12.0 COASTAL PROCESSES

12.1 Introduction

This Chapter of the EIS considers the potential and likely significant effects of the proposed alterations to the permitted development. The purpose of this chapter is to identify and describe any likely significant coastal processes effects as a result of the proposed alterations in the context of the permitted development. This was informed through the use of numerical modelling techniques which provided information on tides and sediment transport.

The coastal process models developed for the permitted development were used as a baseline and the subsequent changes as a result of the proposed alterations were quantified by comparison with pre-development conditions. The models were also used to quantify the impact of the proposed amendments during the construction phase due to dredging.

The computational modelling was undertaken using RPS' in house suite of MIKE coastal process modelling software developed by the Danish Hydraulic Institute as detailed in the following Sections.

The modelling was divided into two main areas as follows:

- Flow Regime Modelling
- Sediment Transport & Water Quality Modelling

The modelling of the coastal processes was undertaken using RPS coupled tide, wave and sediment transport Mike21 flexible mesh model of the Cork Estuary. This tidal model extends from the mouth of the Estuary to Cork City as shown in Figure 12.1 which also indicates the water depth in metres to Chart Datum (CD).

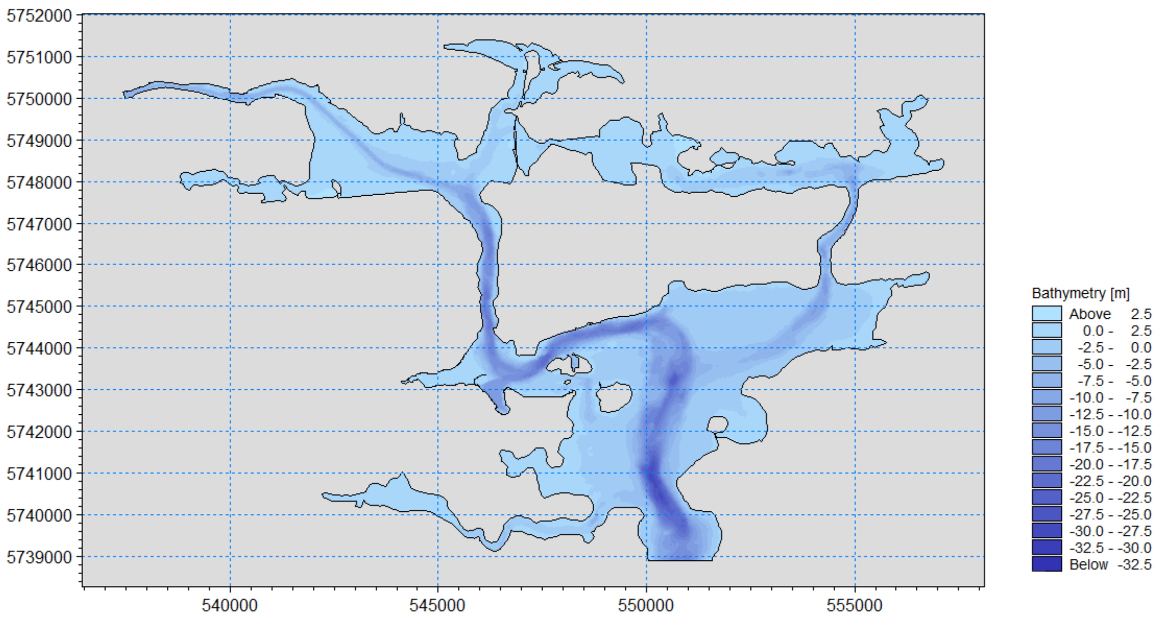

Figure 12.1 Flexible mesh tidal model of the Cork Estuary

The model of the estuary has a southern boundary near Roberts Cove; this tidal station was used to drive the tidal model. The model has graded grid spacing; with areas of fine cells in the vicinity of the redevelopment in the order of 5-10m in resolution and also with cells more concentrated in locations with rapidly varying bed profiles. This means the model has sufficient detail for the modelling of the coastal processes and dredging activity associated with the permitted development and proposed alterations.

12.2 Flow Regime Modelling

The flow models were run for a 16 day period selected so that the hydrodynamics used for the dredge plume and dispersion plume modelling were representative of the full range of tidal states that could be experienced during the permitted development construction phase. The models were verified by comparison of tidal height across the model domain with tide gauge network data and by comparison with recorded current meter readings collected specifically for this EIS by Irish Hydrodata.

12.3 Water Quality Modelling

Both the dredging of the Ringaskiddy East and Ringaskiddy West components of the permitted development were assessed with regard to the level of suspended sediment and deposition of material from the dredging plume. These were simulated using the dredging module in the Mike 21 FM MT model which is the sand and mud transport module within the MIKE suite. The simulations were run for a 12 day period so that the deposition results could be assessed under the widest range of tidal conditions. This is the period required to carry out the dredging programme and the timing was selected to include both small neap and large spring tides to ensure that the full range of dredging plume characteristics were established.

12.4 Data Sources

The model was developed from an existing RPS model. The rectangular 30m/10m resolution nested rectangular model had previously been developed using a combination of bathymetry data taken from local hydrographic surveys and supplemented by Admiralty Chart Data (as digitally supplied by C.Map of Norway). The bathymetric data was transferred from the existing model to a new flexible mesh model and supplemented by more recent surveys. Principally three surveys were added; the first related to the maintenance dredging carried out in the River Lee in 2011, the other two were undertaken specifically for this study. The extents of the surveys are indicated in Figure 12.2.

Figure 12.2 **Extent of bathymetric data survey datasets**

12.5 Model Calibration

The model was verified by comparison with tidal heights across the domain and published Admiralty tidal stream data. The two most relevant gauge locations are Cobh and Ringaskiddy, the locations of which are indicated in Figure 12.3. In addition some limited hydrographic data was collected at four locations near Paddy's Point at the site of the permitted pier and slipway (also indicated on the figure). The model showed good agreement with the current speed during mid tide which was recorded to be 0.6m/s.

Figure 12.3 Calibration locations for data presented

The model was used to simulate the full range of tidal excursion as shown in Figure 12.4 therefore the model was calibrated over this range.

Figure 12.512.5 and Figure 12.6 show the comparison between the predicted astronomic tide from the tide gauge at Cobh with the model data for the spring and neap tides respectively. Figure 12. 7 and Figure 12.8 shows the same data for Ringaskiddy. Both locations indicate that the model simulates the tidal flows well.

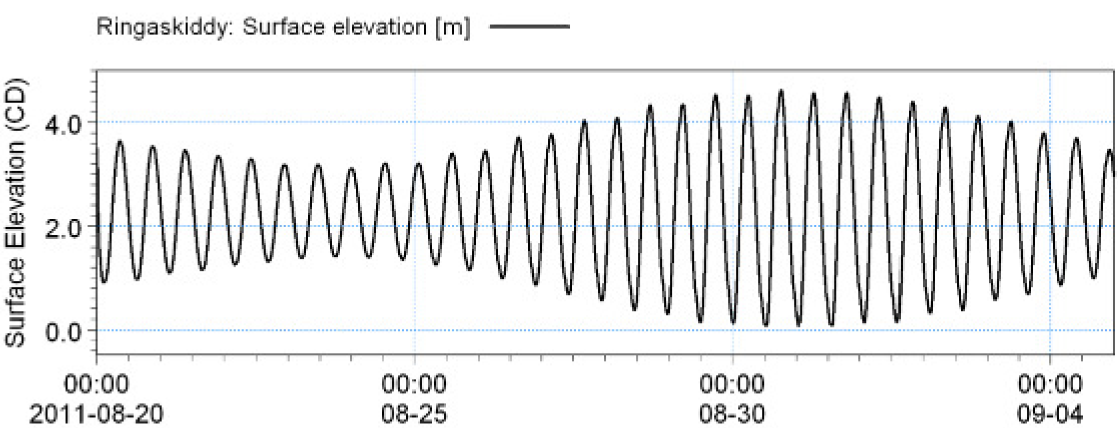

Figure 12.4 Surface elevation for simulation period (CD)

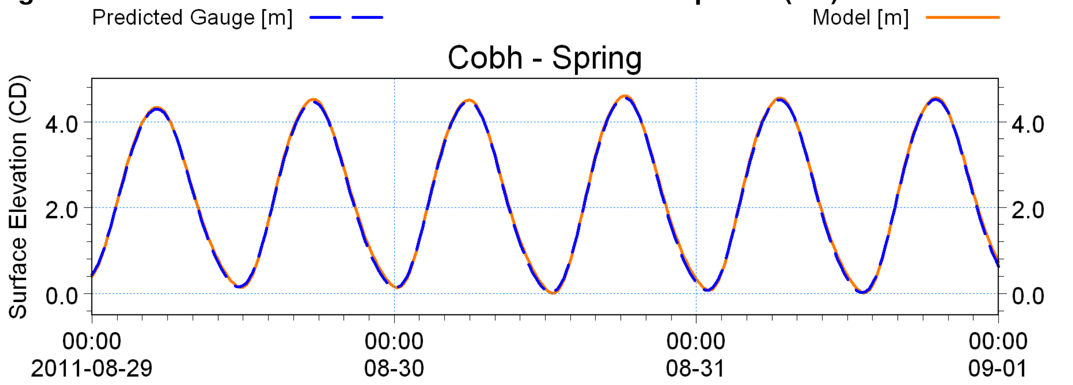

Figure 12.5 Tidal Elevation from Gauge and Model Data - Cobh Spring tide

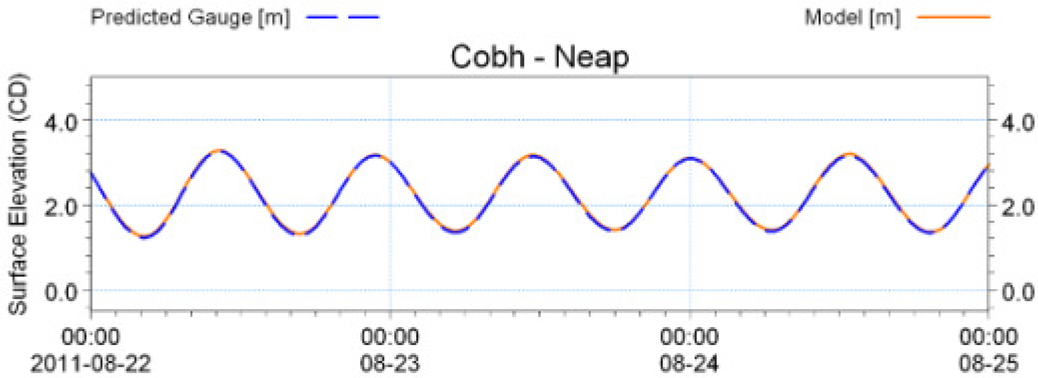

Figure 12.6 Tidal Elevation from Gauge and Model Data - Cobh Neap tide

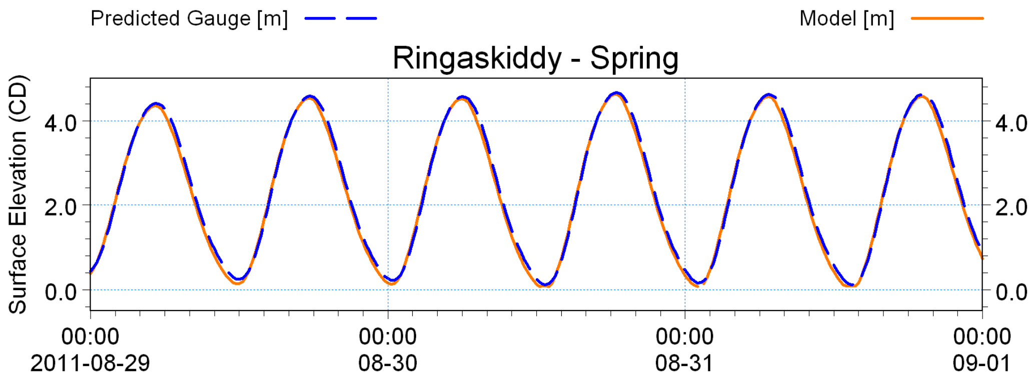

Figure 12. 7 Tidal Elevation from Gauge and Model Data - Ringaskiddy Spring tide

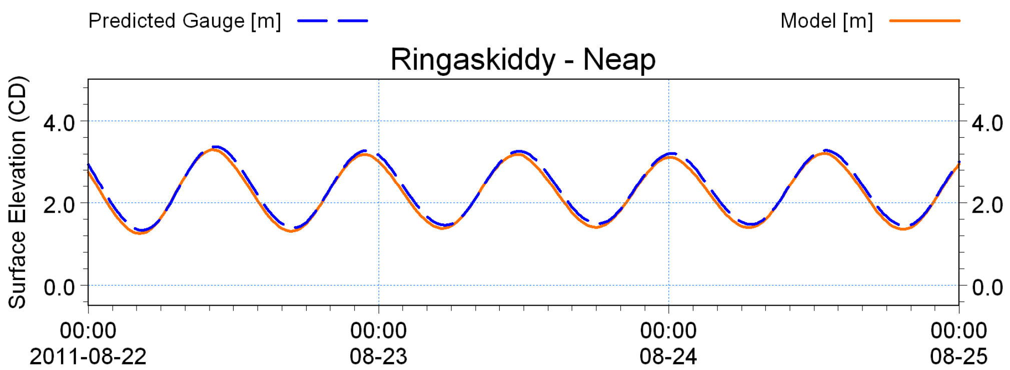

Figure 12.8 Tidal Elevation from Gauge and Model Data - Ringaskiddy Neap tide

12.6 Flow Regime Modelling

12.6.1 Baseline - Ringaskiddy Port Permitted Development

The baseline model bathymetry included the permitted development as shown in Figure 12.9; reclaimed areas are shown in solid yellow whilst dredging extents are outlined in yellow. Figure 12.10 and Figure 12.11 show the mid-ebb and mid-flood flow patterns respectively in the vicinity of the Port and environs.

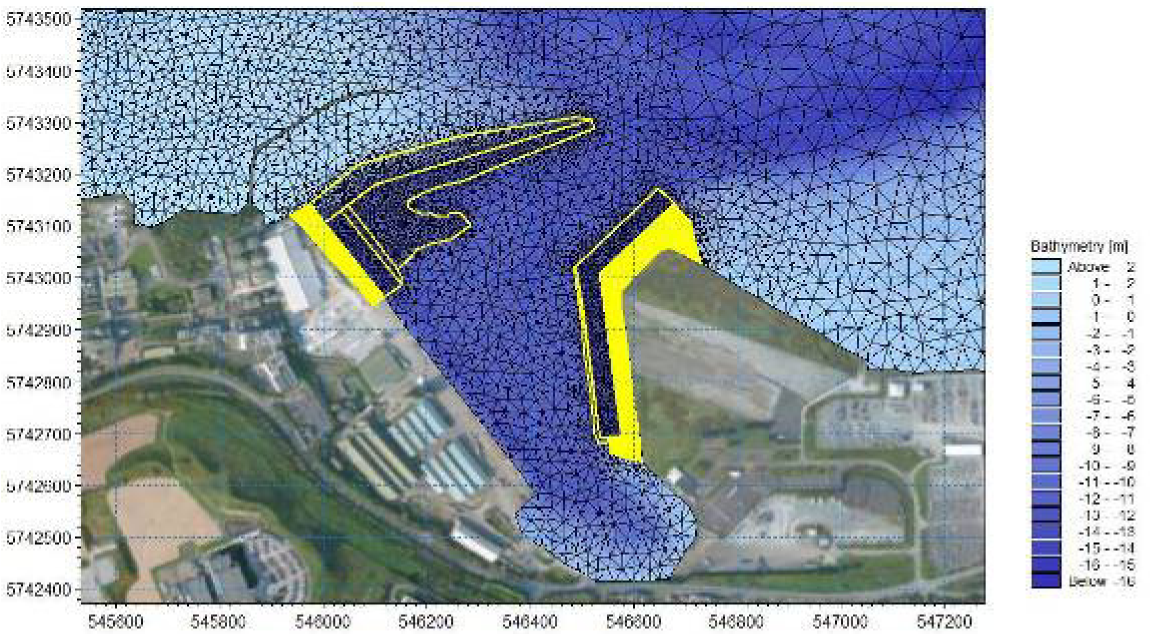

Figure 12.9 Baseline Bathymetry - Ringaskiddy

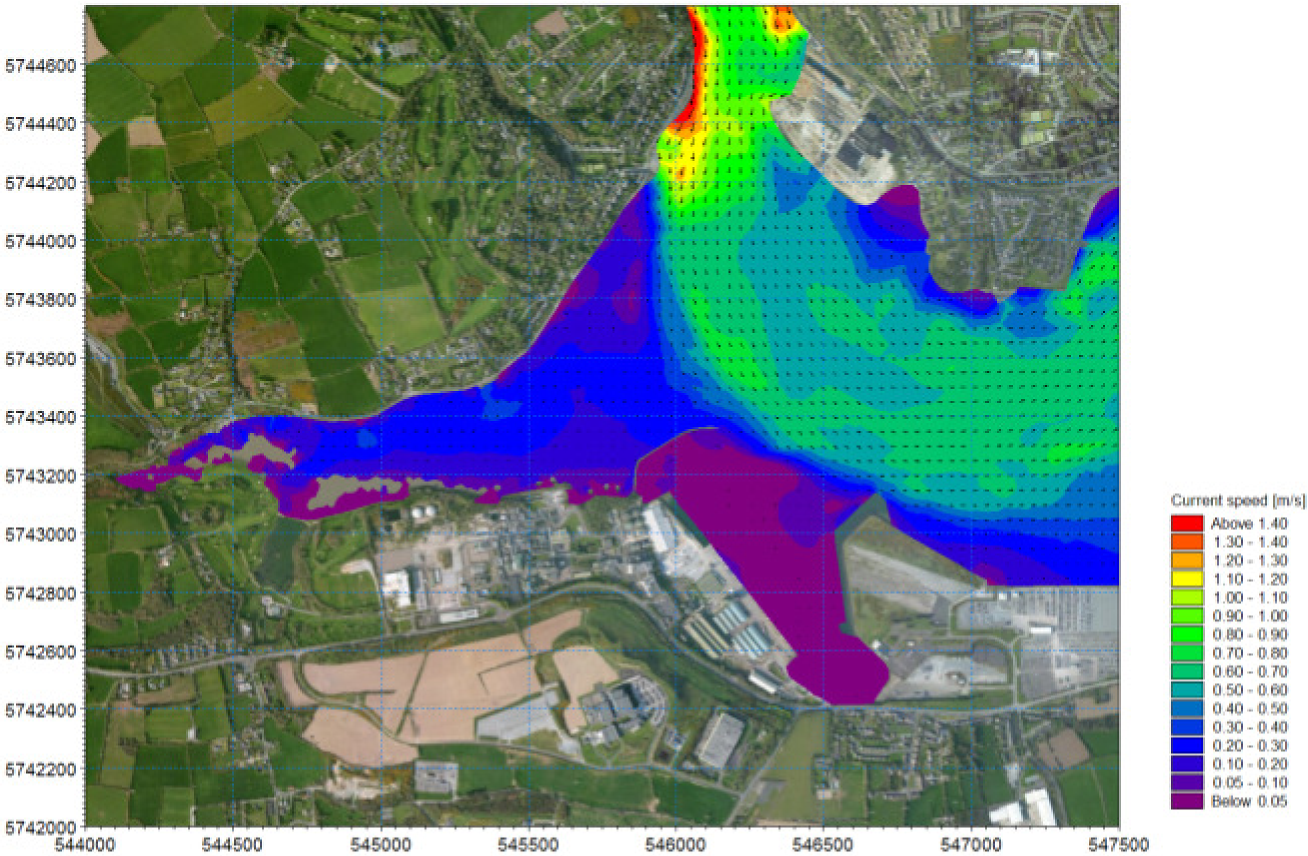

Figure 12.10 Permitted development Current Regime Mid-ebb

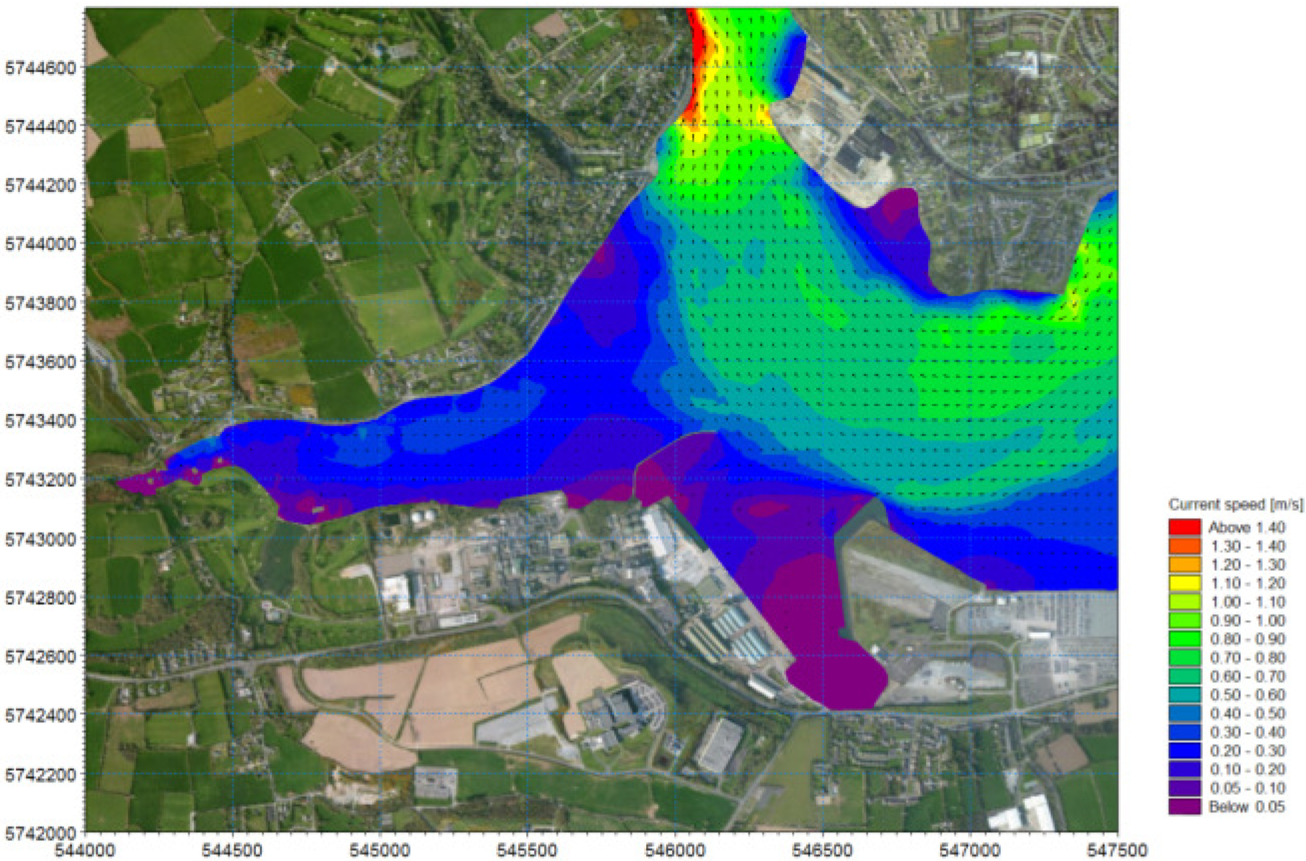

Figure 12.11 Permitted development Current Regime Mid-fld

The tidal currents in the area are strongly bi-directional within the main channel. However behind the Ringaskiddy ADM training wall, at the mouth of the Monkstown Creek, the current speeds are much smaller with some circulatory currents being evident. These reduced currents are illustrated further on an analysis of peak currents. Figure 12.12 and Figure 12.13 show the maximum current speeds experienced through the ebb and flood tide respectively.

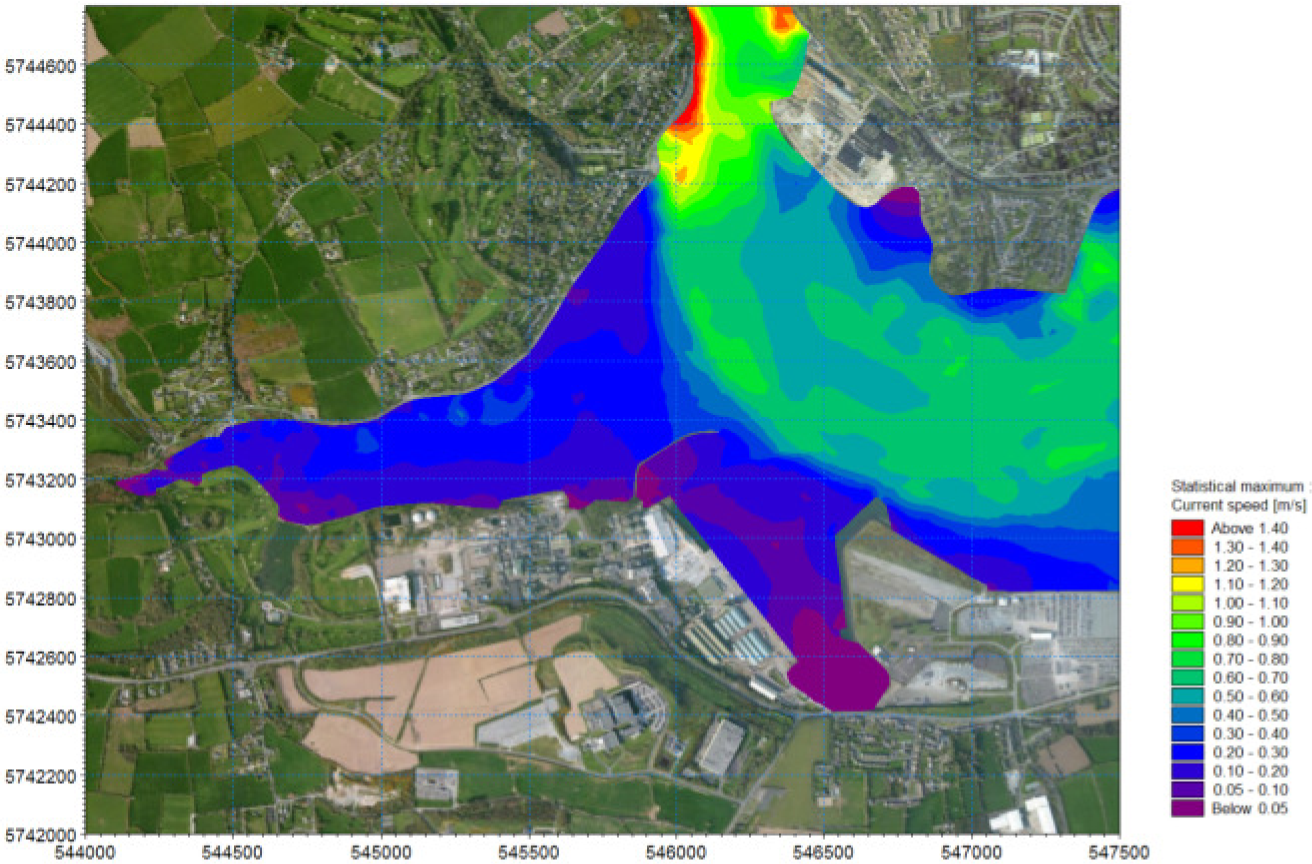

Figure 12.12 Permitted development Peak Ebb Current Speed

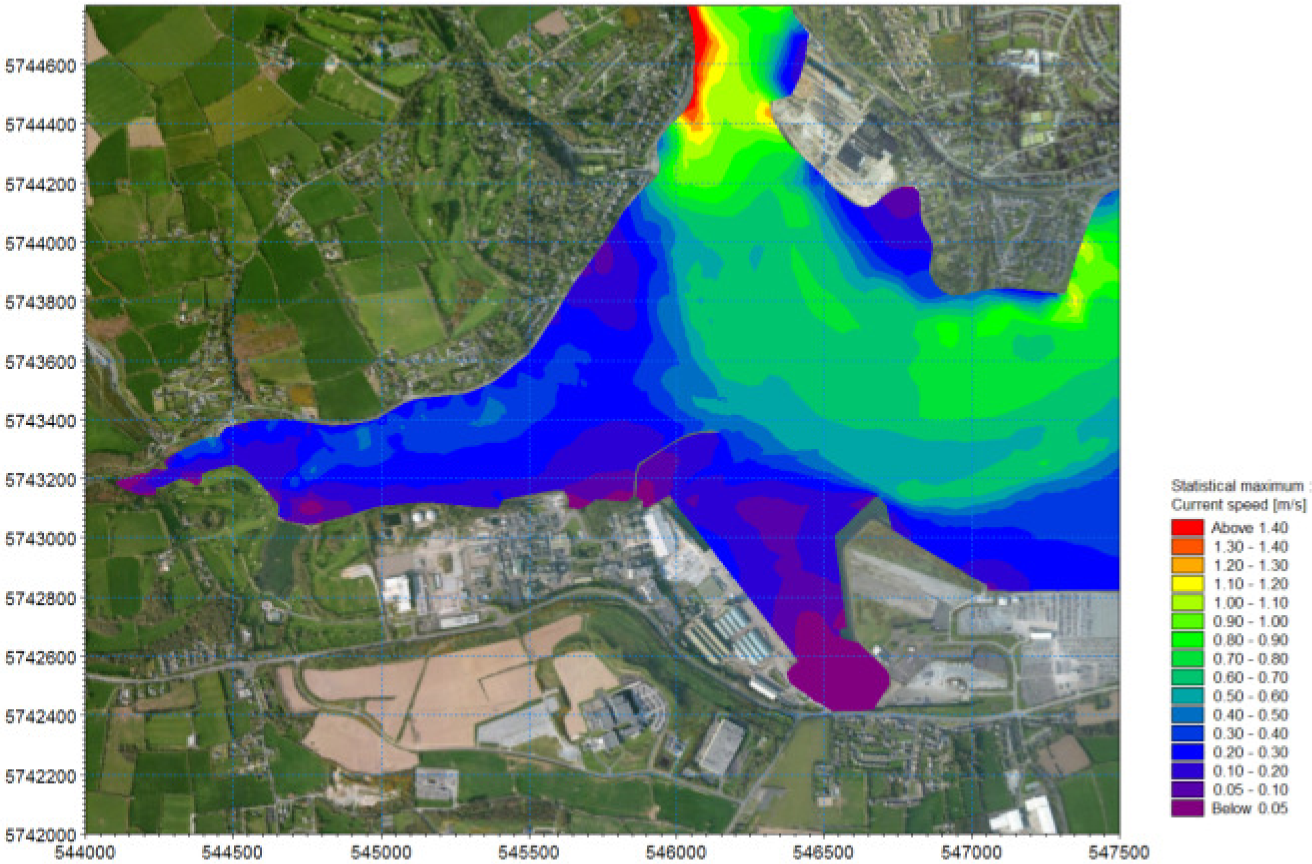

Figure 12.13 Permitted development Peak Ebb Current Speed

12.6.2 Impact of Proposed Alterations on Flow Regime

The proposed alterations include a straight quay wall as part of a proposed phased construction with additional dredging at the southern tip. The flood tide will therefore run unobstructed into the existing ferry terminal to the south rather than being directed around a protruding quay wall for this phase of the development. The proposed alterations will therefore have less impact on tidal currents than the currently permitted design at this southern end of the quay wall and will be more akin to the pre-redevelopment tidal pattern.

Figure 12.14 and Figure 12.15 show change in currents between the pre and post redevelopment flow regimes for ebb and flood tides; in each case the changes are very localised and are insignificant in the vicinity of the proposed berth and quay wall design amendment. Therefore it may be concluded that the less pronounced change proposed would be insignificant in terms of changes in tidal currents. This is also demonstrated in Figure 12.16 and Figure 12.17 which show the changes in the peak current speeds for ebb and flood tides pre and post consented development respectively.

Both the existing and proposed mooring dolphins are open piled structures which do not cause any significant obstruction to tidal currents, therefore no appreciable additional permanent effects are predicted relating to the amended siting of these structures when compared to the effects identified and described in the previous assessment for the permitted development.

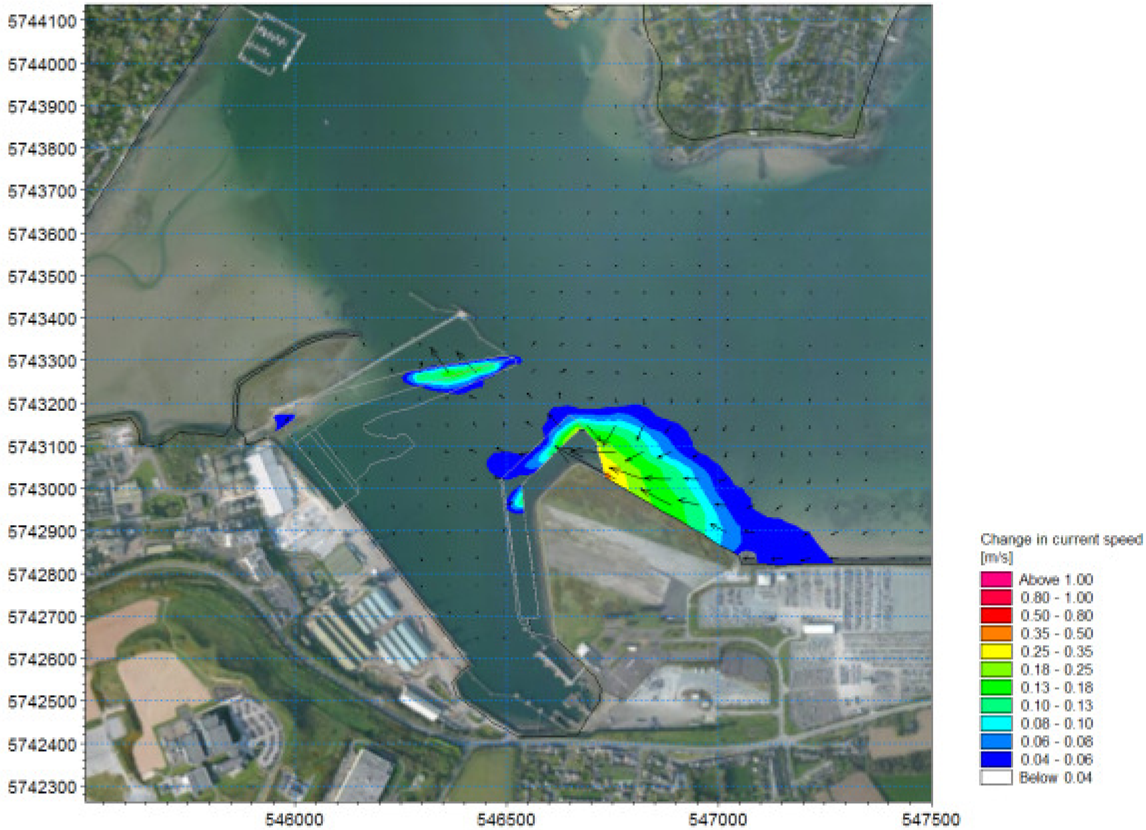

Figure 12.14 Vector Difference in Current Speed Mid-ebb (post minus pre-redevelopment)

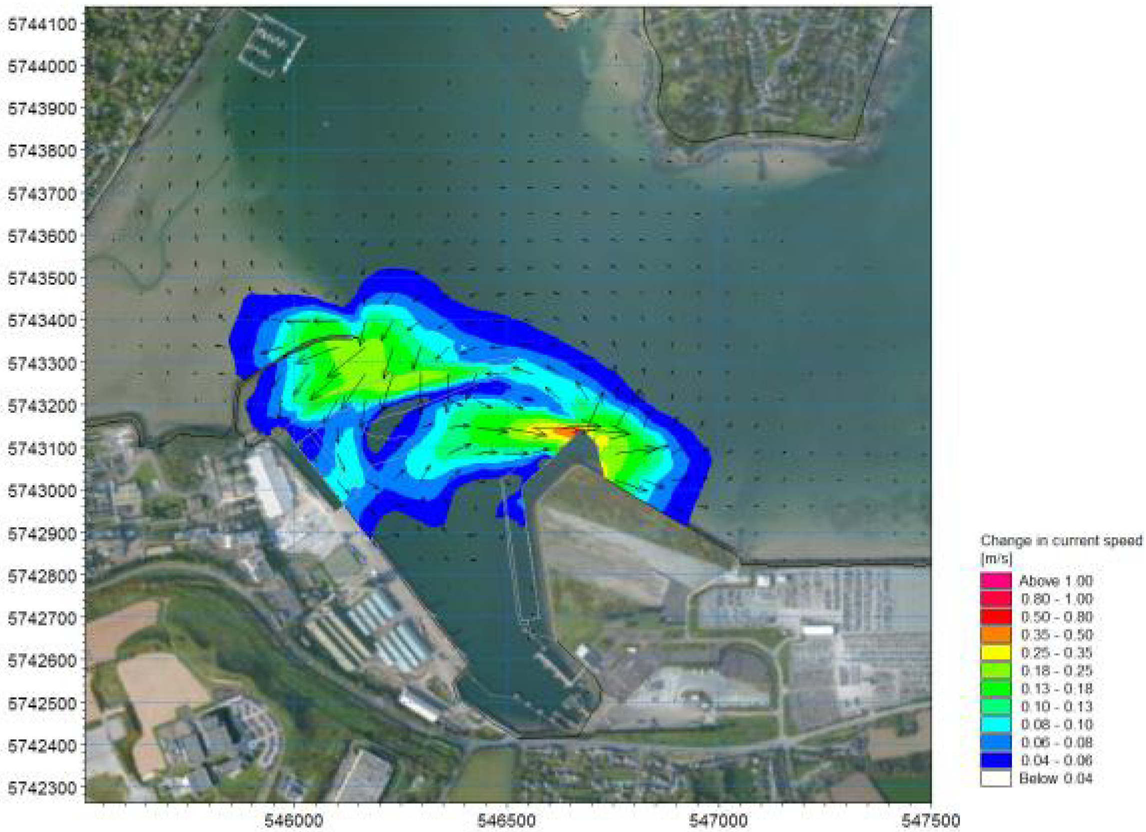

Figure 12.15 Vector Difference in Current Speed Mid-flood (post minus pre-redevelopment)

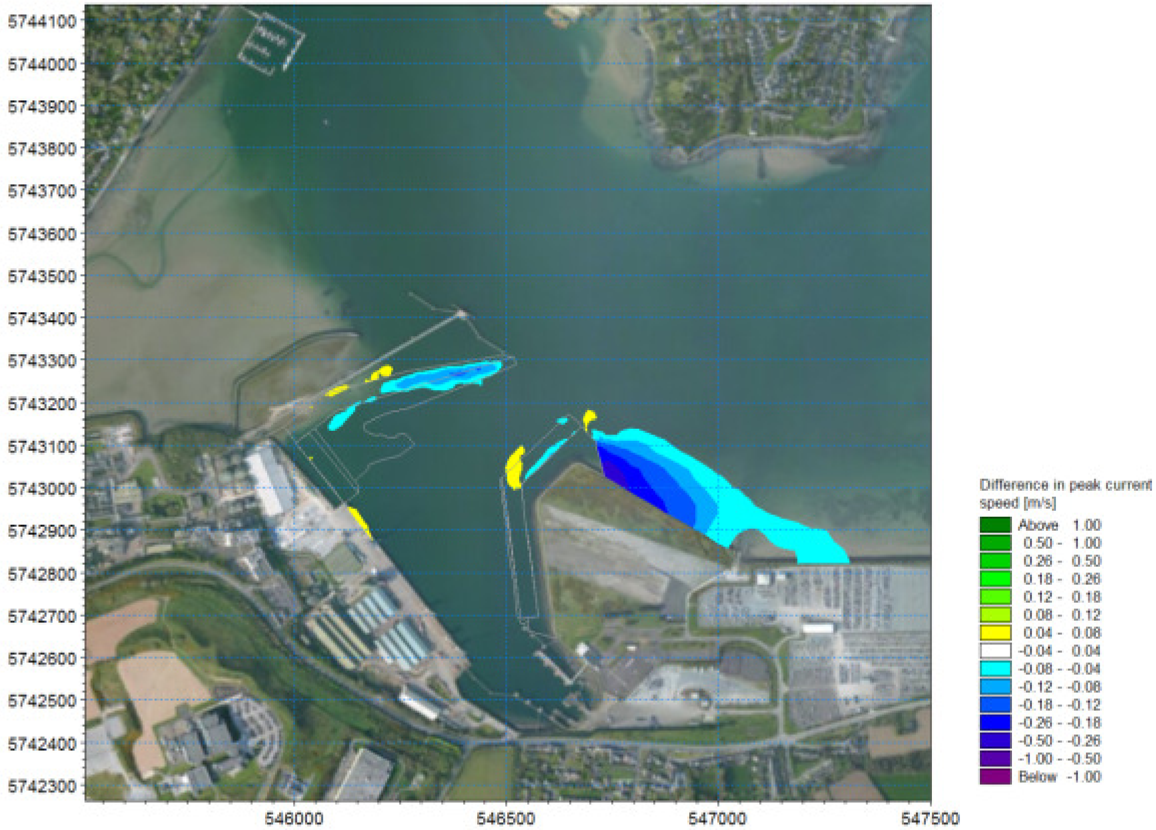

Figure 12.16 Difference in Peak Current Speed Ebb- (post minus pre-redevelopment)

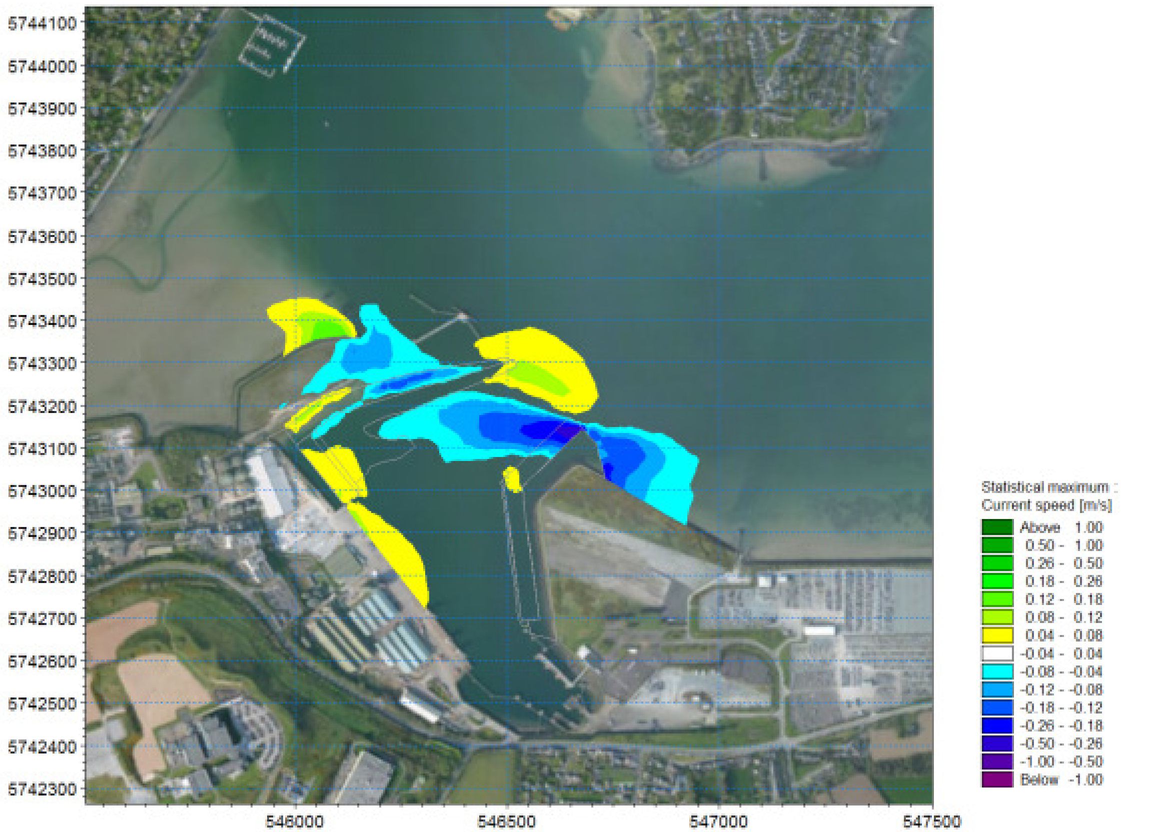

Figure 12.17 Difference in Peak Current Speed Flood (post minus pre-redevelopment)

12.7 Sediment and Water Quality

12.7.1 Baseline Sediment Modelling and Water Quality

Sediment modelling was carried out relating to the dredging plumes and subsequent sedimentation during the capital dredging at the two Ringaskiddy sites for the permitted development. In both cases the modelling was carried out using excess suspended sediment concentrations, therefore background levels were not modelled.

The modelling was carried out using the Mike21 Mud Transport module, which is an advection dispersion model which uses the hydrodynamic conditions generated during the tidal modelling phase. The sediment was modelled using the sediment grading and settling characteristics of the samples collected at each of the dredging sites. The modelling includes sediment settling and also re-suspension with the application of critical shear stress parameters.

The total volume to be dredged at Ringaskiddy West site is 215,000m^3 comprised of a combination of fine silt and sand. The sediment grading used was determined by borehole logs collected at the site and is shown in Table 12.1.

Table 12.1 Sediment grading of Ringaskiddy West material

Sediment Type	Mean diameter (mm)	Proportion (%)
Mud	0.0025	19
Fine silt	0.0165	20
Silt	0.044	42
Sand	0.15	19

The total volume of soft material to be dredged at Ringaskiddy East site is 90,000m^3 with the remaining site depth being rock. The material to be dredged comprised of a mainly coarser material than at Ringaskiddy West. The sediment grading used was again determined by borehole logs collected at the site and is shown in Table 12.2.

Table 12.2 Sediment grading of Ringaskiddy East material

Sediment Type	Mean diameter (mm)	Proportion (%)
Silt	0.044	7
Sand	0.15	58
Coarse Sand	0.3	35

The project description indicates that either a trailing hopper suction dredger (THSD) or a combination of THSD and backhoe dredger will be employed for the dredging operations. The most likely scenario is the use of a THSD at the western site and a backhoe method at the eastern site as these suit the composition of the material to be removed and the works being undertaken.

The modelled dredging applied a spill rate of 2% at each site, with the source being locating at the dredging head or bucket adjacent to the bed to replicate the sediment which is mobilised during operations. A further 2% was released within the water column in accordance with dredging techniques anticipated to used in the eastern site. This sediment was released throughout the water column as the spill occurs as the backhoe bucket is lifted through the water.

The dredging programme included travel time to and from the sea disposal site being 75 minutes of dredging and 130 minutes of travel and disposal time. Given the nature of the dredging regime and the amount to be removed the simulation was undertaken over a period of 12 days, timed to coincide with large spring and small neaps to provide the full range of conditions. The programme was designed to simulate the most proficient dredging rate and therefore includes the maximum rate of sediment release and associated suspended sediment concentrations.

The sediment was released intermittently over the course of the simulation, in line with the regime outlined, during which the sediment was introduced across the area to be dredged. The amount of 'passes' at each release location was proportional to the material to be removed, i.e. less sediment was released where overburden was being removed for bed grading and stability when compared to the full berthing depth. The simulations were undertaken with the reclamation structures in place as some material may be suitable for back-filling and therefore this is the most likely mode of construction.

The results of the dredging simulations for the two sites are presented in Figure 12.18 to Figure 12.21. As with current speed, for sediment thickness and suspended sediment it should be noted that the scales are not equally spaced, to provide more information on lower levels whilst also providing maximum values. The first of the plots shows the anticipated depth of deposition following the dredging of the full dredging volume required. It can be seen that beyond the immediate vicinity of the operations the depths are a fraction of a millimetre, which would not be discernible from background levels but have been included on the figures to demonstrate the maximum excursion from the site.

The largest proportion of the sediment, mainly sand and coarser material, will be deposited at the dredge site itself and be removed by successive operations. The finer material remains in suspension for longer and is dispersed more widely through the area, however subsequent deposition depths are insubstantial.

Ecological assessment has highlighted the sensitivity of the Monkstown Creek area therefore sediment releases into the water column will be minimised with the implementation of suitable mitigation techniques, i.e. no barge overspill being permitted. Suitable monitoring will be undertaken to ensure that suspended sediment concentrations due to the dredging operations fall within acceptable levels.

Figure 12.19 and Figure 12.20 show the typical suspended solids concentration mid ebb and flood when the finer material is most mobile. Areas below 20mg/l are unshaded and would have little significance given the background suspended levels which are known to exist, particularly in relation to silt carried into the Estuary by the Lee River. Figure 12.21 shows the average concentration throughout the course of the dredging operations. The concentrations are largest within the redevelopment site itself as this is where that material is released, however the sheltered nature of the site and the presence of the breakwater reduces the excursion into Monkstown Creek and the River Lee. Typically the suspended sediment concentrations are below 300mg/l and are not expected to reach the northern SPA sites.

Figure 12.18 Final Sedimentation following permitted development Dredging Operations

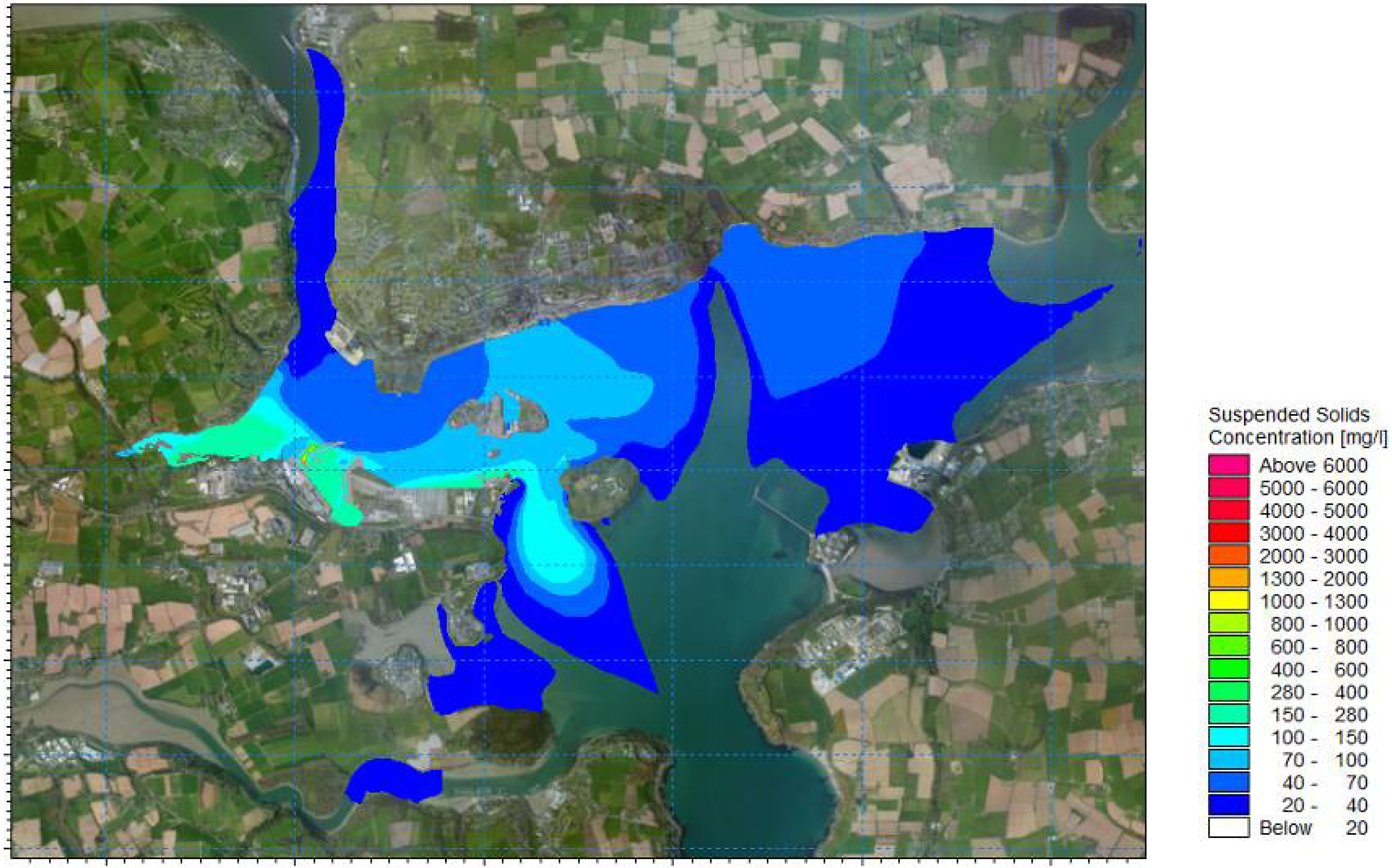

Figure 12.19 Typical Mid-Ebb Suspended Sediment Concentration above Baseline during permitted development dredging

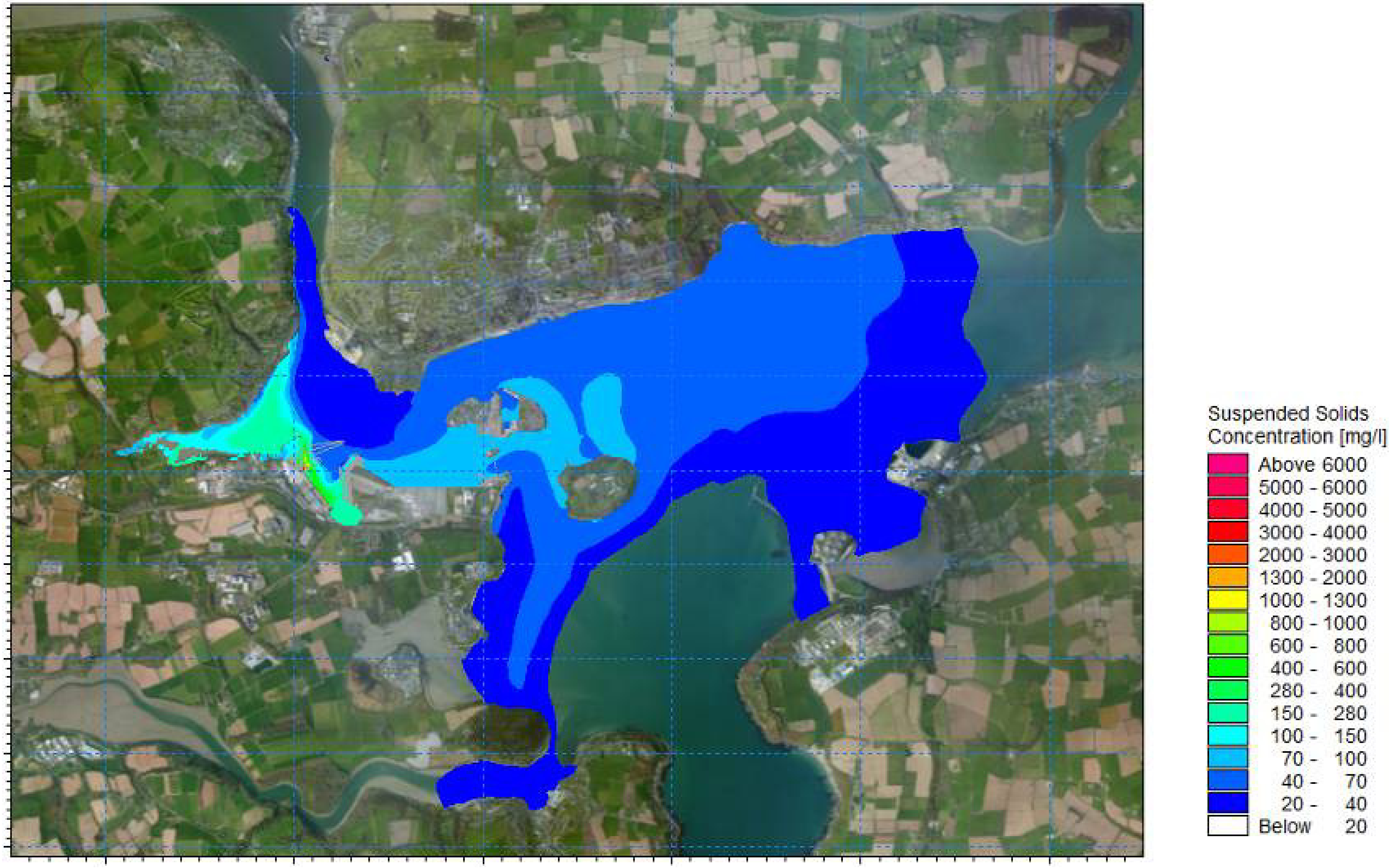

Figure 12.20 Typical Mid-Flood Suspended Sediment Concentration above Baseline during permitted development dredging

Figure 12.21 Average Suspended Sediment Concentration above Baseline during permitted development dredging

The Monkstown Creek site experiences maximum values of around 400mg/l but these do not persist for the entire tidal cycle or across the extent of the inlet. Similarly the other sites in the main channel vary; with those north of the dredging experiencing the lowest concentration. The active shellfish beds to the east in Rostellan will be remain unaffected by the proposed works. Values of suspended solids are anticipated to remain below 40mg/l for the duration of the dredging operations, with average concentrations being less than half this value. This is typically less than the turbidity experienced in estuaries during storm conditions with increased fluvial flows and would be within the normal range of conditions experienced within shellfish areas.

12.7.2 Impacts of Proposed Alterations on Sediment and Water Quality

12.7.2.1 Dredging

During the main berth construction phase additional dredging will be undertaken. The volume of additional material to be removed is estimated to be 15,000m^3. The location of the additional dredging, at the southern end of the quay, is a sheltered position where current speeds do not exceed 0.1m/s therefore the material released into the water column will not be dispersed widely. As demonstrated above, a large proportion of the material spilled in the vicinity will settle back onto the dredging site and be removed during subsequent dredging operations.

It should be noted that the proposed alterations are required to facilitate optimal phasing of the permitted Ringaskiddy development. The baseline modelling presented assumes that dredging is undertaken for all phases coincidently (i.e. worst case) to provide the maximum potential impact. The relatively small increase in material to be dredged will not result in additional impacts to those presented.

The mitigation measures enshrined in the extant permission for the Ringaskiddy Port Redevelopment as part of the previous assessment include the use of suitable dredging technologies which minimise sediment release into the water column.

12.7.2.2 Dumping at Sea

The impact of the proposed 2007 Oyster Bank Strategic Infrastructure Development (Ref: 04.PA0003) on the hydrodynamic regime of the dredge material disposal area was assessed using computational modelling techniques based on the MIKE 21 suite of coastal process modelling software developed by the Danish Hydraulics Institute.

That model was run on the basis of a 385,000m^3 volume which is greater than both the consented dredge material volume and the total with the additional material associated with the proposed alterations (15,000m^3). This modelling related to the placement of material of the same nature (due to the proximity and overlapping nature of the development) at the dump site. It showed that the depth of deposition would be less than 50mm beyond the immediate vicinity of the dumpsite with no perceivable impact beyond 4km. This demonstrated that the modelled volume is within the assimilation capacity of the dumpsite. It should also be noted that the dumping activities modelled as part of the proposed Oyster Bank development were never actually dredged and disposed of at sea, therefore there are no cumulative impacts in this regard.

The authors of the 2007 EIS Coastal Processes chapter are the same authors of the 2014 Ringaskiddy Port Redevelopment EIS Coastal Processes chapter and also this EIS chapter. We can confirm that the model used then is wholly applicable to the current proposal to dispose at sea of material dredged in Ringaskiddy Basin. We can confirm that predicted dispersion patterns of disposed dredge material are identical for the present project.

The model accurately simulated the tidal flows and water level variations in the area. The tidal model was run for a period from late February to early April 2005 so that the hydrodynamic data would include a large equinoctial spring tide. The results of those simulations are shown below in terms of the deposition footprint on the seabed and the maximum concentration envelope. The maximum concentration envelope shows the peak value that occurs at any time during the simulation at the particular point in the model area and is generated in the model as the plume from the dredged material disposal washes over the area in response to the varying tidal flow conditions. The concentrations shown in the figures will therefore not be experienced simultaneously.

Figure 12.22 shows the net deposition footprint on the seabed for the disposal of the 385,000 m^3 of material from the dredging. The deposition thickness on the seabed in millimetres may be estimated by dividing the kg/m^2 value by 1.5. It will be noted that the thickness of the deposited sediment outside the dump site area is generally less than about 50mm and that no measurable amount of material is deposited further than about 4km from the centre of the site.

Figure 12.23 show the maximum instantaneous suspended sediment concentration envelope averaged over the whole of the water column that occurs at any time during the dumping operations. Figure 12.24 shows maximum instantaneous suspended sediment concentration envelope in the top 10m of the water column that occurs at any time during the dumping operations.

It can be seen from the maximum suspended sediment concentration figures that the plume from the dumping of the dredge material, even at very low concentration values, does not extend a great distance from the disposal site.

The offshore dumping modelling examined a volume which is greater than both the consented dredge volume and the additional volume associated with the proposed alterations. It demonstrated that the material to be deposited is within the assimilation capacity of the dumpsite.

The sheltered location of the alterations to the dredging means that the relatively small increase in material released into the water column will not be widely dispersed and will settle back onto the dredging site. The mitigation measures enshrined in the extant permission for the Ringaskiddy Port Redevelopment include the use of suitable dredging technologies which minimise sediment release into the water column. The alterations proposed enable optimal phasing of the permitted Ringaskiddy development and will therefore not result in additional impacts.

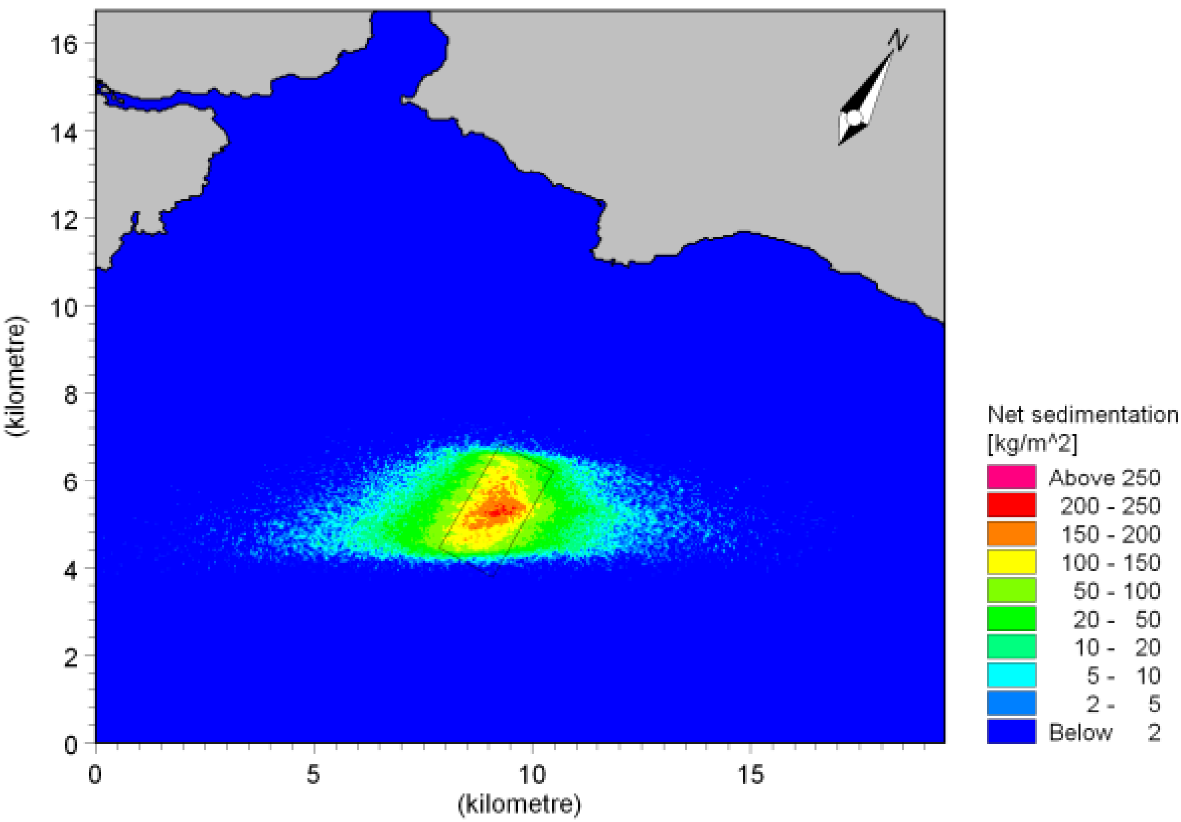

Figure 12.22: Deposition Footprint for dumping of 385,000 m3 of sediment from Oyster Bank and related area

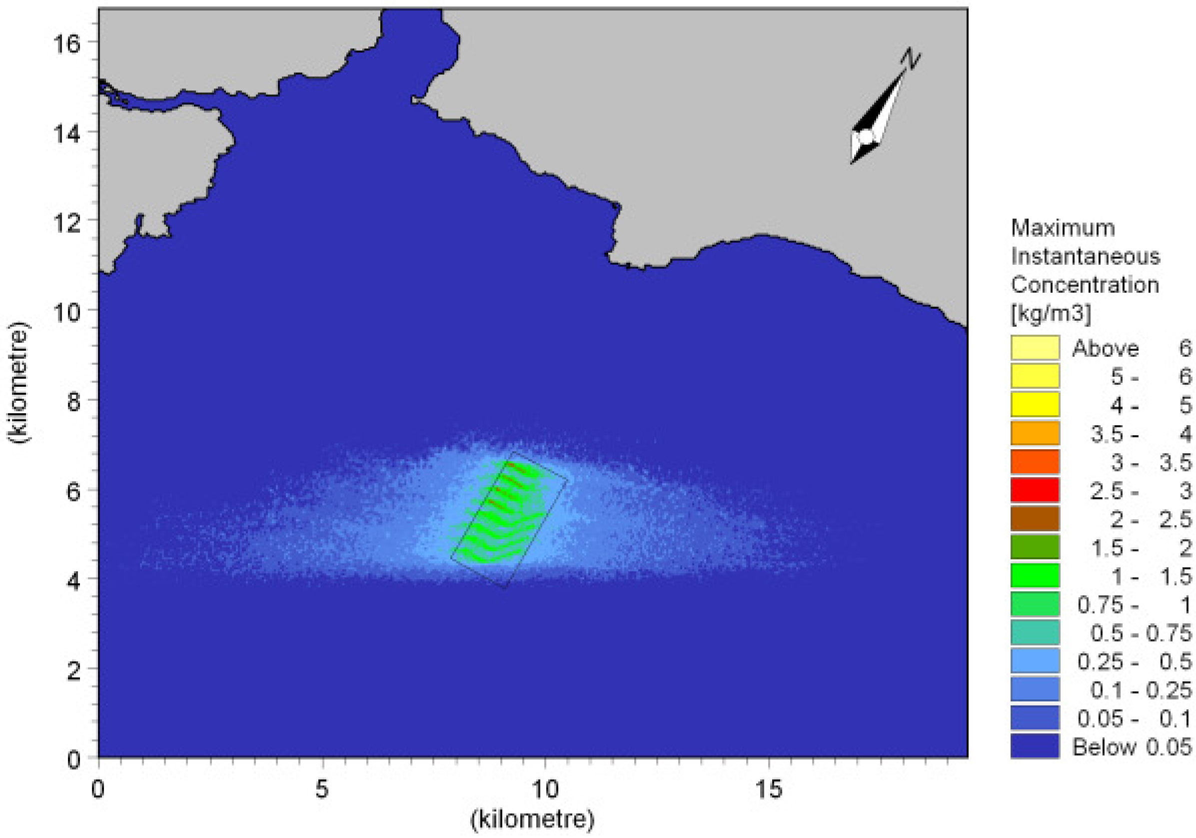

Figure 12.23 Maximum Concentration Contours (instantaneous) of suspended sediment averaged over the of water column dumping of 385,000 m^3 of sediment from Oyster Bank and related area

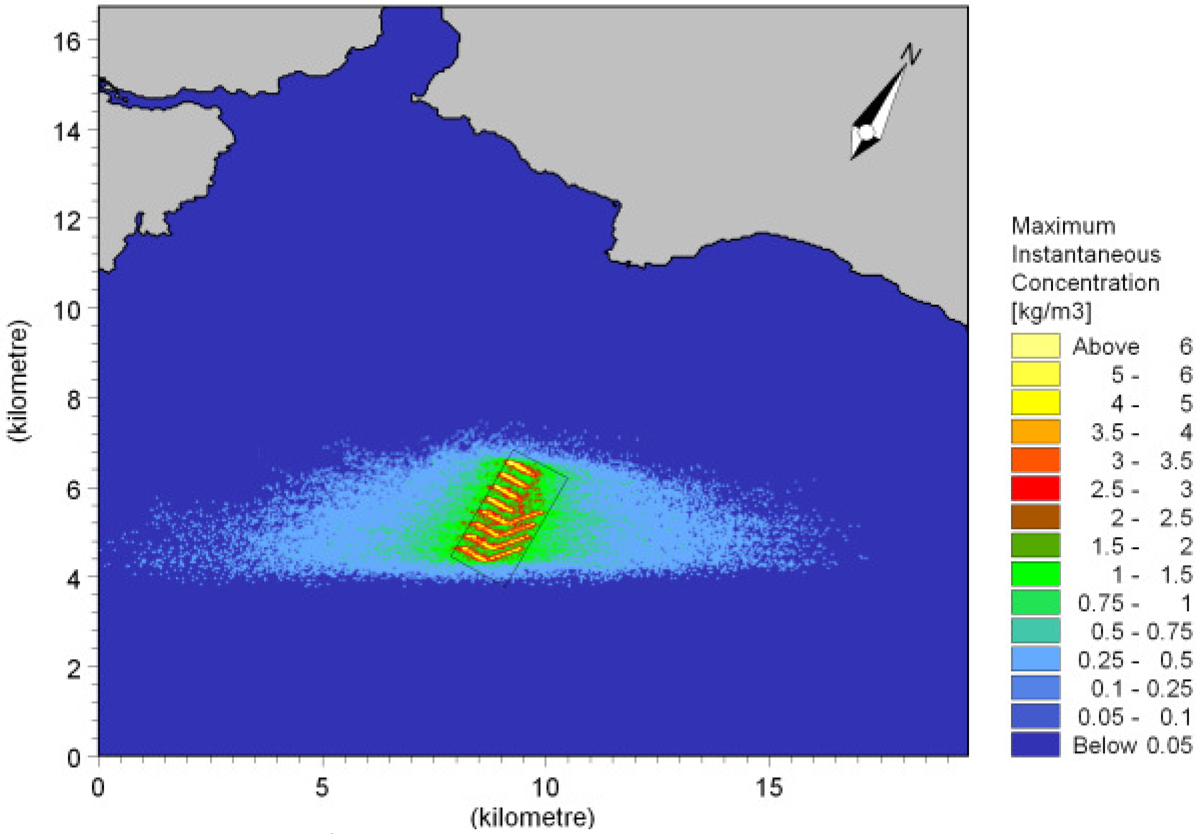

Figure 12.24 Maximum Concentration (instantaneous) of suspended sediment in top 10 metres of water column dumping of 385,000 m^3 of sediment from Oyster Bank and related area

12.8 Cumulative Effects

Examination of the planning history shows that there are three proposed activities which are not land based. The Monkstown Marina consists of floating berths and breakwaters located on the western shore at Monkstown. Modelling of the coastal processes has been undertaken for this development as part of a request for further information by the planning authority. The modelling showed that there would be no effect on the coastal processes with no change in tidal levels and the effect on the tidal currents restricted to the project area with changes of not greater than 0.04m/s. Thus this development will not have a cumulative effect with the permitted port redevelopment or the proposed alterations.

Similarly the remedial work proposed at the eastern end of Haulbowline Island will not have a cumulative effect. While the Haulbowline Island scheme will require some dredging activity at this site, the works proposed will mainly be carried out behind retaining structures to reduce the impact within the estuary and therefore the anticipated footprint of these activities will not encroach on the proposed redevelopment even if they are undertaken coincidently.

The Cove Sailing Club was granted planning permission for a 74 berth marina located at Whitepoint, Cobh. As part of the planning process a hydrodynamic study was undertaken by Cronin Millar Consulting Engineers in January 2010 on behalf of the Cove Sailing Club. The following conclusions are reproduced from this study:

a) It is envisaged that the proposed marina development will not impact on the flow regime in Cork Harbour or at the site of the proposed marina.

b) The proposed marina site is very sheltered from offshore wave conditions (swell). It is anticipated that offshore swell will have negligible (if any) affect on the development.

c) The marina will be subject to locally generated wind waves. Highest waves are generated by winds blowing from the East. A design incident wave height of 1.1m with a corresponding wave period of 3.63sec was calculated for the site. It was estimated that wave transformations (diffraction, refraction and shoaling) will be negligible.

d) A floating concrete breakwater is proposed as wave protection to the marina. The wave characteristics for the marina have been calculated for a 1 in 50 year wind event. The design significant wave (1.1m height) is attenuated by the breakwater resulting in a transmitted wave height of 0.385m. This wave height satisfies the recommended upper limit of 0.300 to 0.400m wave height in a marina.

e) Dredging will not be required for this marina development, therefore there will not be any impact on the natural sediments regimes.

In reference to point a) if the Cove Sailing Club development will not have an impact of the flow regime then there cannot be the potential for in combination effects with the permitted Ringaskiddy development and proposed alterations. Likewise, as outlined in point e) if there is no dredging works relating to the marina project there cannot be any in combination effects on suspended sediment levels.

When potential construction and operational stage effects are considered for the proposed alterations for potential cumulative coastal processes effects they will not result in any changes to the cumulative effects predicted as part of the assessment for the permitted development.

The construction stage and operational stage activities proposed as part of the alterations are sufficiently separated from any permitted or planned projects and minor in the scale of the permitted Ringaskiddy Port Redevelopment project to avoid potential cumulative effects.

12.9 Conclusion

The conclusion of this assessment is that the proposed alterations will not result in any significant change to the assessment of effects and conclusions as previously presented in the 2014 EIS for the permitted development and that the mitigation measures enshrined in the extant permission remain applicable