

The simulation for the dissolved mercury was run for the 20 day dredging period plus a further 10 days. Figure 15.26 shows the concentrations of mercury at the end of the modelling period, i.e. some 10 days after the completion of the dredging. It can be seen from the plot that the mercury is almost negligible at this point.

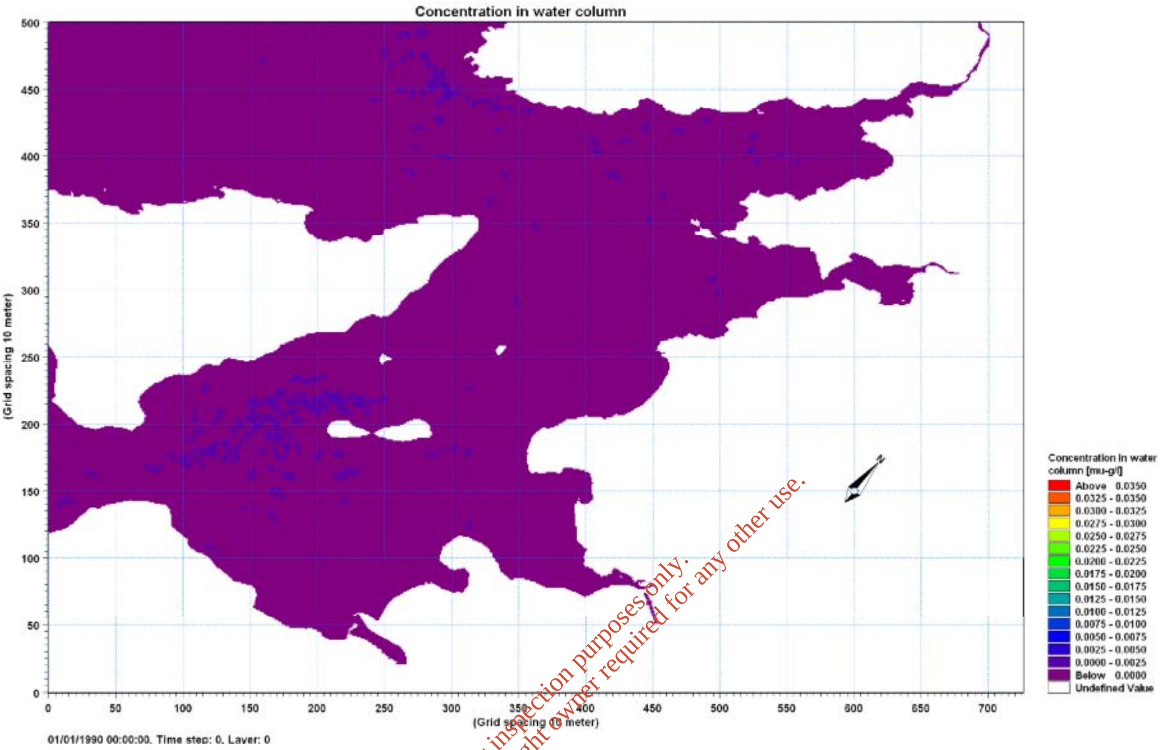

Figure 15.26: Concentration envelop for Hg 10 days after end of dredging of outer harbour assuming all Hg disturbed by dredging goes into solution

15.5 Disposal of Dredged Material

In order to achieve the design dredge levels throughout the harbour, approximately 145,000m^3 of dredging is required. The top 1m of material is considered to be contaminated comprising a volume of approximately 63,500m^3. All material, both contaminated and uncontaminated will be reused within the scheme, as discussed in the following sections.

15.5.1 Contaminated Material

<u>15.5.1.1 Disposal of Treated Material from Inner Harbour</u>

Consultations with the Marine Institute, has indicated that it is their opinion that the contaminated material within the inner harbour at Bantry is suitable for treatment and reuse as fill within the reclaimed areas of the proposed development. This option can also be considered as having an advantage in terms of sustainability as transport is negated and there is no usage of what is generally very limited existing landfill capacity.

<u>15.5.1.2 Disposal of Treated Material from Outer Harbour</u>

Beneficial reuse of the 25,000m^3 of dredge material from outside the harbour is as an alternative fill for use in part of a boat storage scheme at the Abbey Strand site, located as shown in Figure 15.27. This facility will allow for the storage of vessels during the winter months and also facilitate repairs. The land reclamation scheme would involve placing the granular dredged material behind an armoured bund to provide a reclaimed area on the foreshore to the west of the harbour. The bund will prevent the dredged material from escaping into the surrounding waters, and thus providing safety for shellfish within the local area.

As the top 1 metre of material is contaminated, this sediment will be treated before being used as part of the Abbey site.

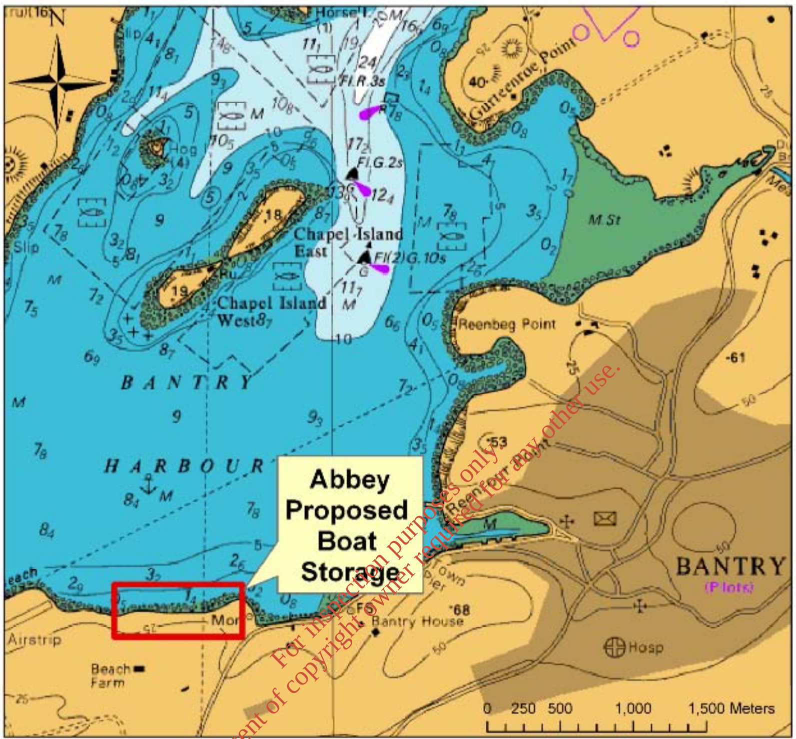

Figure 15.27: Proposed Site of Abbey Boat Storage

Rock size and construction details have been developed to match the storm wave climate at the site. It is estimated that a double layer of rock armour will be required in the structure, of size 0.5 tonnes and approximate nominal diameter of 0.6-0.7metres. Structural levels have been determined as part of the Bantry Inner Harbour Development Preliminary Report, taking into account sea level rise, therefore the design crest level will be +5.75m to Chart Datum. The slope of the structure will be 1 in 1.5. A 300mm thick graded underlayer should be placed beneath the rock armour to provide a firm base, under which the Terram 2000 geotextile will be laid directly on the bank. The geotextile will be of appropriate filter stability and strength. Imported rock fill will form the slope on which the geotextile will be laid, behind which the dredged material will be placed. The imported rockfill and the dredged material will be separated by a further geotextile element, in order to prevent the migration of the dredge material through the bank and thus not impacting on water quality in the area.

15.5.2 Beneficial Reuse of Uncontaminated Material at Cove

After construction of the proposed works, there will be a surplus of approximately 81,500m^3 of uncontaminated material arising from the dredging works. This material will be disposed of offsite as part of a beneficial reuse scheme consisting of beach renourishment at Cove and Beicin Strand, an adjacent and connected site, located as shown in Figure 15.28.

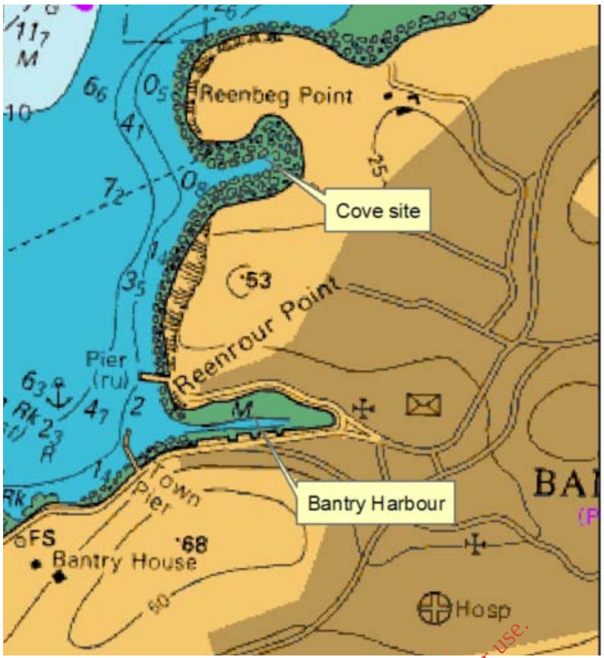

Figure 15.28: Location of the Cove site

15.5.2.1 Cove site

The Cove site offers some natural protection due to its curved shape, and thus, along with appropriate sediment retaining structures, is one of the most suitable sites for beach renourishment in the area. This site is orientated in a west, south-westerly direction and is approximately 300metres wide at the mouth, and over 450m in length. The Cove site is connected to Bantry Harbour by Beicin Strand, a narrow linear beach around 700metres in length with a walkway. This westerly facing beach faces the prevailing winds, but offers no natural protection from the land and hence is relatively exposed in comparison to the Cove site.

Figure 15.29 shows some photographs of the Cove site in its existing state. It currently contains very little sand, as there does not seem to be a supply in the nearby area and it is also particularly subject to wave exposure, hence is composed of mostly gravel and cobbles.


Figure 15.29: Cove Strand (Coast of Ireland Oblique Imagery Survey)

Figure 15.30 shows the Beicin Strand, including some old groynes along the site. As the material mostly moves in an onshore/offshore direction along the strand, these groynes do not provide much impact on sediment movement. There is no significant natural supply of sediment to the site and hence difficulties arise in trying to maintain a sandy beach on Beicin Strand, without incurring significant expense on offshore structures.


Figure 15.30: Beicin Strand (Coast of Ireland Oblique Imagery Survey)

Computational model studies of the scheme were undertaken to predict the effects of beach nourishment and land reclamation on the coastal processes and water quality of the area and to establish the stability of the proposed schemes including the requirements for groynes and protective revetments.

15.5.2.2 Preliminary design

When first undertaking the modelling study, it was assumed that 77,000m^3 of dredge material would be available for the proposed beach renourishment and the basic layout and profile of the material and protective structures were established. The gradient of the beach was anticipated to be as steep as a 1 in 10 or 1 in 15 slope, levelling out towards the water line. At the Cove site, it was anticipated that circa 75,000m^3 of material would be required to produce an adequate beach, with the remainder being positioned along the Beicin Strand.

The design has since been modified to allow for a total of 81,500m^3 of material to be used in the beach renourishment scheme. The scheme was reassessed by the modelling team, which concluded that the additional 4,500m^3 of material should be placed at the Cove site, where there will be negligible difference to the modelling results. This material should not be placed along the Beicin Strand without further assessment.

The dredge material has a wide grading, from cobbles and boulders to sands, clays and silts, but is generally considered as sandy gravel. For the purpose of the modelling exercise, a sediment size of 1mm, with a gradation of 1.3 was assumed, in order to focus on the finer sediments within the grading, as it is this portion of the sediment that is likely to be transported by littoral currents and waves. One of the major reasons for the failure of beach renourishment schemes is due to the grading of the new material not being matched correctly to the existing wave climate, along with the lack of retaining structures to prevent material from drifting offsite. Vertical seawall structures can also cause increased scouring effects of waves and currents.

Beaches composed of finer sediments such as sand are often considered preferable to coarser gravel beaches, as sand is often safer and more enjoyable for children and adults alike. Therefore it is highly preferable that this beach renourishment scheme can retain fine sediments where possible and the Cove site is ideally placed to do so with the help of two beach retention breakwaters. If these breakwaters were not in place, the finer fractions of the sediment would be likely to be lost, due to the nature of the currents in the area. The finer part of the sediment placed along Beicin Strand is not expected to remain as placed, without a significant and expensive offshore breakwater system, and thus only the coarser fraction of the dredged material should be placed there. The Beicin Strand will form an important part of this integrated scheme, and will retain the coarser sediment without hard defences, acting as an ideal passageway along the beach between Bantry Harbour and Cove Strand. Dredged material should be placed at Cove and along Beicin Strand in the dry at low tide. Figure 15.31 shows the proposed beach profile at Cove and the associated breakwater structures.

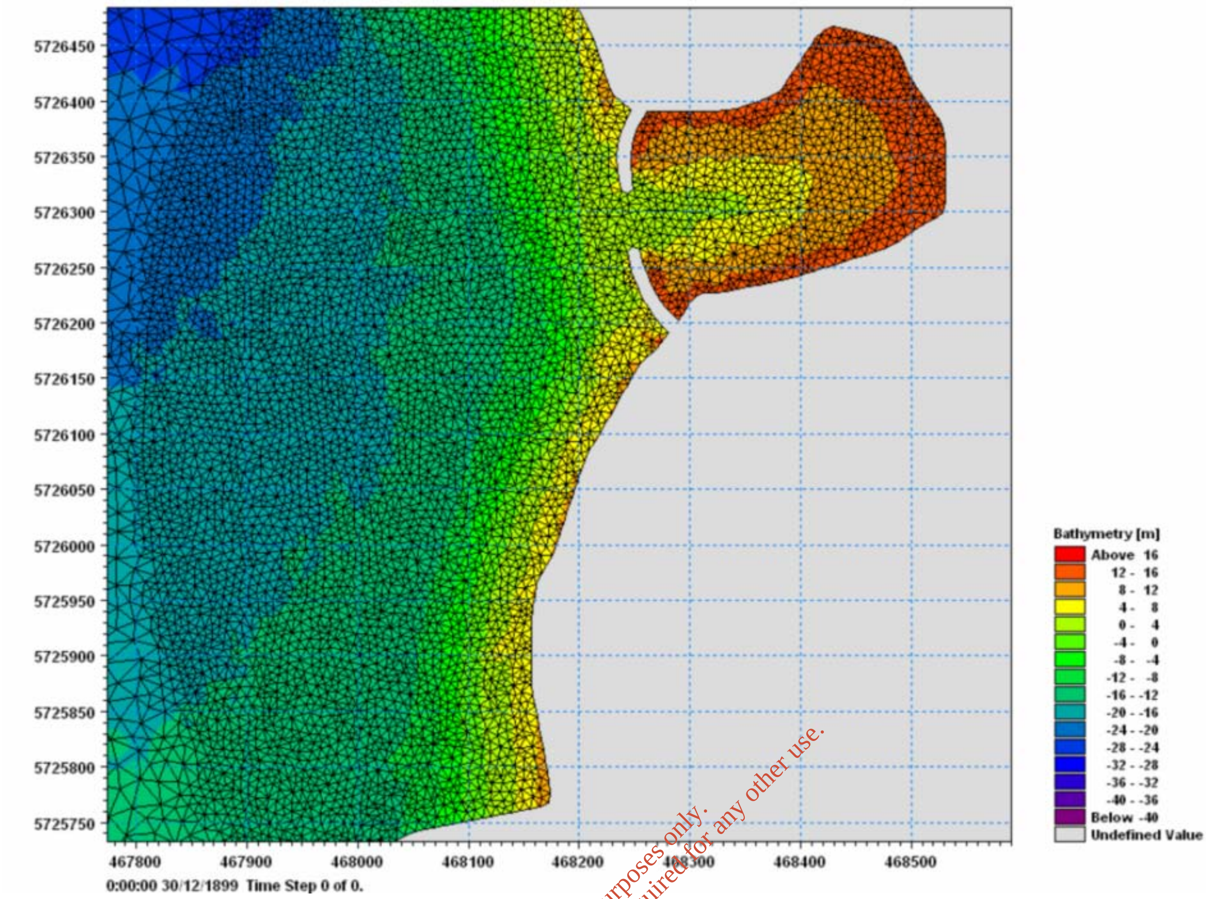

Figure 15.31: Proposed Beach Profile at Cove, including Breakwaters

<u>15.5.2.3 Hydraulic Modelling System</u>

A key consideration in the development of the proposed scheme was to assess the stability of the material to be placed on the beach and in particular to ascertain whether a sandy beach could be achieved in the area. Hydraulic modelling investigations were undertaken to assess the stability of the renourished beach and the effectiveness of proposed breakwaters at the entrance to Cove.

In order to fully understand the potential for sediment transport in the area, hydrodynamic, wave and sediment transport modelling were undertaken for the east of Bantry Bay. A typical winter storm of something in the order of a 1 in 1 year return period event was considered the most appropriate to assess beach response, as sediments are generally driven by more frequent smaller events, rather than a rare single event. Three separate wind condition scenarios have been simulated, covering the significant directions of exposure, 255°, 300° and 345°, along with a further pseudo storm scenario where the storm progressing in three steps from south west to north west, similar to a typical passage of a deep depression.

A flexible mesh modelling system was chosen from the Mike21 suite of coastal process software developed by the Danish Hydraulics Institute. The same mesh was used for the hydrodynamic, wave and sediment transport modelling to allow for a fully morphological simulation. An integrated modelling approach was chosen in the form of the MIKE 31/3

Coupled Model FM, allowing the simulation of the mutual interaction between waves and currents using a dynamic coupling between the Hydrodynamic Module and the Spectral Wave Module. The MIKE 21/3 Coupled Model FM also included a dynamic coupling between the Sand Transport Model and the Hydrodynamic Module and the Spectral Wave Module. Hence, a full feedback of the bed level changes on the waves and flow calculations were included.

The model bathymetry was taken from bathymetric survey data, digital chart data provided by C-Map of Norway, along with Infomar and LiDAR data provided by the Geological Survey of Ireland (GSI). The area covered by the tidal model is shown in Figure 15.32. The outer area was defined by a varying resolution of up to 200m while the area around Bantry Harbour was modelled at a very fine resolution of 10m.

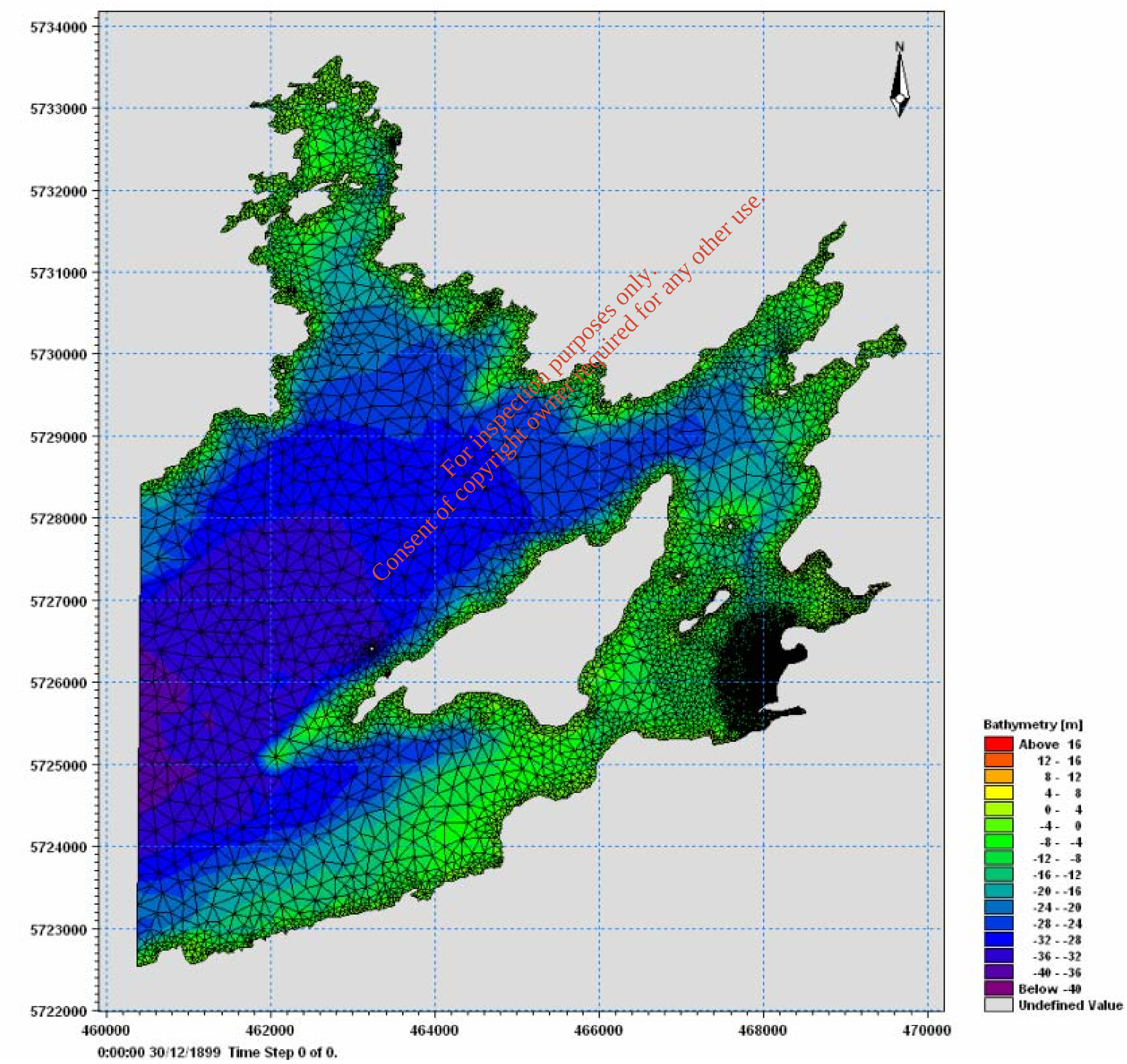

Figure 15.32: Flexible Mesh tidal model bathymetry of Bantry Bay

Hydrodynamics were run for both the proposed and existing scenarios. The proposed and existing meshes are shown in Figure 15.33 and Figure 15.34 for comparison. The software was able to take account of the wave reflections from various harbour structures and hence the proposed breakwaters were assumed to be partially reflective within the wave module, with a reflection coefficient of 0.5 included in the set-up.

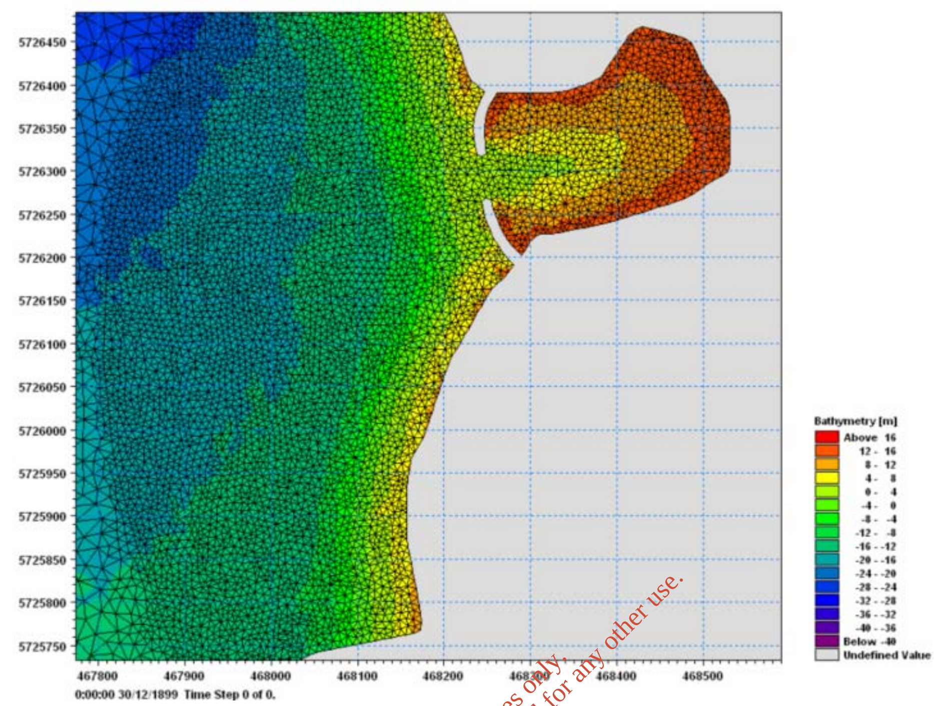

Figure 15.33: Proposed Beach layout at Cove, including breakwaters

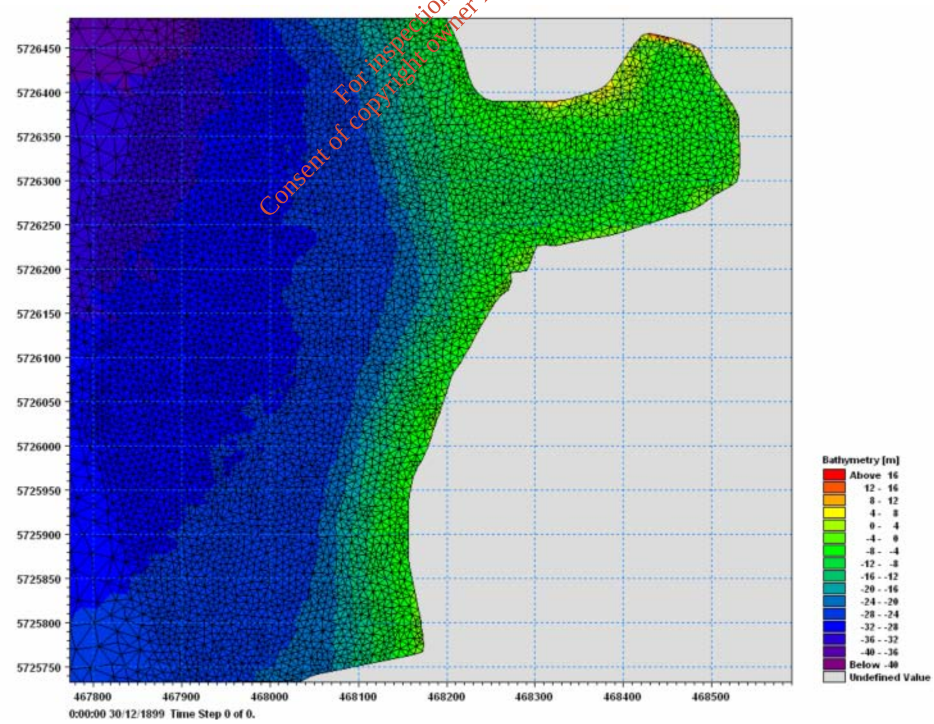

Figure 15.34: Existing bathymetry at Cove

Boundary conditions for the hydrodynamic module were taken from the previous model which was developed as part of the earlier Bantry study and covers the whole of Bantry Bay. A high water spring tide was assumed the most appropriate for use with a typical winter gale, with the simulations being implemented over a 3 day period, allowing 2 days for model warm up. Closed boundaries were taken for the wave module, as it was determined previously that the area is dominated by locally generated wind waves only.

For the purpose of the sediment transport modelling, a sediment size of 1mm, with a gradation of 1.3 has been assumed, in order to focus on the finer sediments within the grading, as these are the ones that are likely to be more easily displaced by the storm conditions.

15.5.2.4 Tidal flow modelling

The tidal flow modelling was undertaken using the MIKE 21 Flexible Mesh module, incorporated within the MIKE 21/3 Coupled Model FM. RPS initially determined the wind and wave induced littoral currents for the three critical wind directions for the existing beach profile. The littoral currents around the Cove and Beicin Strands are shown for a typical winter storm from wind directions 255°, 300° and 345° for a flood tide in Figure 15.35 to Figure 15.37, revealing evidence of circulation.

It was noted that the littoral currents are dominated by wind and wave generated currents with little or no influence from the tidal flows. It was also seen that while the strongest littoral current speeds occur along the Beicin Strand, there is considerable circulation in and out of the Cove site during storm conditions.

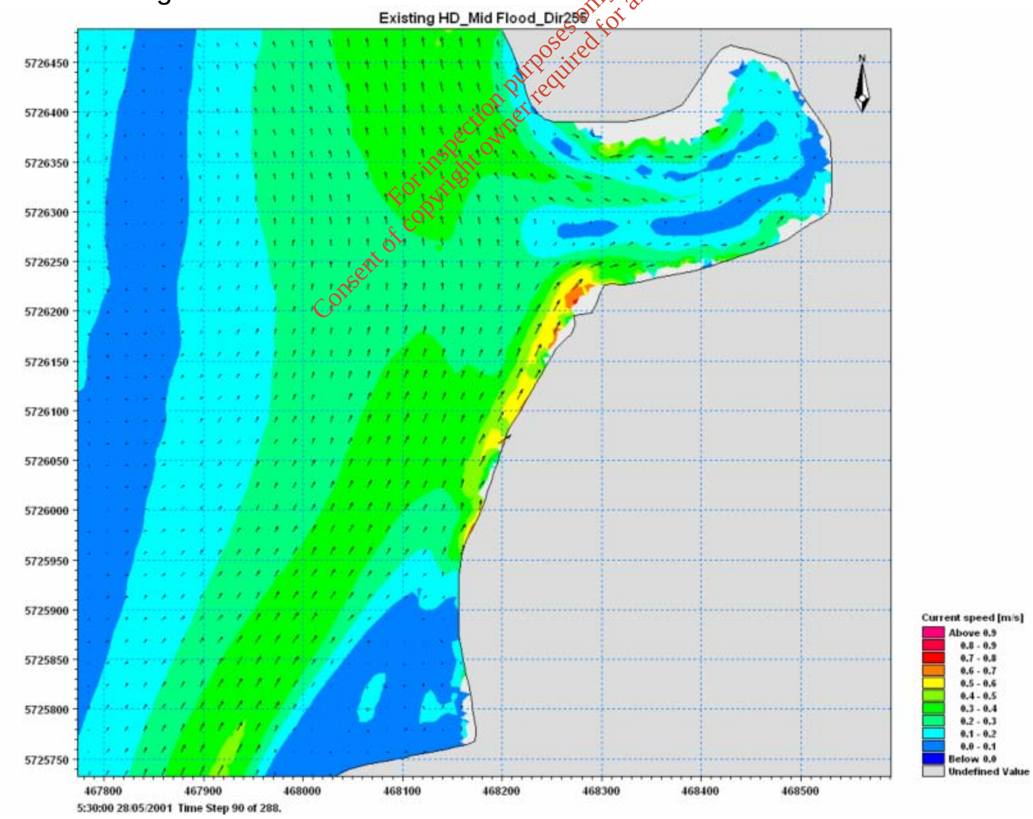

Figure 15.35: Existing Littoral Currents around Proposed Site for a typical winter storm from 255° - Flood Tide

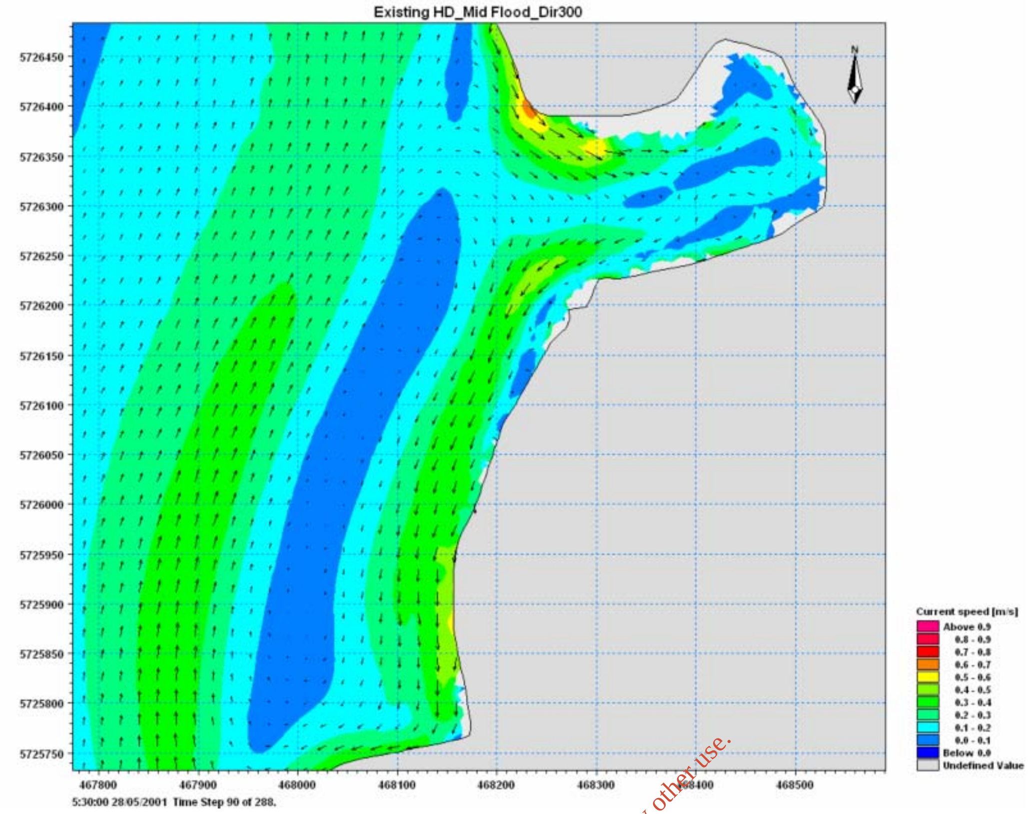

Figure 15.36: Existing Littoral Currents around Proposed Site for a typical winter storm from 300° - Flood Tide

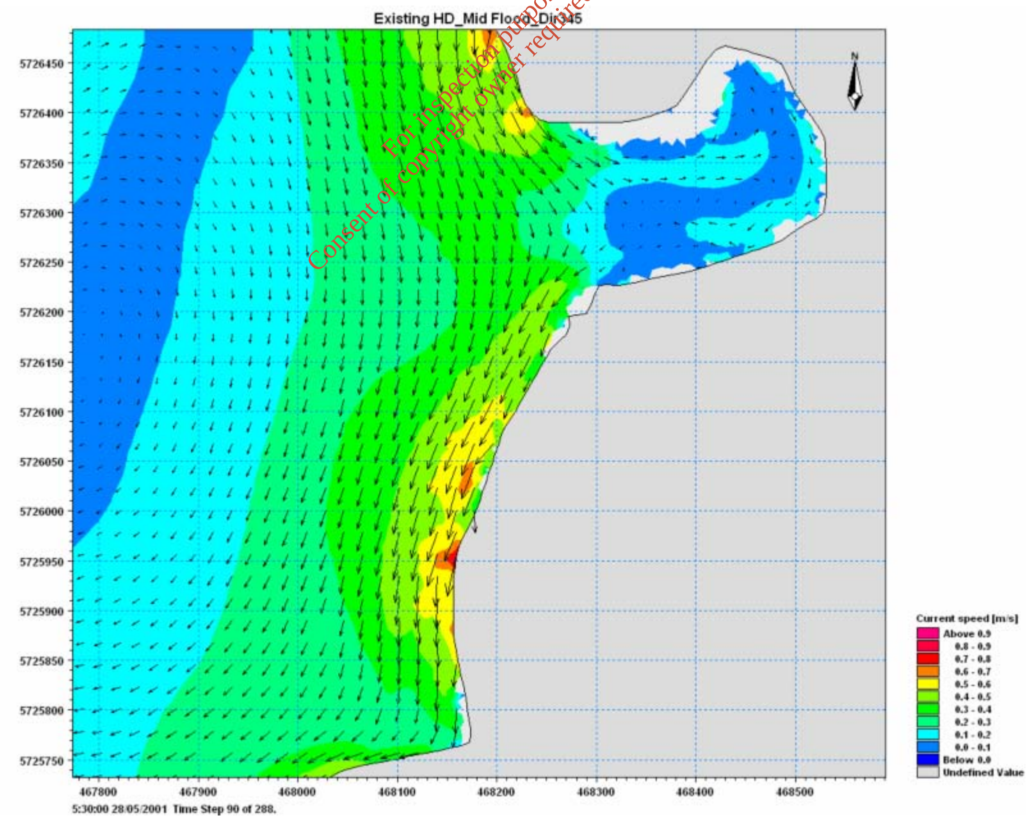

Figure 15.37: Existing Littoral Currents around Proposed Site for a typical winter storm from 345° - Flood Tide

With regard to the new beach profile, littoral current result plots are shown in Figure 15.38 to Figure 15.40. Figure 15.38 shows the littoral current speeds over the domain of the model during a flood tide, showing significant eddying due to the dominant effect of wind and waves on the currents.

Figure 15.39 shows the littoral current pattern within the Cove site for a wind direction of 255°, revealing the circular movement within the sheltered Cove, as the currents travel down the north and south shorelines and back out through the centre. The 300° result plot shown in Figure 15.40 portrays a similar pattern, although this is more like a figure of eight, with the 345° wind direction showing a more simple clockwise circulation around the bay (Figure 15.41). Current speeds reach up to 0.6m/s during the 255° run, although generally remain less than 0.5m/s.

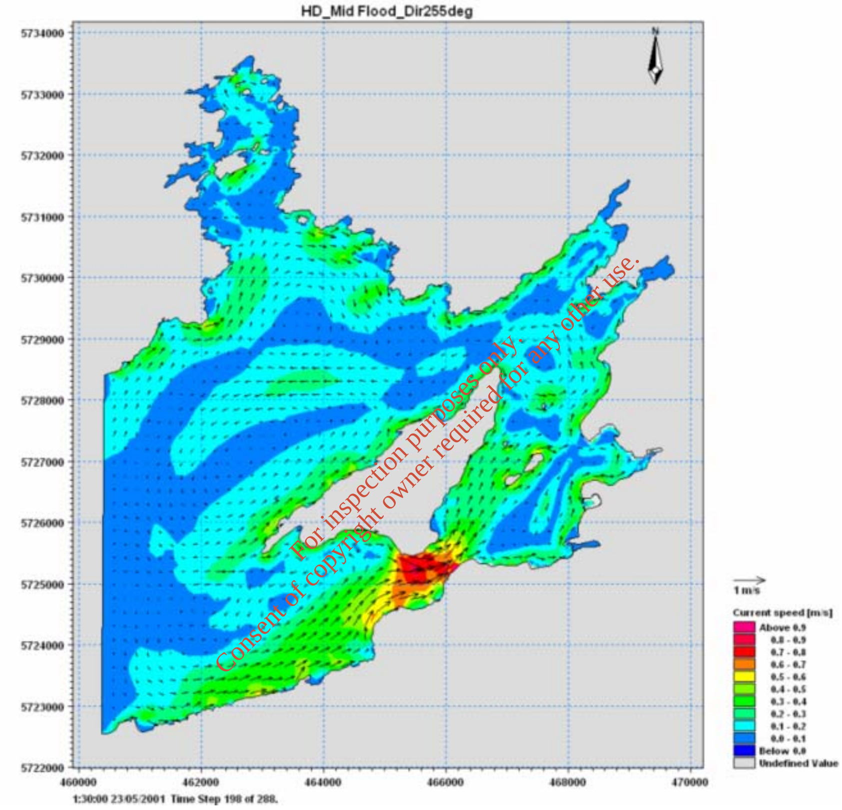

Figure 15.38: Littoral Current Speed Vector Plot over model domain during a flood tide– Wind Direction 255°

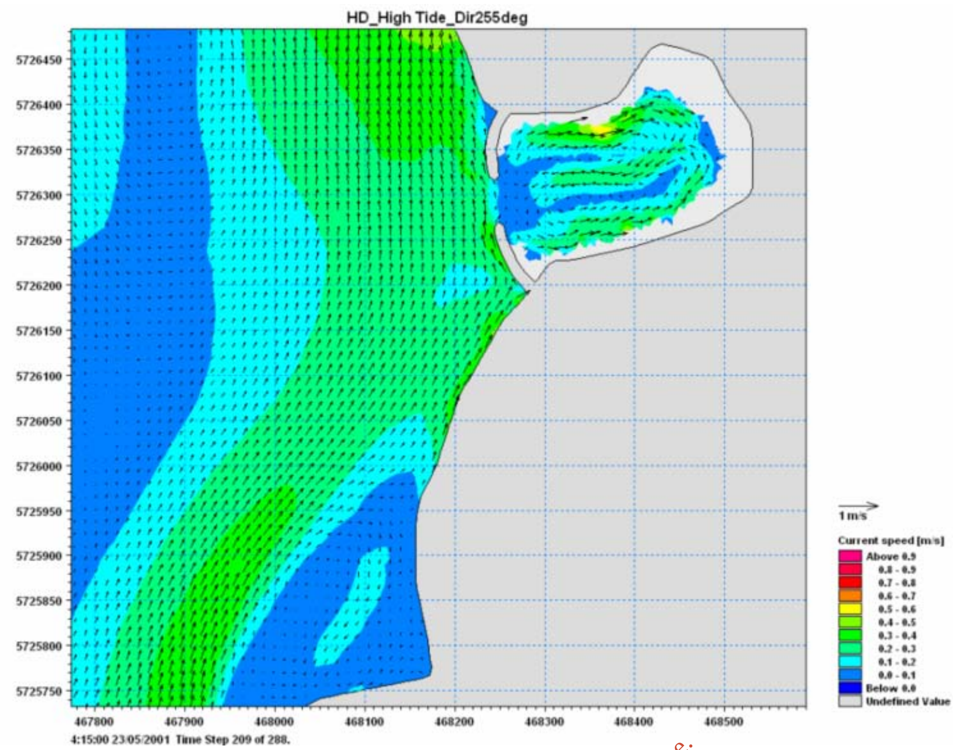

Figure 15.39: Littoral Current Speed Vector Plot for Proposed Beach during at high tide– Wind Direction 255°

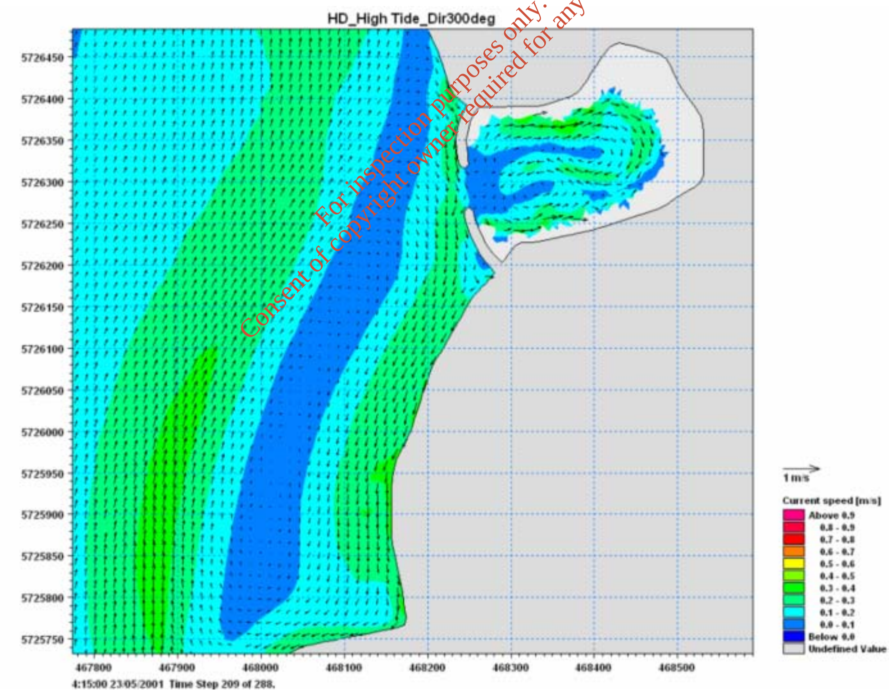

Figure 15.40: Littoral Current Speed Vector Plot for Proposed Beach during at high tide– Wind Direction 300°

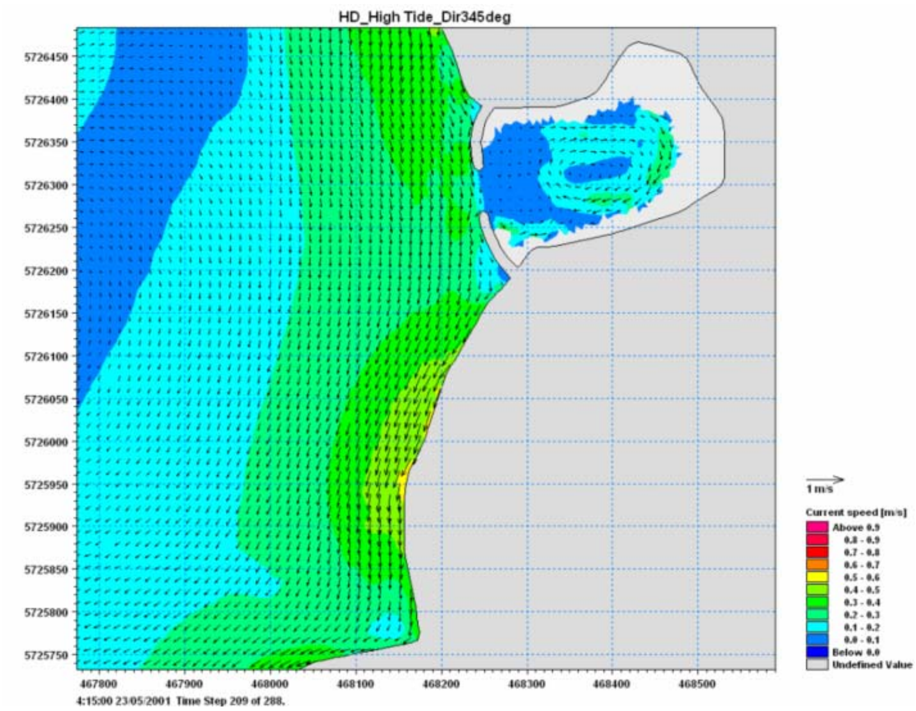

Figure 15.41: Littoral Current Speed Vector Plot for Proposed Beach during at high tide– Wind Direction 255°

<u>15.5.2.5 Wave modelling</u>

The wave modelling was undertaken using the MIKE 21 Spectral wind-wave module (SW), incorporated within the MIKE 21/3 Coupled Model FM. Figure 15.42 shows the significant wave height and direction at the site, for a wind direction of 255°. It can be seen that the significant wave height reaches 0.8metres at the opening between the breakwaters, with 0.7metres along the Beicin Strand. Wave diffraction is evident as the waves encounter the breakwater structures, with an obvious spreading through the opening.

Figure 15.43 shows the significant wave heights and directions for a wind direction of 300°, with Figure 15.44 showing the same results for a wind direction of 345°. A wave height of 0.7metres is encountered at the opening to the Cove site and along the Beicin Strand for the 300° simulation, with a slightly smaller wave height of 0.6metres along both strands for a wind direction of 345°. As for the 255° simulation, wave diffraction is evident when the wind is coming from 300°. When the wind comes from the more northerly 345°, only very small waves are able to proceed through the breakwaters, due to the almost parallel direction of the waves. As per the littoral currents, the critical wind direction is from 255°.

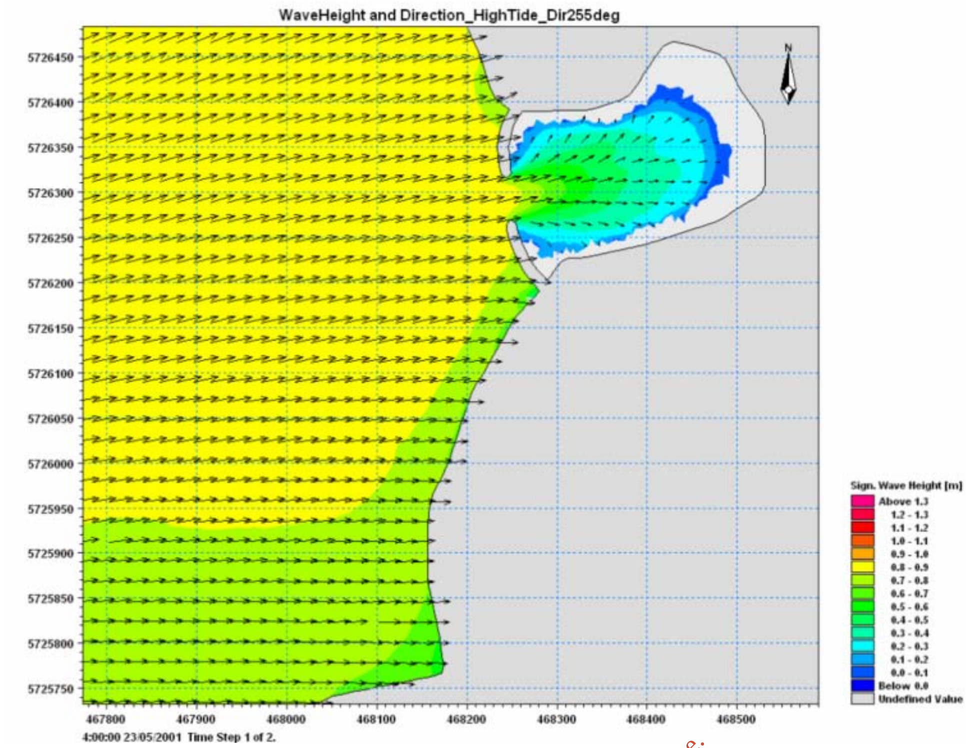

Figure 15.42: Significant Wave Height and Direction around Proposed Beach at High Tide – Wind Direction 255°

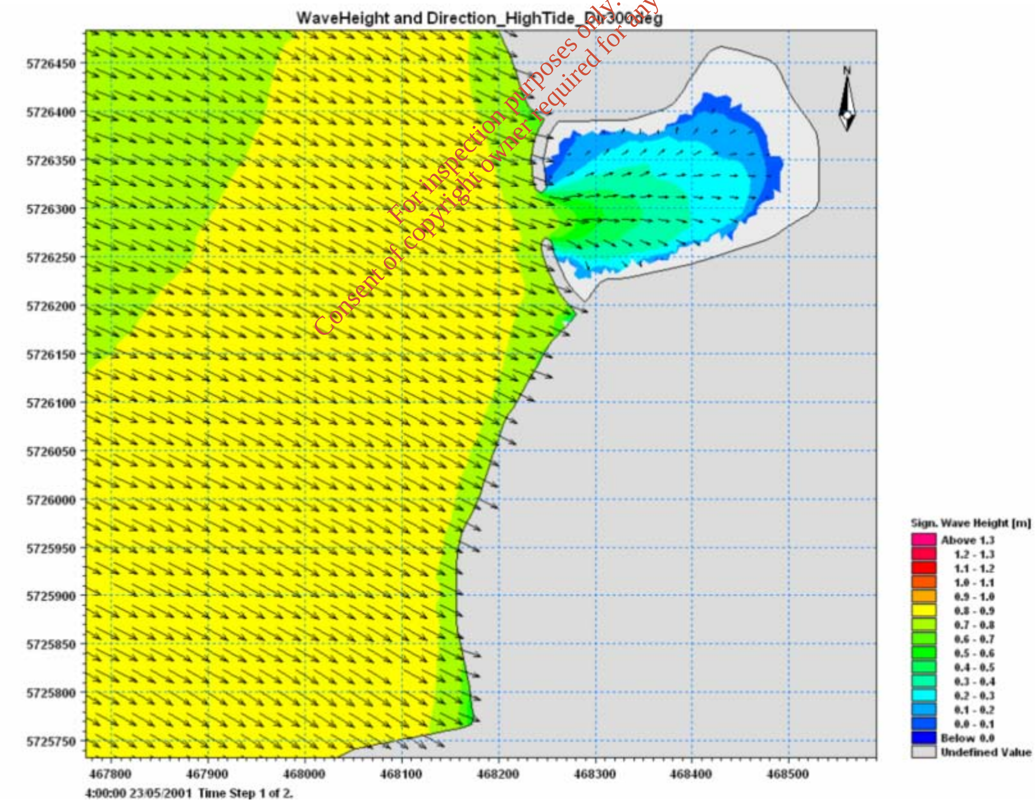

Figure 15.43: Significant Wave Height and Direction around Proposed Beach at High Tide – Wind Direction 300°

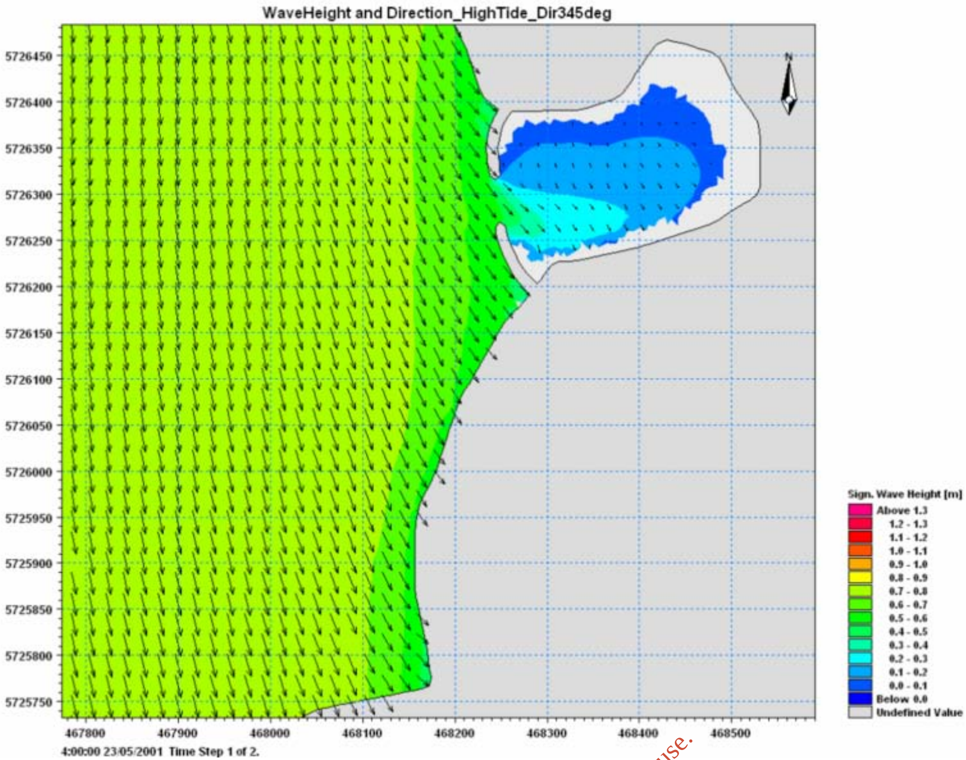

Figure 15.44: Significant Wave Height and Direction around Proposed Beach at High Tide – Wind Direction 345°

15.5.2.6 Sediment modelling

The sediment modelling was undertaken using the MIKE 21 Sand Transport module, incorporated within the MIKE 21/3 Coupled Model FM. The results of the sediment module are shown in Figure 15.45 through to Figure 15.52.

Figure 15.45, Figure 15.46 and Figure 15.47 show the potential rate of sediment transport and direction in the water column during the more critical ebb tide for wind directions of 255°, 300° and 345° respectively. For all directions, there is greater sediment transport on the ebb tide than on the flood tide. Each plot shows how the sediment is moved slightly offshore from the Beicin Strand as it is picked up and carried by the littoral currents. Some beach readjustment at the Cove site is apparent, particularly in the 255° result plot. Critical directions for the Beicin Strand are 255° and 345°, and for the Cove site 255° and 300°.

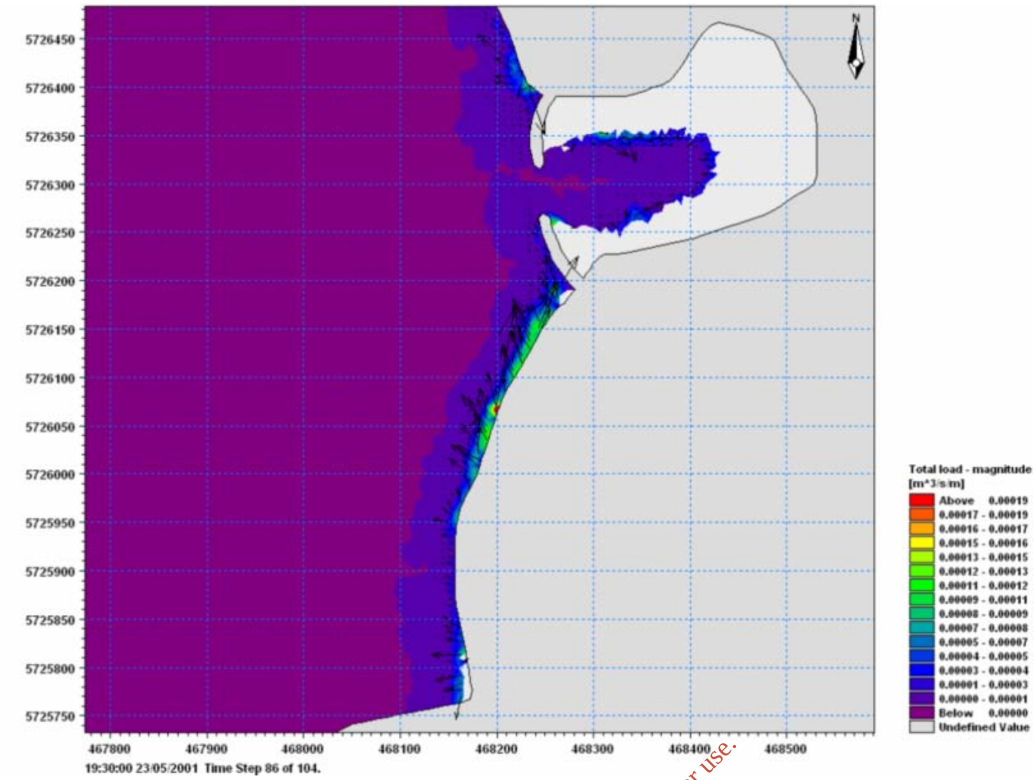

Figure 15.45: Potential Rate of Sediment Transport and Direction in the water column during an ebb tide for a wind direction of 255°

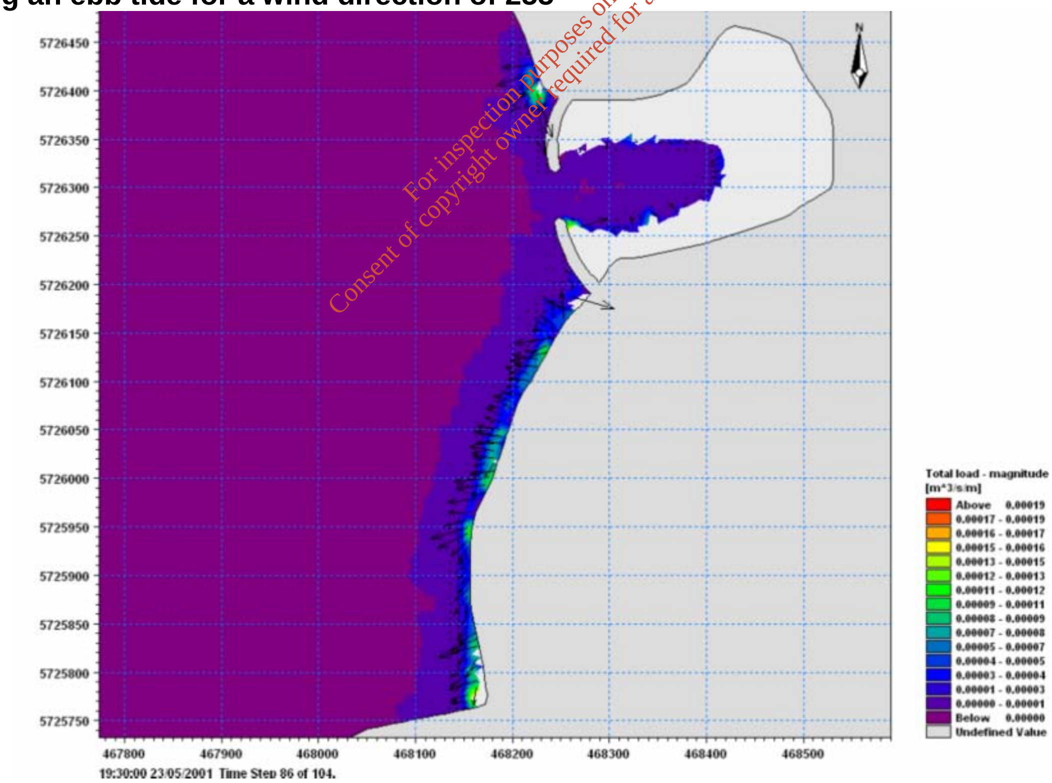

Figure 15.46: Potential Rate of Sediment Transport and Direction in the water column during an ebb tide for a wind direction of 300°

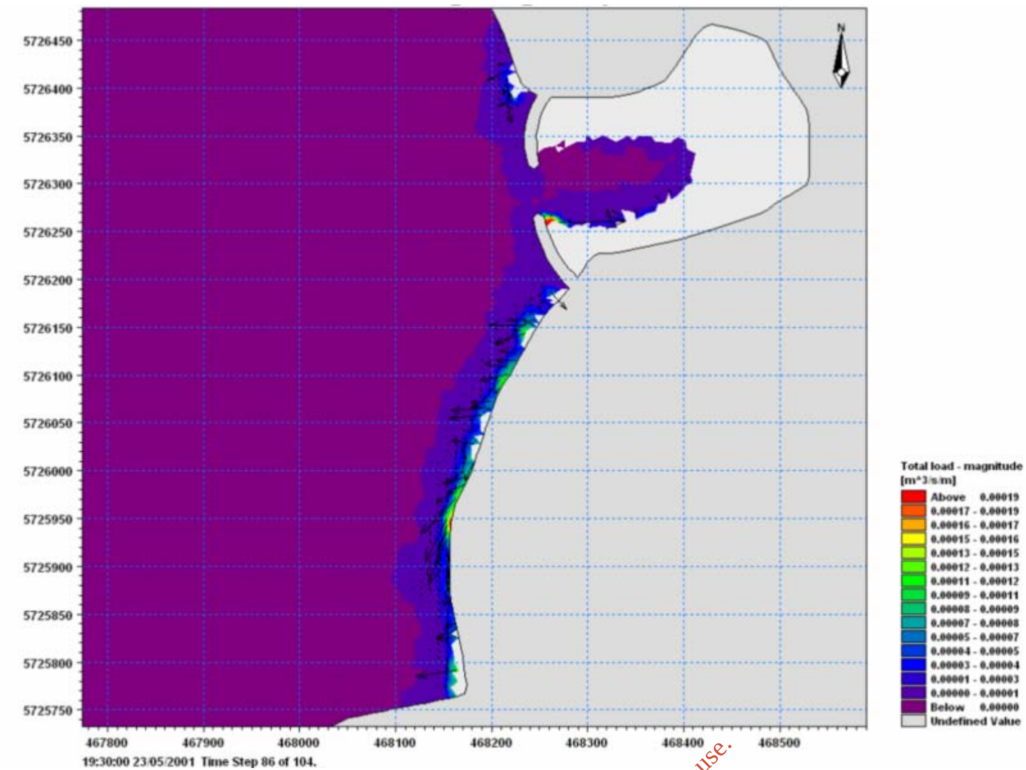

Figure 15.47: Potential Rate of Sediment Transport and Direction in the water column during an ebb tide for a wind direction of 345°

When analysing beach response, bed level change is one of the most important elements to consider and this is why a fully morphological model was chosen to represent the various scenarios, with continuous updates to bed level being made throughout the simulation of the model. Bed level change results are displayed in Figure 15.48 and Figure 15.49 for a storm from 255°, with Figure 15.50 and Figure 15.51 showing results for storm direction 300° and 345° respectively. All scenarios reveal an evident shift in material from the Beicin Strand slightly offshore, creating the formation of a nearshore sandbar, as the dominant wave direction is perpendicular to the line of the beach. This is particularly apparent where there is an initial formation of a nearshore bar and a consequent drop in the onshore beach levels. In time some of the fine material from this nearshore sandbar may be redistributed in the area, depending on the tidal regime. The consequences of the finer material being moved offshore of the strand will result in the final beach having a relatively coarse grain size, as is the existing condition. However, in practice, only the coarse material should be placed along Beicin Strand, and thus these results provide the worst case scenario, assuming the finer particles are included.

Some beach readjustment at the Cove site is evident for all three scenarios. Although this is minimal, it is expected that the Cove beach profile will level out over time, and take on its own natural shape. Figure 15.48 has been included to highlight potential scour around the new breakwater structures, with a small sandbar potentially forming just offshore of these, particularly on the southern breakwater for the 255° wind direction. Thus, some scour protection will thus be included in the design. It is clear from these plots that the breakwaters are functioning as anticipated, and if were not included in the scheme, the sand from within the Cove bay would be dispersed offshore.

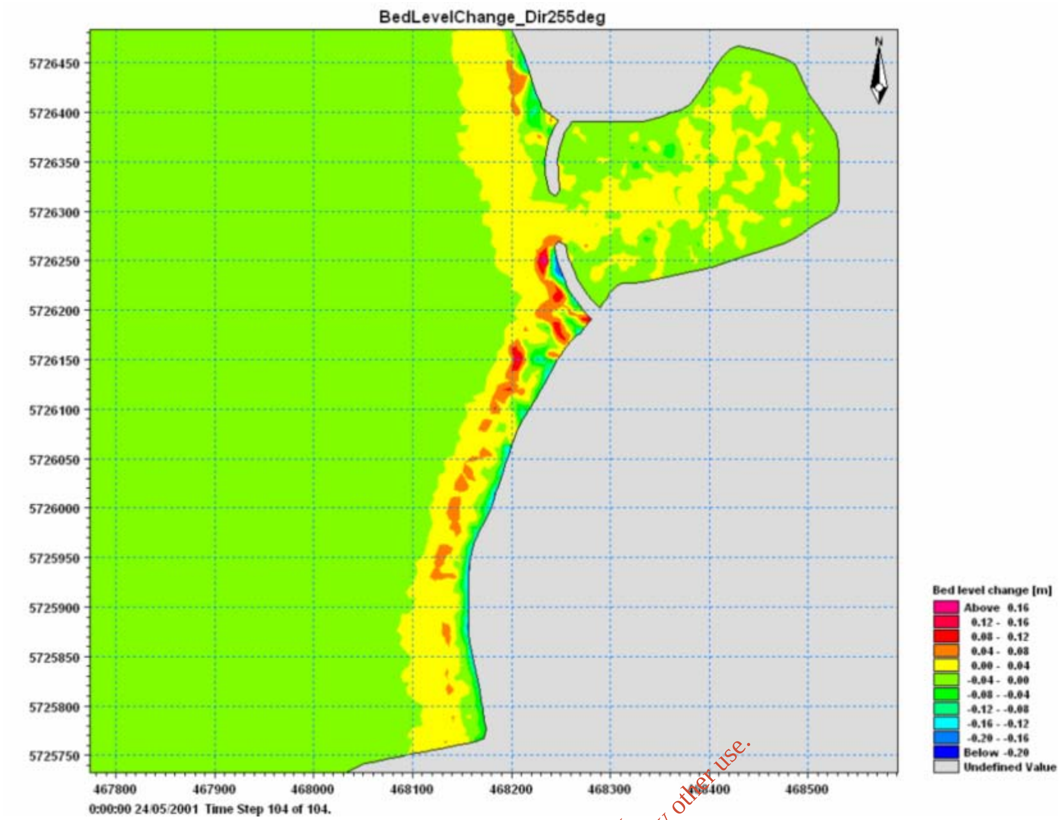

Figure 15.48: Bed Level Change after a typical winter storm with wind from 255°

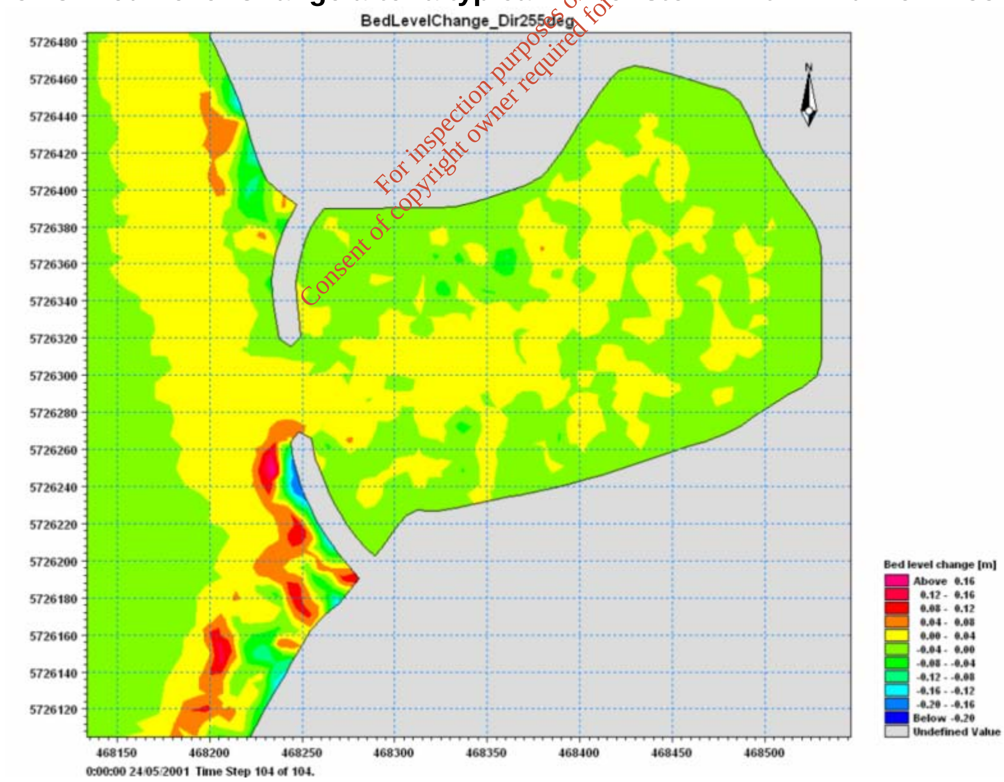

Figure 15.49: Bed Level Change after a typical winter storm with wind from 255° - showing associated scour at breakwater structures

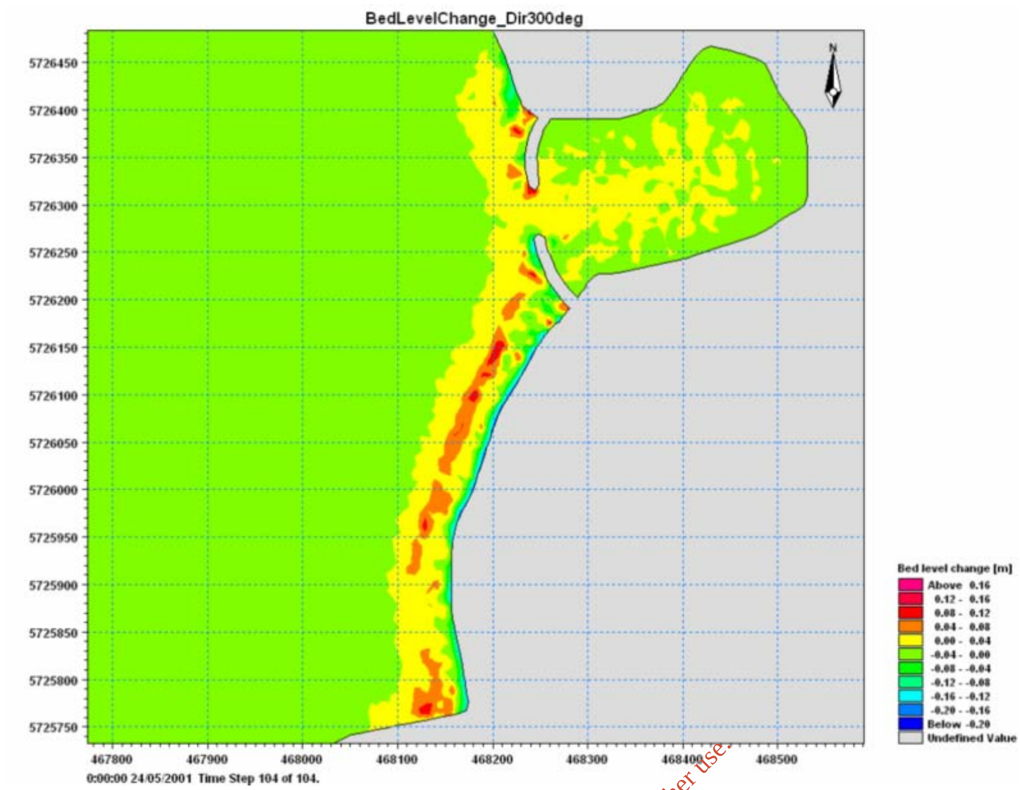

Figure 15.50: Bed Level Change after a typical winter storm with wind from 300°

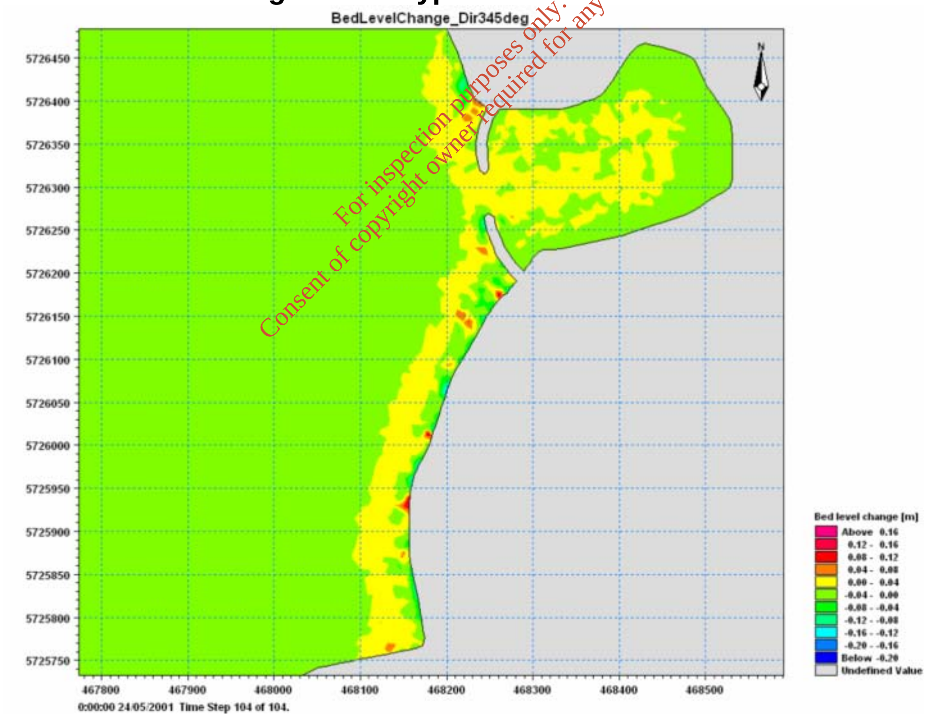

Figure 15.51: Bed Level Change after a typical winter storm with wind from 345°

In order to identify the impact on the sediment regime of a more realistic combined wind event of changing direction, wind directions of 255°, 300° and 345° were run in immediate succession, to represent a typical depression passing through the area. The bed level change results are shown in Figure 15.52. The results show the same pattern of sediment movement as for the individual events, with particular similarity to the 255° simulation, although more extreme, with an even more evident sandbar formation in the nearshore area.

It is interesting to note that most of the sediment movement occurs early in the simulation during the 255° wind, before stabilising.

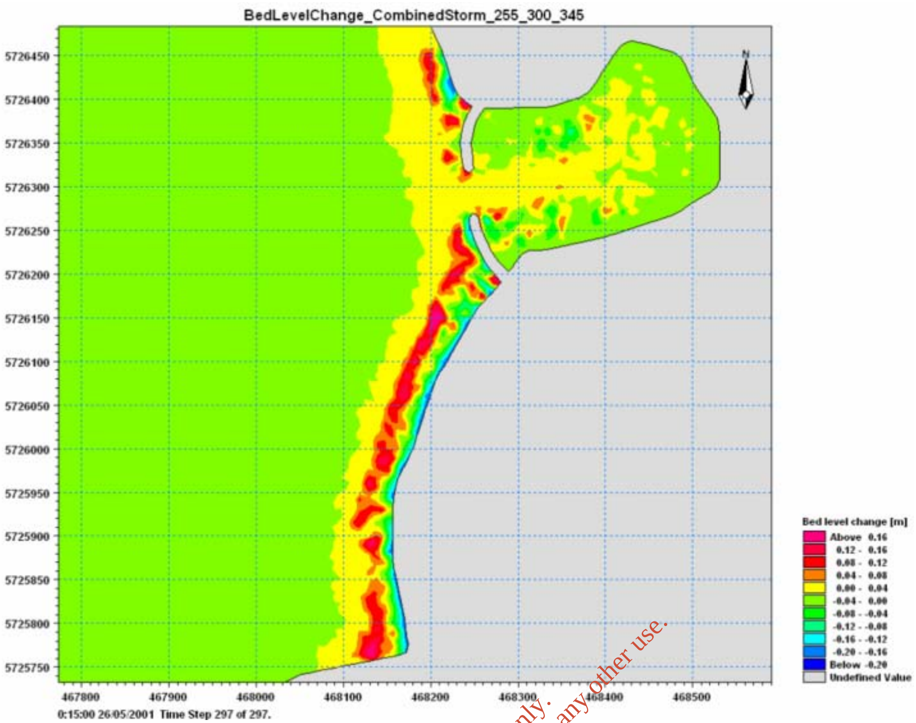

Figure 15.52: Bed Level Change after a typical winter storm with combined wind directions of 255°, 300° and 345° in immediate succession

15.5.2.7 Shellfish

Shellfish are an important ecological factor in the Bantry area, with the proposed site lying within EU designated Shellfish Waters, as shown in Figure 15.53. However, modelling studies have indicated that the impact on shellfish is expected to be minimal, due to the small tidal currents in the areas, which are not expected to carry the sediment over any significant distance in a short term period. A large proportion of the sediment to be placed on the beach is quite coarse, which will decrease the likelihood of it moving offshore.

Although the finer particles at the Cove site are expected to move around, the results of this study conclude that there is no mass movement of these beyond the breakwater structures. Fine sediment would be expected to move from the Beicin Strand during an onshore wind, although the material is not expected to move far, and it is very unlikely to be transported offshore to the main shellfish sites. In practice, only the coarse material should be placed along the strand, so this reflects a worst case scenario involving the finer particles.

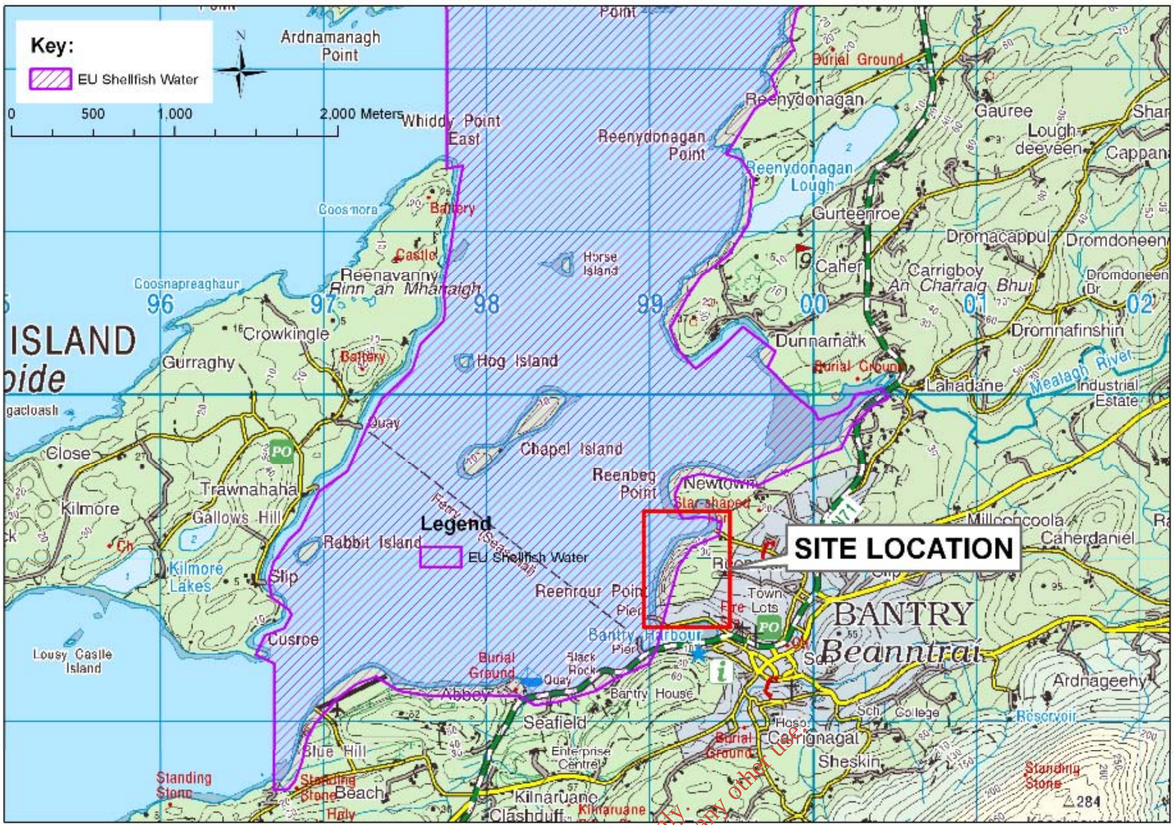

Figure 15.53: Location of Proposed Beach Renourishment Sites relative to EU Shellfish Waters

15.5.2.8 Cove Conclusions

RPS have investigated the feasibility of renourishing a beach in the vicinity of Bantry town, and have subsequently chosen the Cove and Beicin Strands as potential receptor sites of dredge material arising from the deepening of Bantry harbour. 81,500m^3 of material is available for the beneficial re-use in the Cove and Beicin area, largely comprising of sandy silty gravels. Based on this volume of material, RPS have established the basic profile of the beach and the two protective breakwater structures required for sediment retention. The gradient of the beach is anticipated to be as steep as a 1 in 10 or 1 in 15 slope, levelling out towards the water line. At the Cove site, it is anticipated that circa 79,500m^3 of material will be required to produce an adequate beach, with the remainder being positioned along the Beicin Strand.

In order to ascertain the response of the beach to a typical winter storm from three directional sectors 255°, 300° and 345°, investigative computational modelling was carried out using the MIKE 21/3 Coupled Model FM from the Mike Suite of Software, by DHI, Denmark. This incorporated hydrodynamic, wave and sediment transport modelling within the one modelling simulation for each direction, enabling a clear picture of the coastal processes in the area around the site.

Results from the hydrodynamics indicated a dominate influence from wind and waves on the littoral currents in the Bantry area, due to the small nature of the tidal currents, thus creating significant eddying. Littoral currents within the Cove site were found generally to form a circular pattern, either moving up each side and returning through the centre of the breakwaters, or by a simple clockwise circulation in the case of the 345° wind direction. If the breakwaters were not in place, the finer sandy material would almost certainly be lost during a typical winter storm.

Model results show that the significant wave height reaches 0.8metres at the opening between the breakwaters, with 0.7metres along the Beicin Strand for the critical wind direction of 255°, with wave diffraction through the opening between the breakwaters evident for sectors 255° and 300°.

The sediment transport modelling has shown that for all directions, there is a greater potential rate of sediment transport in the water column on the ebb tide than on the flood tide, with evidence of cross shore sediment transport at the Beicin Strand resulting in the formation of a sandbar and some minor occurrence of drawdown in the Cove Bay. The maximum potential rate of sediment transport at any point was circa $0.002m^3/s/m$. Potential scour will occur around the new breakwater structures, with a small sandbar likely to form just offshore, therefore requiring some scour protection incorporated in the design. Overall, it seems that the wind direction 255° will be the critical direction for sediment movement off both the Cove and Beicin Strands. Due to the small tidal currents in the area, and the relatively coarse material to be placed on the beaches, it is not expected to impact significantly on any shellfish in the area.

It is clear from these modelling results that the proposed breakwater structures will function as anticipated, and if they were not included in the scheme, the sand from within the Cove bay would quickly be dispersed offshore. Although the finer sediment placed along Beicin Strand is not expected to remain on site, without a significant and expensive offshore breakwater system, the courser material is expected to remain intact, resulting in a valuable connection between Bantry Harbour and the sandy Cove Bay, an important concept in this integrated scheme.

15.6 Summary

The coastal processes in the Bantry area have been assessed and modelled, along with the impact of the proposed development on these processes. The construction of breakwaters, inner and outer harbour dredging, along with the various fates of both contaminated and uncontaminated material have been modelled and reviewed using various software programmes under the DHI Mike Suite of software.

Computational modelling has shown that the potential for the spread of contaminants if dredging in the wet is minimal and as such there would not appear to be any particular advantage to adopting a 'dry' dredging technique at Bantry, however a semi-wet solution may be most appropriate. Environmental risks associated with dredging in a wet or semi-wet environment should be manageable with the use of appropriate equipment and environmental monitoring of the dredging operation. Such monitoring measures may include the installation of monitoring buoys and regular sampling of turbidity and suspended solids. In some cases prevention measures such as a silt screen may also be required. However, the results of the preliminary hydraulic modelling indicate that there will be limited movement of suspended sediments during the dredging operation; therefore a silt screen may not be required.

Due to the presence of mercury in the top 1m of the bed both inside and outside the harbour, specific dispersion modelling was carried out to determine the fate of the contaminant during and after dredging. For all scenarios, suspended solids concentrations were well below the critical 0.07kg/m^3 level.

The dredge material from outside the harbour will be reused as an alternative fill as part of a boat storage scheme at the Abbey Strand site. The land reclamation scheme will involve placing the granular dredged material behind an armoured bund to provide a reclaimed area on the foreshore to the west of the harbour. The bund will prevent the dredged material from escaping into the surrounding waters, and thus providing safety for shellfish within the local area. The sediment will be treated before being used as part of the Abbey site.

Contaminated material from the inner harbour will be treated and reused as fill within the reclaimed areas of the proposed development. The uncontaminated dredge material from the inner harbour will be beneficially reused in a beach renourishment scheme at Cove and Beicin Strand. Breakwater structures will be constructed in order to retain the new sediment. In order to ascertain the response of the proposed beach and breakwaters to a typical winter storm from three directional sectors, investigative computational modelling was carried out using the MIKE 21/3 Coupled Model FM. This incorporated hydrodynamic, wave and sediment transport modelling within the one modelling simulation for each direction, enabling a clear picture of the coastal processes in the area around the site. It is clear from the modelling results that the proposed breakwater structures will function as anticipated, and if they were not included in the scheme, the sand from within the Cove bay would quickly be dispersed offshore. Although the finer sediment placed along Beicin Strand is not expected to remain on site, without a significant and expensive offshore breakwater system, the coarser material is expected to remain intact, resulting in a valuable connection between Bantry Harbour and the sandy Cove Bay, an important concept in this integrated scheme.

16.0 WATER

This section of the EIS assesses the potential impact of the proposed development on water quality. Existing water quality in the vicinity of the proposed development is established based on available water quality information. Potential impacts related to the construction and operational phases of the proposed development are assessed and mitigation measures proposed to reduce significant environmental impacts on the receiving water environment. In addition, this section provides a brief summary of the Flood Risk Assessment (FRA) which was carried out for the proposed scheme.

This section therefore covers the following topics:

- Consultation;
- Potential impacts;
- Current water quality status;
- Assessment of impacts;
- Water quality mitigation measures;
- Residual impacts.
- Flood Risk Assessment

16.1 Consultation

Preparation of this section of the EIS included consultation, either directly or through publicly-available information, with a number of organisations with an interest in water quality.

Any submissions received in relation to potential water quality issues as a result of the proposed works have been taken into consideration.

16.2 Potential impacts

The types of water quality impacts which could potentially be associated with the proposed development at Bantry harbour include:

- Construction phase impacts;
- Operational phase impacts.

16.2.1 Construction phase impacts

Temporary impacts on water quality can occur during construction. Pollution from mobilised suspended sediment is the prime concern.

- Increased suspended sediment levels due to dredging mainly, but also due to run-off from on-land construction areas;
- Sedimentation due to settling of suspended sediment;
- Water quality impacts associated with the contaminated sediments (metals, TBT);

- Water quality impacts associated with works machinery and infrastructure (fuels and other chemicals and waste water).

16.2.2 Operational phase impacts

Operational phase impacts will be associated with the increased number of boats and other traffic in the area.

- Water quality impacts due to increased boating activities (fuels, oils, hydrocarbons and other chemicals, waste water, suspended sediment levels).

Any of these impacts have the potential to impact on water quality and associated species and habitats and therefore the activities associated with the construction and operation phases of the development require mitigation.

16.3 Current water quality status

A desk-based assessment of surface water quality in the vicinity of the proposed development site was conducted. The sources of the water quality information summarised include:

- Shellfish monitoring programme;
- Water Framework Directive water body status information arising from the Water Framework Directive monitoring programme and outlined in the South Western River Basin Management Plan (2009-2015) (SWIRBD, 2010).
- Water quality information outlined in the EPA's most recent water quality report, Water Quality in Ireland 2007-2009 (EPA, 2010).

16.3.1 Shellfish water quality

The Shellfish Directive (2006/113/EC), transposed in Ireland by the Quality of Shellfish Waters Regulations (S.I. No. 268 of 2006), as amended, aims to support shellfish life and growth and to contribute to the high quality of directly edible shellfish products within designated shellfish areas.

The Cove and Abbey sites are located within a designated shellfish area – Bantry Bay Inner shellfish area (**Figures 16.1** and **16.2**). Therefore, the sites are subject to the achievement of shellfish water quality parameter values outlined in Annex I of the Shellfish Waters Directive (2006/113/EC) and Schedule 2 and 4 of the Quality of Shellfish Waters Regulations (S.I. No. 268 of 2006). **Table 16.1** summarizes these shellfish water quality mandatory and guideline values. Mandatory (I) values must be fully achieved while it must be endeavoured to achieve guideline values (G).

Figure 16.1 Designated shellfish areas within the vicinity of Bantry Harbour

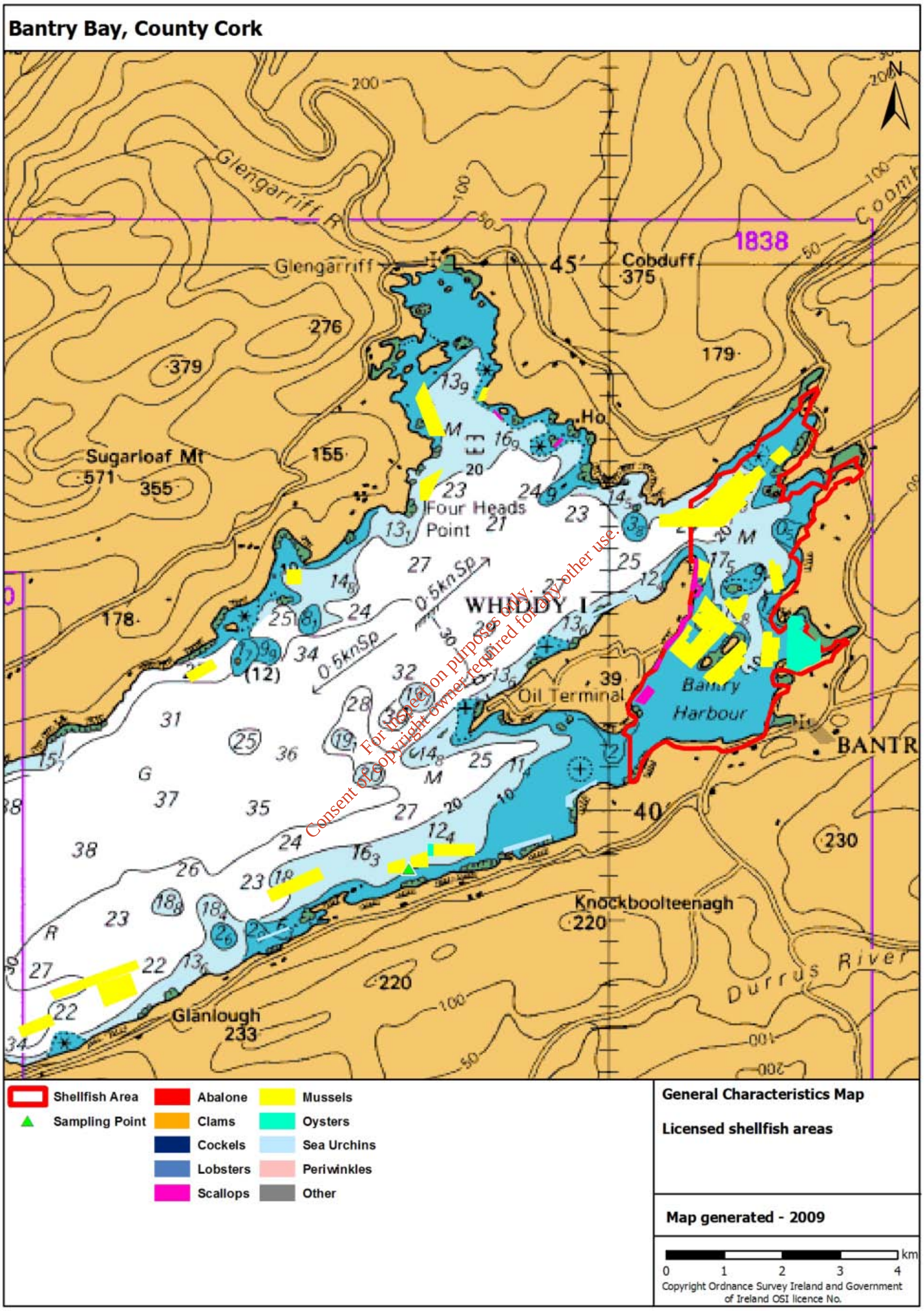

Figure 16.2 Licensed shellfish areas

Table 16.1 Parameters listed in Annex I of the Shellfish Water Directive

Physical	**Guideline Values (G)**	**Mandatory Values (I)**
pH (pH units)		7 – 9 pH units
Temperature (°C)	A discharge affecting shellfish waters must not cause the temperature of the waters to exceed by more than 2°C the temperature of waters not so affected	No mandatory value set in the Directive
Colouration (after filtration) (mg Pt/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 unaffected waters
Suspended Solids (mg/l)		A discharge affecting shellfish waters must not cause the suspended solid content of the waters to exceed the content in unaffected waters by more than 30%
Salinity (%)	12 to 38%	≤ 40% A discharge affecting shellfish waters must not cause their salinity to exceed the salinity of unaffected waters by more than 10%
Chemical	**Guideline Value (G)**	**Mandatory Value (I)**
Dissolved oxygen (Saturation %)	≥ 80%	≥ 70% Should an individual measurement indicate a value lower than 70%, measurements shall be repeated An individual measurement may only indicate a value of less than 60% if there are no harmful consequences for the development of shellfish colonies
Petroleum hydrocarbons		Hydrocarbons must not be present in the shellfish water in such quantities as to: - produce a visible film on the surface of the water and/or a deposit on the shellfish - have harmful effects on the shellfish
Organohalogenated substances	The concentration of each substance in shellfish flesh must be so limited that it contributes in accordance with	The concentration of each substance in the shellfish water or in shellfish flesh must not reach or exceed a level which has harmful effects on the

	Article 1 (of the Directive), to the high quality of shellfish products	shellfish larvae
Metals (Ag, As, Cd, Cr, Cu, Hg, Ni, Pb and Zn) (mg/L)	The concentration of each substance in shellfish flesh must be so limited that it contributes in accordance with Article 1 (of the Directive), to the high quality of shellfish products	The concentration of each substance in the shellfish water or in the shellfish flesh must not exceed a level which gives rise to harmful effects on the shellfish and their larvae The synergic effects of these metals must be taken into consideration
Others	**Guideline Value (G)**	**Mandatory Value (I)**
Faecal coliforms (per 100 mL)	≤ 300 per 100 mL in the shellfish flesh and intervalvular liquid	No mandatory value set in the Directive
Substances affecting the taste of shellfish		Concentration lower than liable to impair the taste of the shellfish
Saxitoxin (produced by dinoflagellates)	No limit given	No limit given

The dedicated shellfish monitoring programme, carried out by the Marine Institute, involves analysing for general components, metals and organics in both water and biota samples. For Bantry Bay Inner shellfish area, there were 21 water samples and 8 biota samples available which were taken between 2004 and 2010. The mandatory and guideline values were not breached in any of these samples.

Of 24 faecal coliform biota results available from between December 2003 and August 2009, the shellfish guideline value for faecal coliforms in biota was breached in 16 samples (December 2003, May 2004, August, 2004, December 2004, February 2005, August 2005, December 2005, May 2006, December 2006, August 2007, December 2007, February 2008, May 2008, August 2008, November 2008, August 2009). Therefore, this shellfish area is non-compliant with the shellfish faecal coliform guideline values.

Shellfish flesh classifications (carried out under the European Communities (Live Bivalve Molluscs) (Health Conditions for Production and Placing on the Market) Regulations, 1996 (S.I. No. 147 of 1996)) are an indicator of faecal contamination in shellfish flesh. Sampling is carried out by the Sea Fisheries Protection Authority (SFPA) on at least a monthly basis. The licensed area within Bantry Bay Inner is classified as Class B (2011/2012 classification) meaning that '*shellfish may be placed on the market for human consumption only after treatment in a purification centre or after relaying so as to meet the health standards for live bivalve molluscs laid down in the EC Regulation on food safety (Regulation (EC) No 853/2004)*'. The shellfish flesh classification for the previous monitoring period (2010/2011) was also B. This monitoring therefore also indicates faecal contamination in the area.

16.3.2 Water Framework Directive status

Directive 2000/60/EC establishing a framework for Community action in the field of water policy (the Water Framework Directive), and transposing regulations, European Communities (Water Policy) Regulations, 2003 (S.I. No. 722 of 2003), as amended by the European Communities (Water Policy) (Amendment) Regulations, 2005, establish a legal framework for the protection, improvement and sustainable management of rivers, lakes, transitional waters (estuaries), coastal waters and groundwater.

The aim of the WFD is to prevent deterioration of the existing status of waters and to ensure that all waters are classified as at least 'good' status (by 2015 in most cases, with all waters achieving good status by 2027 at the latest). A water body must achieve both good 'ecological status' and good 'chemical status' before it can be considered to be at good overall status.

Environmental Quality Standards (EQSs) for classifying surface water status are established in the European Communities Environmental Objectives (Surface Waters) Regulations, 2009 (S.I. 272 of 2009). These regulations set standards for biological quality elements, physico-chemical conditions supporting biological elements (including general conditions and specific pollutants), priority substances and priority hazardous substances.

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

In order to establish the WFD status of water bodies, the EPA developed a new, WFD-compliant monitoring programme which began in 2006. Interim status classifications were published in 2010 based on monitoring information collected between 2006 and 2008. Final status classifications, based on the results of a complete monitoring cycle, i.e. 2007 to 2009, were reported in 2011.

Bantry Harbour and the adjacent Cove and Abbey sites are within Inner Bantry Bay transitional water body (water body code: IE_SW_170_0100). The interim WFD status of this water body was reported as 'high' in the South Western River Basin Management Plan. However, this water body was not monitored between 2006 and 2008 this status is extrapolated based on a similar water body (IE_SW_190_300 – Inner Kenmare River). Similarly, the Inner Bantry Bay water body was not included in the final status classifications reported in 2011.

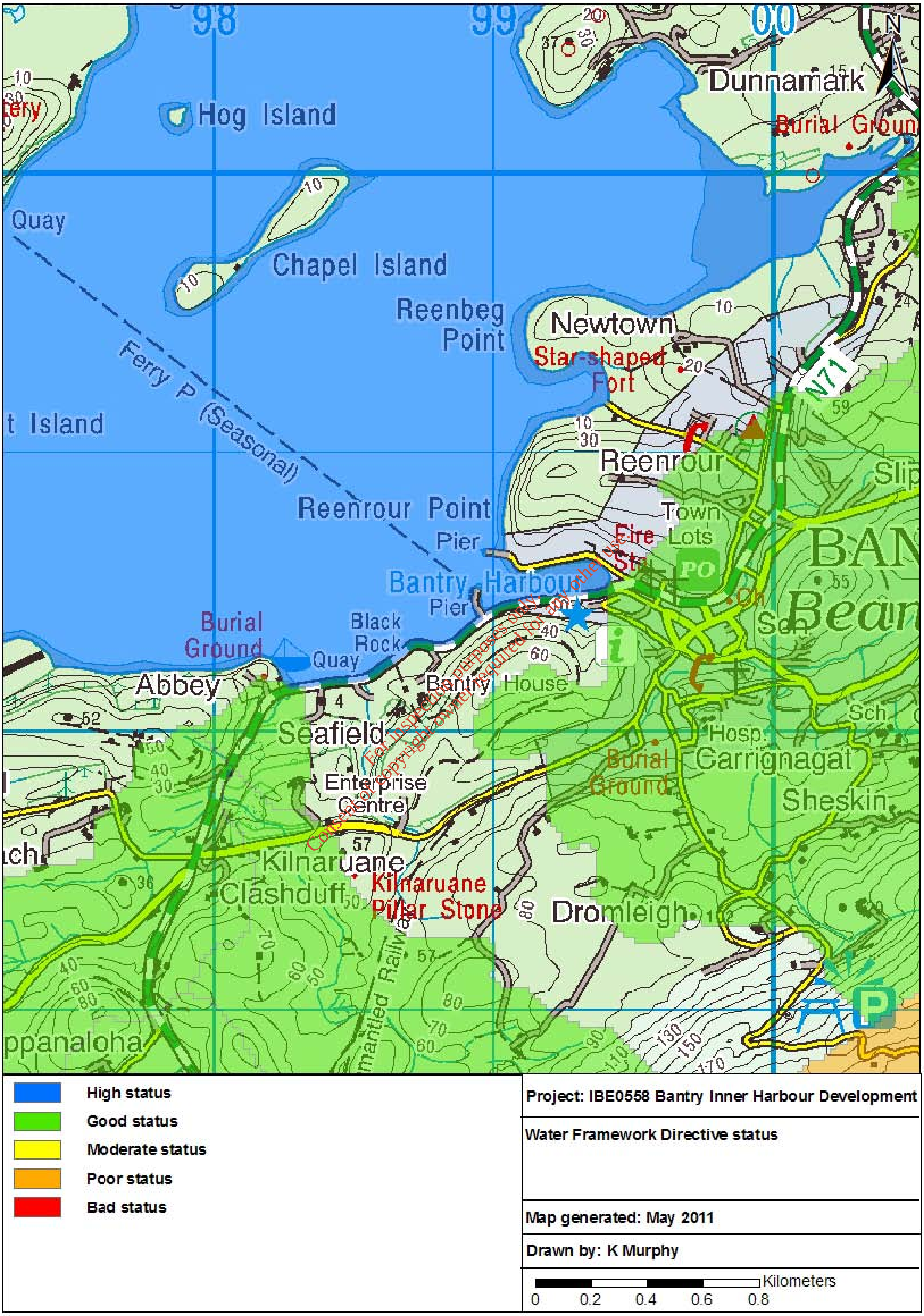

Figure 16.3 WFD status

16.3.3 EPA Water Quality 2007-2009

The EPA Water Quality Report 2007-2009 was published in 2010 and presents a review of Irish ambient water quality for the years 2007 to 2009. The water quality information in relation to transitional and coastal waters outlined in the report was generated by the EPA as well as other organisations including the Marine Institute, the Sea Fisheries Protection Authority (SFPA), National Parks and Wildlife Service (NPWS), Waterways Ireland; and the Irish Coast Guard.

Bantry Bay is however not included in the EPA estuarine and coastal waters monitoring programme and therefore no results for the proposed development area are reported in the EPA Water Quality Report 2007-2009.

16.3.4 Overall water status

The available monitoring information for the waters in the vicinity of the proposed development arises from the shellfish monitoring programme. It indicates issues with faecal contamination. However, 21 water samples analysed for general components, metals and organics between 2004 and 2010 did not breach mandatory and guideline values for these parameters. Therefore, the available monitoring data indicates that the only water quality issues in the area are associated with faecal contamination.

16.4 Assessment of potential impacts

16.4.1 Suspended sediment and sedimentation impacts

<u>16.4.1.1 Bantry harbour site</u>

Modelling carried out as part of the current environmental impact assessment exercise, and summarised in Chapter 15 of this EIS, demonstrates that suspended sediment concentrations in the water column during the dredging operation would be very low outside the confines of the harbour. Within the harbour, most of the material lost to the water column would fall back quickly onto the bed within the harbour area to be removed during final cleanup operations.

Similarly, sedimentation impacts associated with the proposed dredging in the harbour would be small and confined to the immediate area of the harbour due to the low tidal velocities in the area and the relatively coarse nature of the material to be dredged.

During the operational phase, minor suspended sediment and sedimentation impacts may be associated with increased boat traffic and resultant wake issues.

<u>16.4.1.2 Cove and Beicin sites</u>

The works associated with the beach renourishment at the Cove and Beicin sites involve placing the dredged material from the land side at low tide, meaning that the material will not be sprayed in close proximity to the water. Therefore, the works are not likely to directly result in increased suspended sediment loads at either the Cove or Beicin Strand sites.

A large proportion of the sediment to be placed at Cove and Beicin is quite coarse, which will decrease the likelihood of its moving offshore. However, modelling has demonstrated that some movement of sediment will occur associated with tide and wave action.

Modelling of the potential movement of the material placed along Beicin Strand reveals that an offshore shift in material would occur, thus creating an offshore sandbar. In time, some of the fine material from this offshore sandbar may be redistributed in the area, depending on the tidal regime. Due to the fact that the tidal currents in the area are small, it is not expected that they will carry sediment over any significant distance in a short term period. The consequences of the finer material being moved offshore of the strand will result in the final beach having a relatively coarse grain size, as is the existing condition. It is not possible to avoid this movement without a significant and expensive offshore breakwater system.

Some beach readjustment at the Cove site is also evident from the modelling that was undertaken. The finer particles are expected to move around due to wave action but there is no mass movement beyond the breakwater structures expected. However, a small sandbar could potentially form just offshore of the breakwaters.

16.4.1.3 Abbey site

The works at Abbey will take place behind an armoured bund which will prevent the migration of the dredge material. There is scope for the suspension of bed material during placement of the bund structure but this material, which is not introduced material, would quickly re-settle and would not be carried far due to the small tidal currents in the area.

The impacts described above are rated in **Table 16.2** according to their severity (major, moderate, minor and neutral) in the absence of any mitigation

Table 16.2 Impact matrix (in the absence of mitigation)

	Bantry Harbour (dredging)	Cove and Beicin (re-nourishment)	Abbey Strand (land reclamation)
Construction phase			
Suspended sediments	Moderate	Moderate	Minor
Sedimentation	Moderate	Moderate	Minor
Operational Phase			
Suspended sediments	Minor	Neutral	Neutral
Sedimentation	Minor	Neutral	Neutral