

4.0 COASTAL PROCESSES

4.1 Introduction

The coastal processes affecting the site of the proposed replacement linkspan have been assessed using computational modelling techniques based on the Mike coastal process software which has been developed by the Danish Hydraulics Institute. The modelling included the simulation of the wave climate and tidal flows over the approaches to Fishguard Harbour as well as within the Harbour and at the Port itself.

The bathymetry for the hydraulic models has been taken from data supplied by the UK Hydrographic Office under the EU INSPIRE project, digital bathymetry supplied by C-Map of Norway together with the latest hydrographic surveys within the port. The extent of the model used for hydrodynamic modelling of Fishguard Harbour is shown in Figure 4.1.

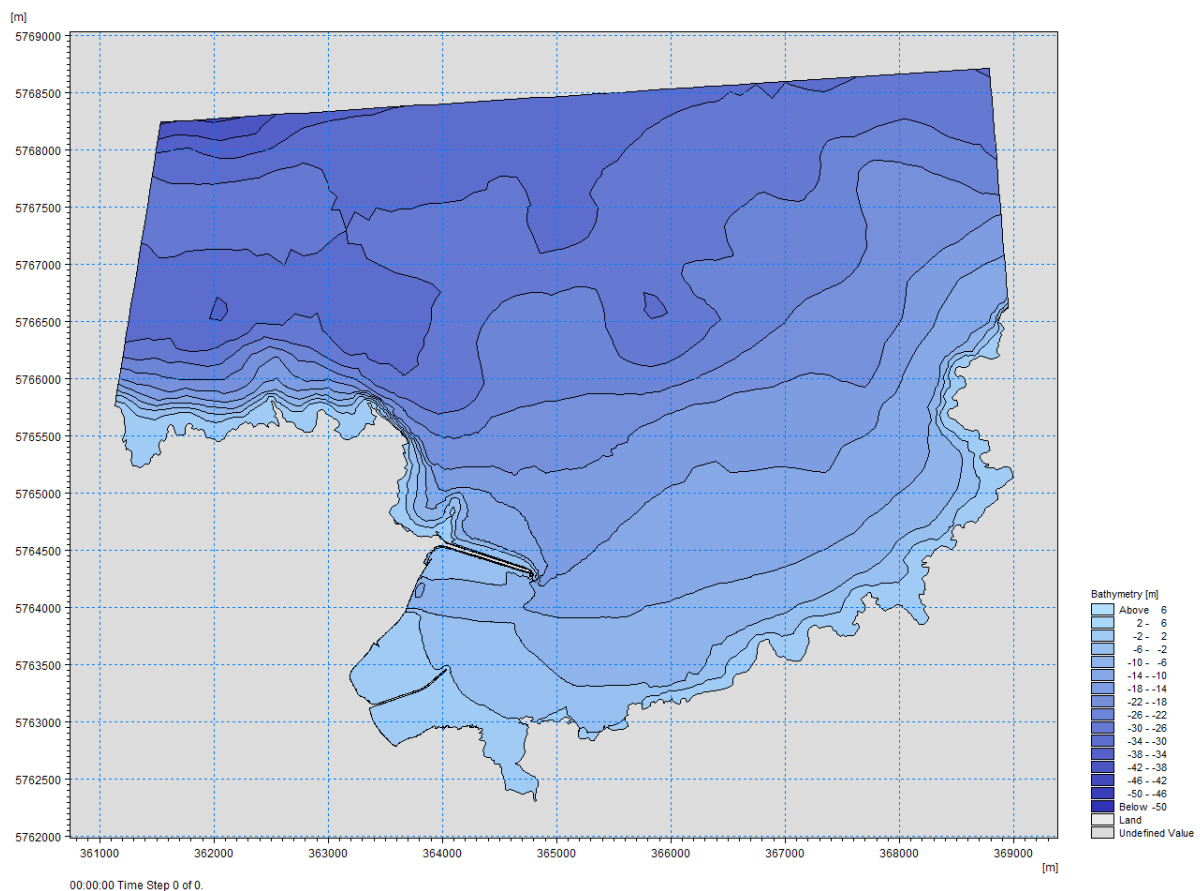


Figure 4.1: Extent of hydraulic model of Fishguard Harbour and its approaches

4.2 Existing Coastal Process

4.2.1 Wave Climate

The wave climate at the site of the proposed development has been simulated using a combination of the spectral wave energy model, Mike21 SW and the harbour disturbance, Mike21 BW. The wave climate approaching Fishguard Harbour from the south west approaches and the Irish Sea was simulated for 1 in 1, 1 in 50 and 1 in 100 year return period storms from directional sector south south west to north east using the spectral wave generation and transformation model, Mike21 SW. This model was also used for the generation of wind waves across the local fetches from the east and east

south east. The wave conditions around the harbour were then simulated using the Boussinesq wave disturbance model, Mike 21 BW.

The most arduous conditions for wave heights at the site of the proposed development were found to be with waves approaching the harbour from the northerly sector, when waves were diffracted around the end of the breakwater and approached the site from the east. Waves of a similar height were also found to occur during storms from the east south east when waves approached the linkspan site directly across the fetch from the adjoining coast. However the waves from this direction were short compared to those at the site during northerly storms.

Figure 4.2 shows the wave patterns around and behind the breakwater during storms from the northerly sector with a return period of 1 in 50 years. It will be seen from this figure that the waves which approach the breakwater are diffracted around the end of the breakwater and approach the site of the linkspan from an easterly sector. The impact of the wave reflections from the port structures and adjoining coastline can also be seen in this diagram.

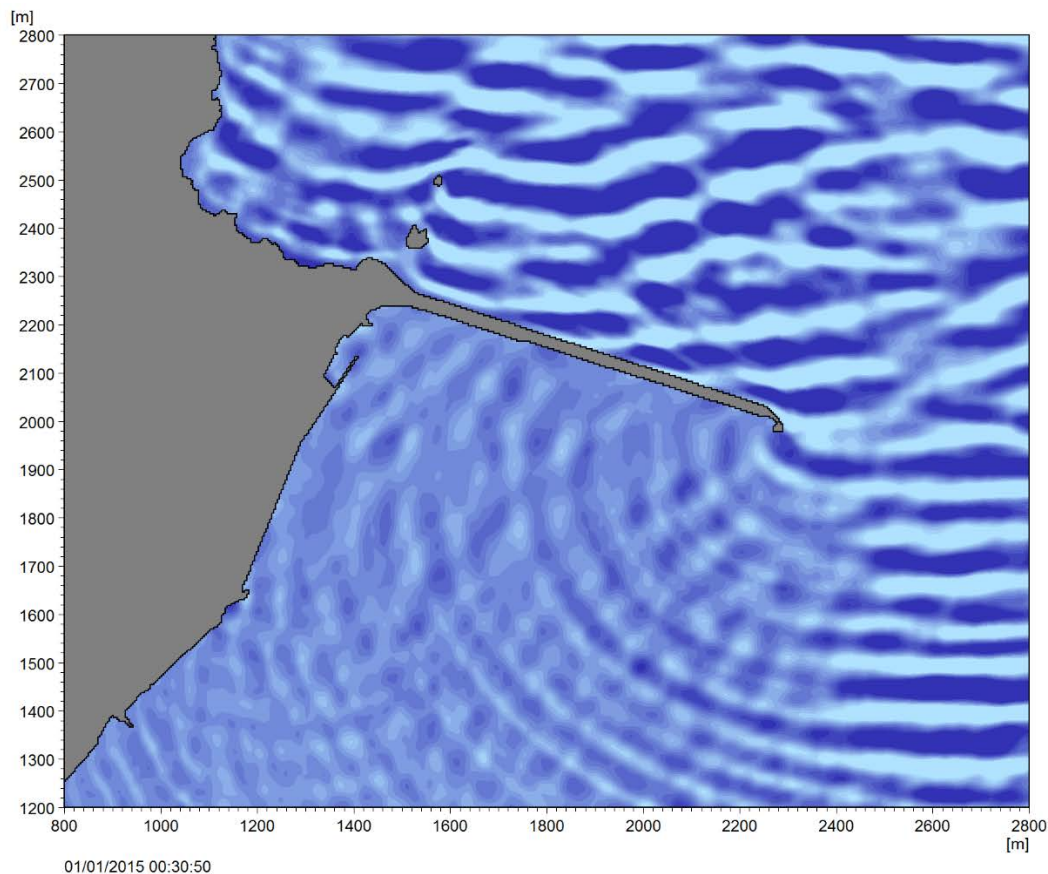


Figure 4.2: Wave disturbance patterns – 1 in 50 year return period storm from N

During a 1 in 50 year return period storms from the northerly sector the waves approaching the linkspan will typically have significant wave heights of about 1 metres with peak energy wave periods of about 9 seconds. Although waves approaching the proposed development from the east and east south east they will also have wave heights of about 1 metre during the equivalent return period storms, the peak energy wave periods will be in the range of 2.4 to 3.1 seconds so the disturbance will be of a short steep wave. An example of the wave heights and directions of the waves approaching the linkspan site during a 1 in 50 year return period storm from 120°N is shown in Figure 4.3. In this simulation the effects of diffraction and wave energy reflection from the harbour walls and breakwater are included in the model.

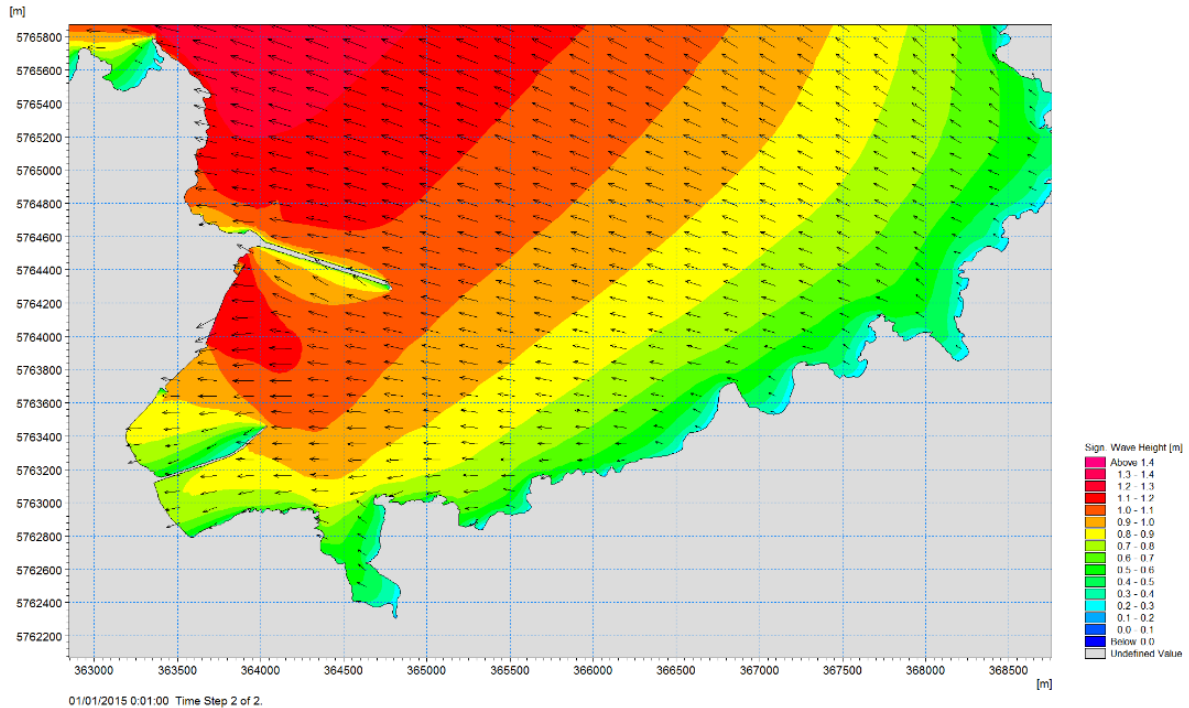


Figure 4.3: Significant wave heights and mean wave direction 1 in 50 year return period storm from 120° N

4.2.2 Tidal Regime

The tidal range at Fishguard Harbour varies from about 4.0m at springs to 1.4m at neaps. The tidal flow regime around the harbour has been simulated for a series of typical spring tide using the Mike21 FM flow model. Typical flood and ebb current patterns in the harbour are shown in Figure 4.4 and 4.5. It will be seen from these diagrams that the tidal currents around the linkspan site are extremely weak. The time series of the current velocities at a point immediately to the south east of the proposed development is shown in Figure 4.6.

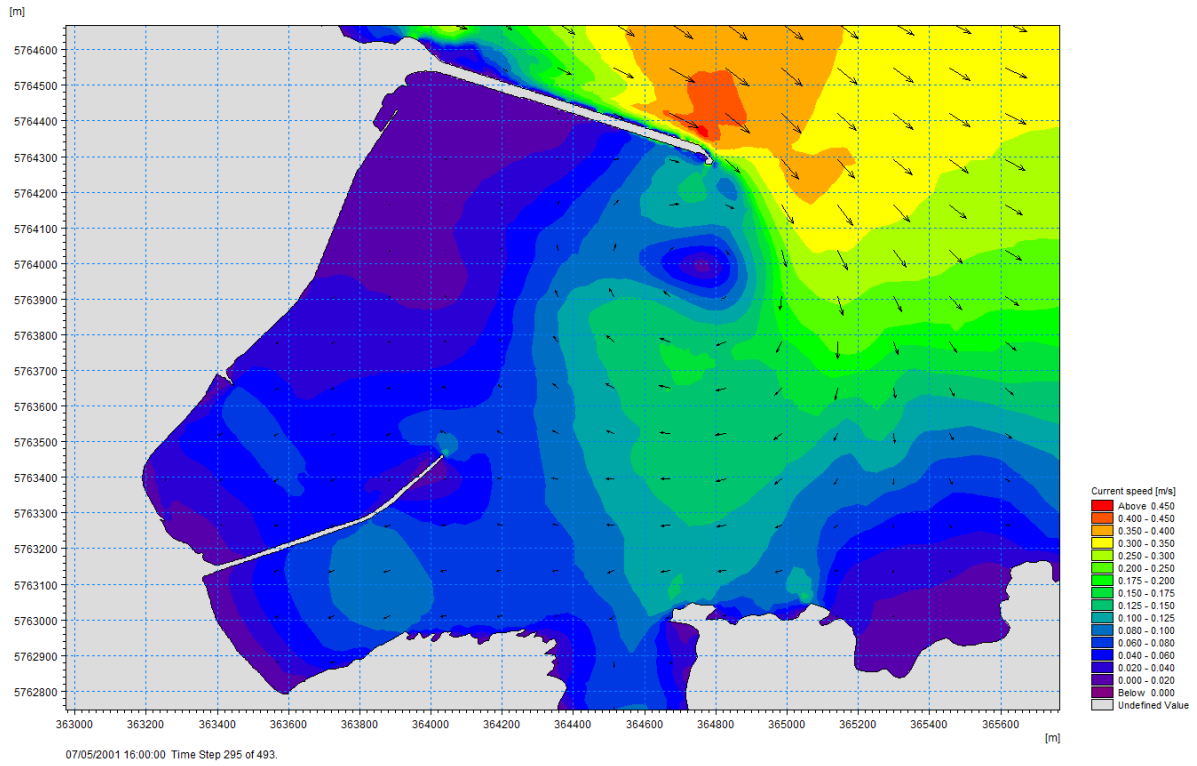


Figure 4.4: Typical tidal flood flow patterns in Fishguard Harbour

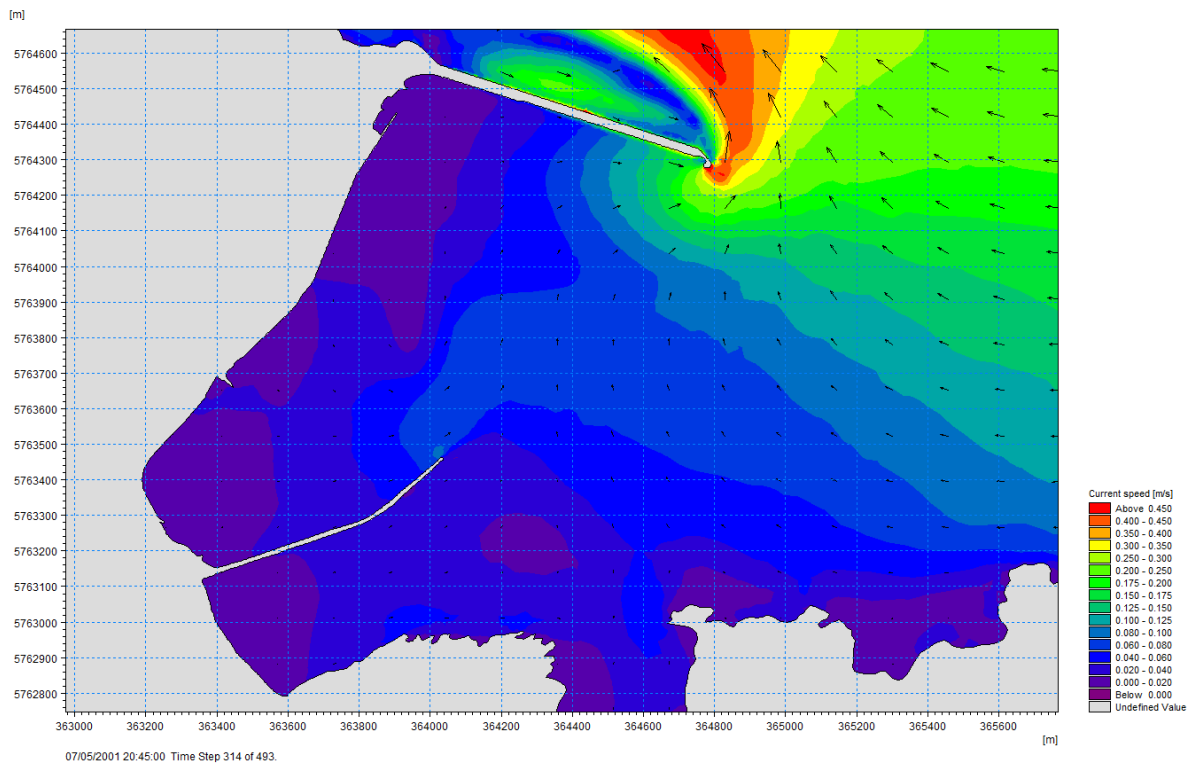


Figure 4.5: Typical tidal ebb flow patterns in Fishguard Harbour

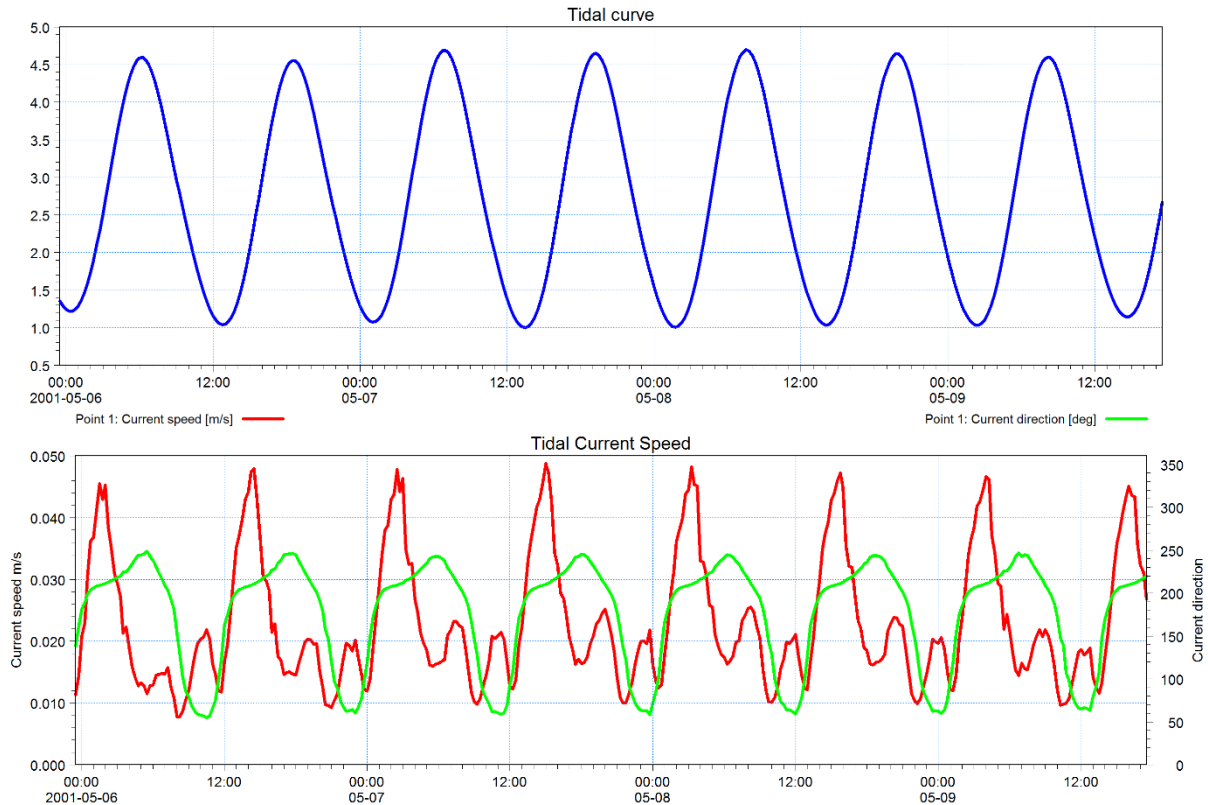


Figure 4.6: Tidal levels currents and directions at the proposed development site - spring tide

It will be seen that tidal currents at the proposed development site are extremely weak with peak current speeds of less than 0.05 m/s. The tidal flow will generally be in a south/south-westerly direction for the majority of the tidal cycle.

4.2.3 Sediment Transport Regime

During northerly storms and particularly during the flood tide, there will be a tendency for there to be a general clockwise circulation round the bay due to the presence of the breakwater. However, around the linkspan site area the currents are so weak and the wave climate so benign that there will be very little sediment movement due to the coastal processes. As can be seen from the bathymetry of the sea bed of the harbour around the linkspan, the most significant impact on the seabed sediment regime comes from the movement of ships on and off the berth, particularly at times of low water when the ships propulsion systems can stir up and redistribute fine sediment.

4.3 Impact of the Proposed Development

4.3.1 Impact on the Wave Climate

As will be seen from section 4.2.1 the proposed development is effectively on a “lee shore” during significant wave events thus the proposed development will have no significant impact on the wave climate in the remaining parts of the harbour or its adjoining areas. The proposed replacement of the open piled approach ramp with a rockfill reclamation area, complete with wave absorbing revetments, will marginally improve the wave reflections in the immediate area around the linkspan.

4.3.2 Impact on the Tidal Regime

The impact of the proposed project on the tidal regime has been simulated by rerunning the spring tide tidal simulation with the proposed replacement structures in place. The impact on the flow regime

has then been assessed by means of difference plots, proposed minus existing. As expected with such a small change in the footprint of the harbour, there was no detectable change in the tidal elevation in the harbour. Figure 4.7 shows the difference in the tidal current speed around the harbour at the time of the maximum current speed at the site. It will be seen from Figure 4.7 that the differences away from the immediate area of the site are extremely small, generally less than 0.005m/s.

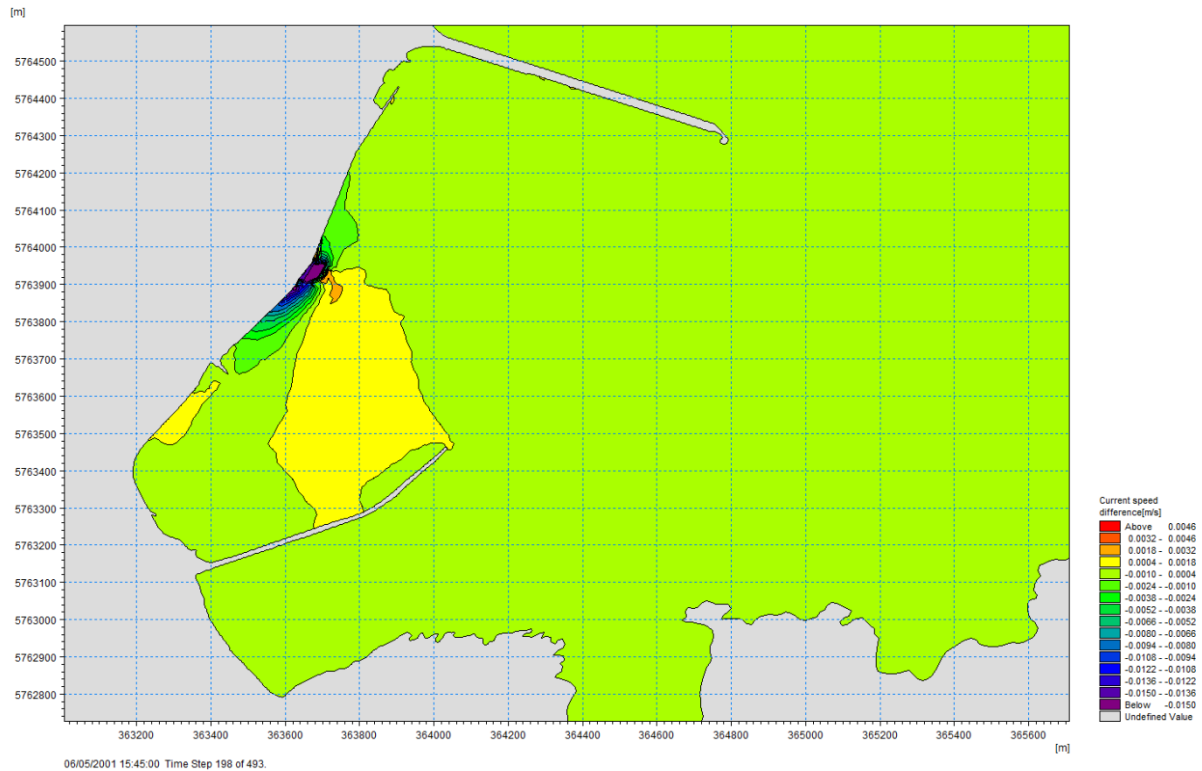


Figure 4.7: Tidal current speed difference, proposed minus existing, at time of maximum current speed at the site

4.3.3 Sediment transport

In view of the fact that there is no significant change in either the wave climate or the tidal regime due to the proposed project it is concluded that there will be no significant change in the sediment transport regime of the Harbour or its adjoining areas.

It is proposed to remove any silt from below the footprint of the small reclamation area prior to the placing of the rockfill embankment. An amount of up to some 10,000m³ of silt may have to be removed (soft sediments may be removed to landfill or if suitable reused for infill between the new revetment and the existing land; there will be no reuse of dredged materials within the marine environment, seaward of mean high water springs). To be conservative it has been assumed that this silt will be removed over twenty 8 hour day periods using a long reach excavator bucket machine. The losses to the water column are estimated to 5% of the dredged volume with the losses included in the model as 2.5% near the bottom as the machine digs and 2.5% at the surface as the bucket is lifted clear of the water.

The dispersion and fate of the material lost to the water column during the dredging operation has been simulated using the coupled Mike21 FM tidal and mud transport model. Three 8 hour periods when dredging is being undertaken have been simulated and then the results uprated where appropriate to accurately represent the total 20 day dredging period. The three 8 hour periods are shown by the red bars in the simulation tidal elevation plot, Figure 4.8.

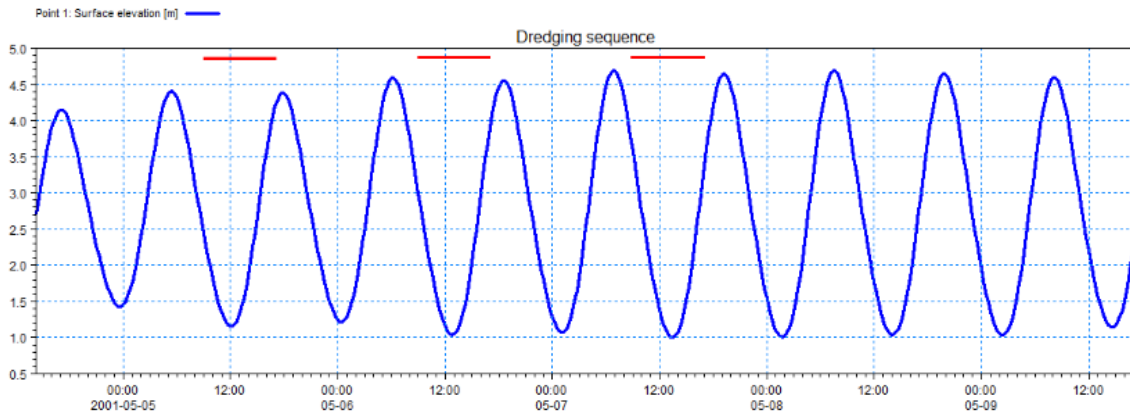


Figure 4.8: Dredging periods (red bars) during silt dispersion simulation

The impact of the dredging of the silt has been assessed in terms of the maximum suspended sediment concentrations and the deposition depths of the silt lost to the water column during the dredging operations.

Figures 4.8a, 4.8b, and 4.8c show the total suspended sediment concentration (SSC) plumes during the silt dredging operation at a time of ebb, low water and flood tide respectively. Figure 4.9 shows the maximum SSC envelope for the whole of the simulation. Note that this is not a plume diagram but rather a concentration envelop which shows the maximum value of the SSC in every grid point of the model even if it only exists for a very short space of time as the plume sweeps over the model area. Figure 4.10 shows the mean SSC of the silt lost to the water column during the whole of the dredging simulation period.

It will be seen from the plume and envelop diagrams that the suspended sediment concentration only exceeds 20 mg/l in an area around and to the south west of the proposed reclamation area and even then it only exceeds 20 mg/l for relatively short period of time.

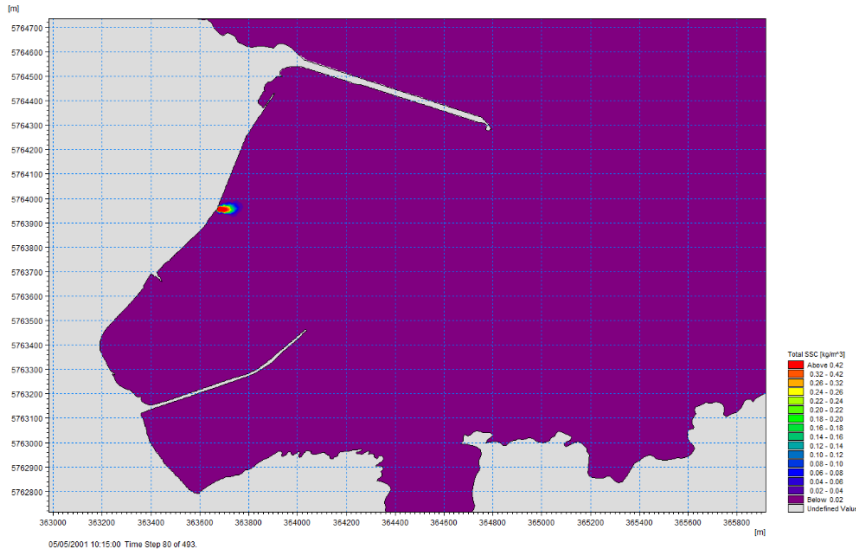


Figure 4.8a: Dredged silt plume ebb tide

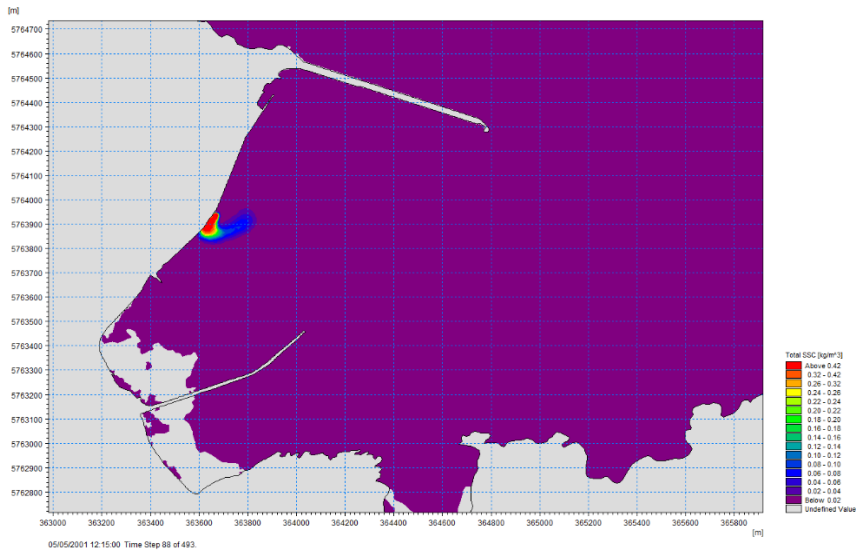


Figure 4.8b: Dredged silt plume low water

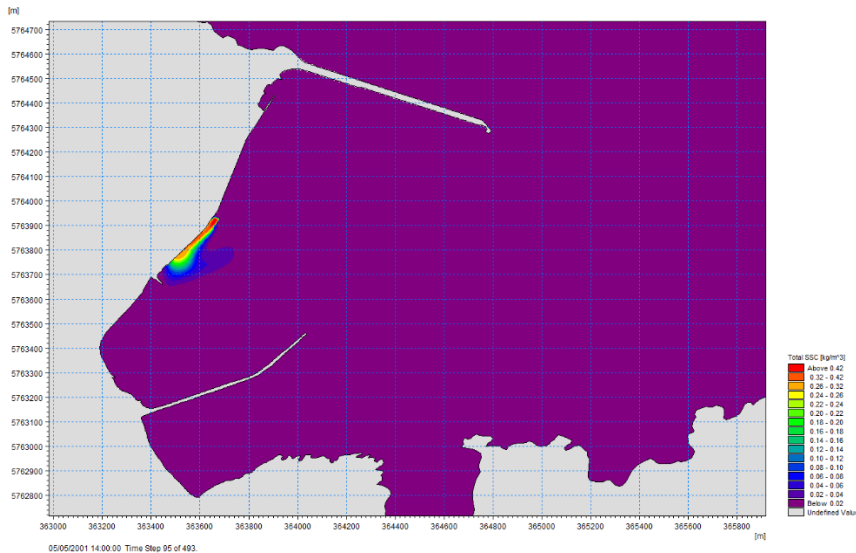


Figure 4.8c: Dredged silt plume flood tide

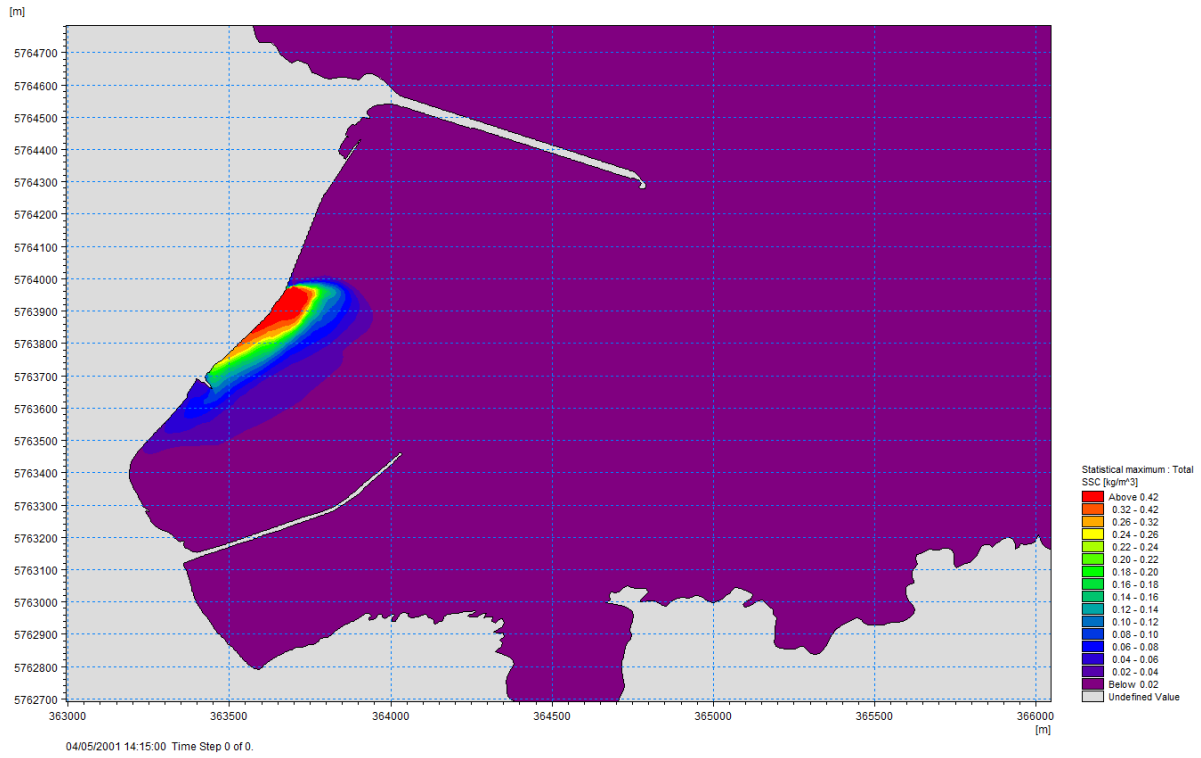


Figure 4.9: Dredged silt maximum SSC envelop over whole of dredging period

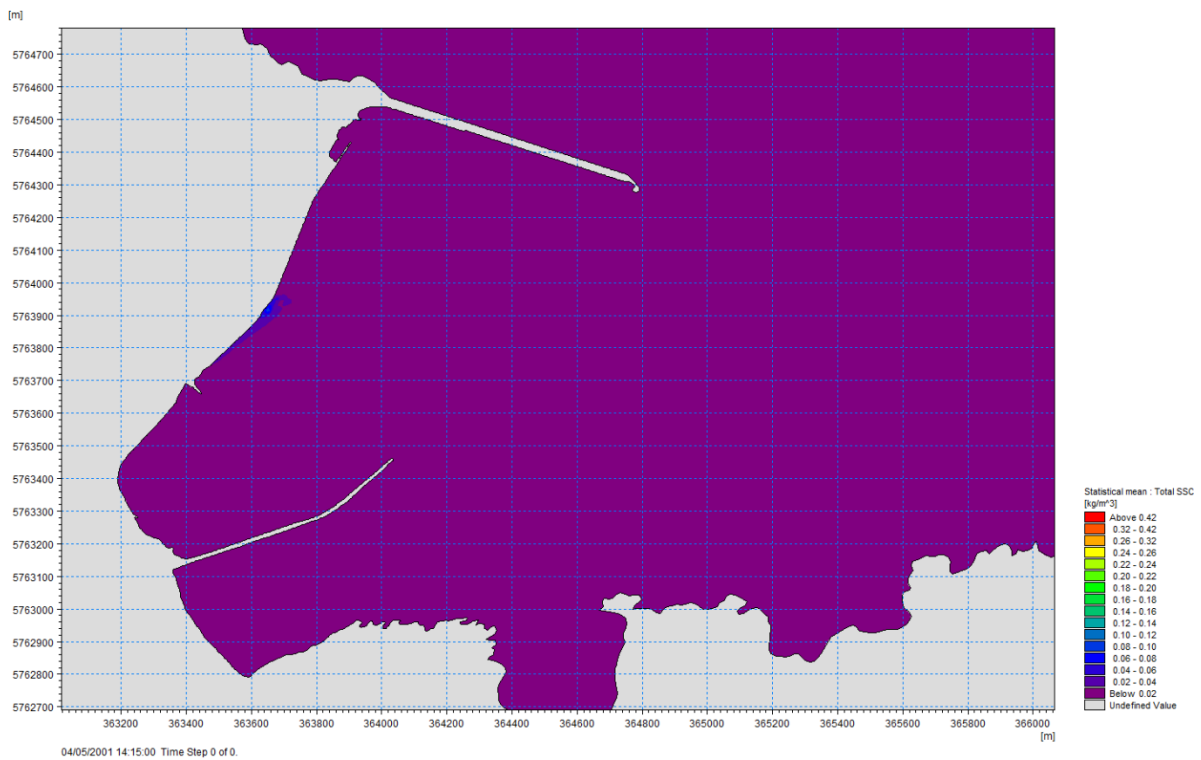


Figure 4.10: Dredged silt mean SSC over the whole of the dredging period

Figure 4.11 shows the maximum sea bed deposition depth of the silt, which is lost to the water column during the dredging of 10,000m³ of silt. It will be seen that silt lost to the water column will be deposited mainly within the reclamation area with only a minor depth of circa 2.5mm in a restricted area along the sea wall to the south west of the proposed development.

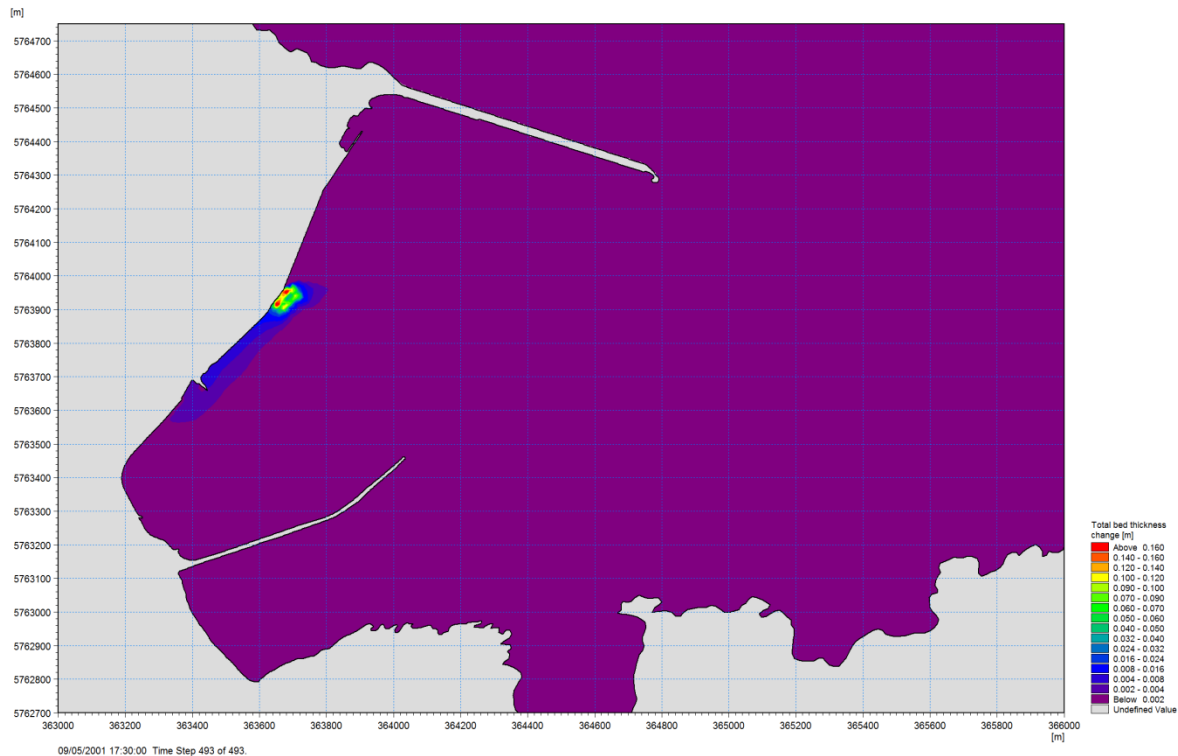


Figure 4.11: Maximum depth of deposited silt resulting from Dredging operations

Due to the very low current speeds at the site of the proposed development other construction activities such as piling will not have any significant impact on the waves, tides or sedimentation processes. The reclamation is to be undertaken using rockfill with a specification of stone sizes to range between 50mm and 450mm. 10% of the stone material is allowed to be below the 50mm sieve size and the smallest particle size is likely to be greater than 0.1mm. The peak current speed at springs at the site is about 0.048 m/s, the fall velocity of a 0.1mm particle is 0.0088m/s and the water depth at the site during times of peak current speed is about 3.5 metres. Thus the maximum excursion of the finest particles in the rockfill will be less than 20 metres before they reach the sea bed. Thus any wash out from the rockfill reclamation material is likely to settle on the sea bed within 20 metres of the reclamation footprint.

4.3.4 Cumulative Effects

Cumulative or in-combination effects could occur upon coastal processes as a result of other activities or projects in addition to the proposed development.

The Fishguard Harbour Marina Development was consented under the Marine Works (Environmental Impact Assessment) Regulations 2007, in June 2017. The ES assessed the impacts of Hydrodynamics and Geomorphology in Chapter 5, which has been reviewed. The development proposes to reclaim 16 ha of foreshore across the entire south of the harbour and extending north along the western edge to the extent of the existing Stena Line Quay. The reclaimed area will be used for potential future port expansion along with a residential area, an offshore marina area and parking areas. To accommodate boats at all states of the tide, the marina will be dredged to -3.0 m using a cutter-section dredger. Two breakwaters will also be built to protect the marina from wave action. Material from the dredge will be used entirely to form the reclaimed platform.

Chapter 5 of that ES concludes that:

- The new breakwaters at the entrance to the marina would not significantly impede tidal movement.
- The construction of the development would result in a net decrease in the tidal volume of Fishguard Harbour of approximately 630,000m³ on spring tides. This is estimated to be about 17% of the tidal volume of the harbour as a whole. There would be a slight decrease in tidal velocities in the harbour entrance but, as peak velocities are approximately 0.03m/s, this would be negligible. That part of the tidal volume, which is to be enclosed by the new breakwaters, would have to pass through the relatively narrow marina entrance. The estimated peak velocity through the entrance is 0.12m/sec on spring tides (0.04m/sec on neaps). The configuration of the entrance is unlikely to have an impact on the flood tide but on the ebb may introduce a weak clockwise circulation within the harbour. It is considered that this would have a negligible impact upon the operation of the harbour.
- The presence of the new breakwaters would all but eliminate wave action along the southern boundary of Fishguard Harbour and would reduce the impact of waves generated within the harbour during southerly winds. In achieving the above there is the potential for adverse impacts in the northern half of the harbour. The breakwaters would, in effect, replace a gently shelving beach with a more steeply angled rock slope. The rock slope is likely to be less effective in dissipating wave energy, particularly for that of longer period waves.
- The proposed dredging for the approach channel to the marina may modify wave patterns by refraction, but at this stage it is considered the effects are likely to be negligible as the increase in depth relative to the existing conditions is small.

There is not likely to be any significant cumulative or in-combination effect on coastal processes as a result of the proposed development when considered along with the consented marina development.

4.4 Conclusions

The modelling and studies for the coastal processes have shown that the proposed development at Fishguard will have no significant impact on the coastal process away from the immediate area around the site. The impact of the construction activities such as dredging of silt from the foundation area for the rockfill embankment and the placing of the rockfill itself will result in small localised temporary increase in suspended sediments concentrations around the site area on the western side of the harbour. However, there will be no significant impact on sedimentation within the Harbour away from the immediate area surrounding the site.