EX 5780

HR Wallingford
Working with water

London Gateway Port
Scheme Refinement - Port frontage - interim and final scenarios.

Hydraulic studies and assessment of environmental significance

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Summary

London Gateway Port - Technical Assistance

Scheme refinement –
Port frontage - interim and final scenarios

Hydraulic studies and assessment of environmental significance

Report EX 5780
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Background

DP World received approval in May 2007 to build London Gateway Port and Logistics Park. The applications were submitted in 2002 and supported by an Environmental Statement. The project went to Public Inquiry in 2003.

In relation to the port the following marine works were and still are proposed:

- Reclamation
- New Jetty for aviation and bitumen vessels
- Quay wall for berthing of deep sea container and cargo ships
- Quay wall to enable Ro-Ro ships to berth
- Dredging to deepen the navigation channel

Of particular relevance to the marine works is the Mitigation, Compensation, Monitoring Agreement (August 2003). The MCM was developed to secure the measures that would be incorporated into the pre-, during and post development plan. An updated version of the Environmental Statement was produced to include the updates of the Public Inquiry and Mitigation, Compensation and Monitoring Agreement (updated Environmental Statement 2004).

Scheme refinements

The Environmental Statement discussed the option of the Ro-Ro berth being located at either the east or the western end of the port land. For the purposes of the modelling the impact of the project for the EIA, a scenario was used that positioned the Ro-Ro terminal at the eastern end. This "original scenario" considered a -14.5m CD channel depth with a -16m CD berthing pocket adjacent to the deep water quay with the shallower berth of the Ro-Ro at the eastern end of the development.

The current planning dictates that container berths are more suitable at the eastern end of the development so the detail of locating a Ro-Ro at the western end has been assessed and compared against the assessment of the option of locating the Ro-Ro at the eastern end. This scheme, "the final refined scenario" also sees a -17m CD berth box extended along the whole length of the quay with the exception of a Ro-Ro berth where an operational depth at -10m CD is proposed at the western end of the quay line.

It is also expected that in the first build out phase two container berths will be developed. The likelihood that the whole development would not be built as one phase was discussed in the EIA and it was recognised that the container berths would be built out in accordance with market demand. A scenario has therefore been modelled, "the interim refined scenario", that considers

two container berths plus protection, in the form of a revetment, along the remaining reclamation. For the two eastern most berths a berthing box at -17m CD is proposed. Further westward the berths have not yet been completed and the whole of the berth approach area and berthing box are represented as being dredged to -14.5m CD.

Hydraulic studies

HR Wallingford were commissioned by London Gateway to advise on marine and coastal processes and in particular are responsible for the modelling of the impacts of the marine works to enable an understanding of impact to be developed. They have been involved in the project since 2001.

The modelling, analysis and interpretation described in this report is based on the methodologies originally employed in the hydraulic studies undertaken to support the EIA.

The physical impacts of the two refined scenarios "interim" and "final" have been assessed and contrasted with the "original" scenario as assessed in the EIA. The main findings are as follows:

- At an estuary wide scale, no significant changes to predictions of impact on upstream tidal propagation or extent of impact of the works as a result of scheme refinements.
- Minor changes to flow regime compared to original scheme.
- Siltation on Mucking Flats less than for original scheme
- Maintenance (mud deposition) in the original scenario was 1.7 Mm^3/year:
  - initial refined scenario is predicted to be 2.0 Mm^3/year
  - final refined scenario is predicted to be 1.3 Mm^3/year
- In neither scenario would there need to be a change to the approach to future maintenance dredging requirements as outlined in the EIA.
- Maintenance (mud deposition) at nearby berths for both refined schemes is predicted to be similar to that predicted for the original scheme.

It can be inferred from these results that if the interim scheme were modified to a scenario where three container berths had been built, there would be no further change to the flow regime at the adjacent downstream berth.

Environmental Considerations

HR Wallingford have direct responsibility for assessing the impacts on navigation dredging and flood defence. The assessment as to whether or not there are consequences arising that are different to those addressed in the EIA have been made in consultation with other experts as follows:

Responsibility	Organisation	Individual	Position
Marine Ecology	Marine Ecological Surveys Ltd	Dr Richard Newell	Chairman
Water and Sediment Quality	Water Research Centre	Dr Mike Gardner	Principal Environmental Chemist
Fish	Pisces Conservation Ltd	Dr Peter Henderson	Director

The modelling predicts no change to the original assessment of hydraulic effects at an estuary wide scale. The localised effects were investigated in more detail and indicated a small reduction in footprint of impact arising as a result of the proposed scheme refinements on Mucking Flats. Predicted changes to the siltation rates in the berthing and manouevering area at

London Gateway do not require an alternative approach to management of the muddy deposition. Siltation at the riverside berths between London Gateway Port and Holehaven Creek, where navigation dredging is currently required, is predicted to be comparable to that presented in the EIA.

Accordingly the implications for navigation dredging, flood defence, water quality, intertidal invertebrates and organisms that depend upon them as a food resource (birds and fish) are as originally assessed in the EIA.

Mitigation, Compensation and Monitoring

The Mitigation, Compensation and Monitoring Agreement (MCM) sets out the measures that London Gateway will implement in order to minimise the risk of impact to the marine environment. Monitoring as outlined in the MCM will provide a means of confirming the prediction of physical effects and the assessment of consequence arising on the marine environment. No further measures are required in the MCM to minimise risk to the marine environment as a result of the proposed refinement scenarios.

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1. Introduction

1.1 BACKGROUND

DP World received approval in May 2007 to build London Gateway Port and Logistics Park. The applications were submitted in 2002 and supported by an Environmental Statement. The project went to Public Inquiry in 2003.

In relation to the port the following marine works were and still are proposed:

- Reclamation
- New Jetty for handling aviation and bitumen fuel vessels
- Quay wall for berthing of deep sea container and cargo vessels
- Quay wall to enable Ro-Ro ships to berth
- Dredging to deepen the navigation channel

Of particular relevance to the marine works is the Mitigation, Compensation, Monitoring Agreement (August 2003). The MCM was developed to secure the measures that would be incorporated into the pre-, during and post development plan. An updated version of the Environmental Statement was produced to include the updates of the Public Inquiry and Mitigation, Compensation and Monitoring Agreement (updated Environmental Statement 2004).

1.2 SCHEME REFINEMENTS AND ENVIRONMENTAL STATEMENT

1.2.1 *'Final refined scheme'*

While the Environmental Statement discussed the option of the Ro-Ro berth being located on either the east or the western end of the port land, for the purposes of the modelling the impact of the project for the EIA, a scenario was used that positioned the Ro-Ro terminal on the eastern end.

The current master plan proposes that container berths are more suitable at the eastern end of the development so the detail of locating a Ro-Ro at the western end has been assessed and compared against the assessment of the option of locating the Ro-Ro at the eastern end. An important outcome is that the results show similar, if not better effects and are within the envelope of the original environmental assessment. This scheme, "the final refined scheme" sees the -17m CD berth box extended along the whole length of the quay with the exception of a Ro-Ro berth where the operational depth is at -10m CD (see Figure 1). The original EIA considered a -14.5m CD manoeuvring area with a -16m CD berthing pocket adjacent to a shorter length deep water quay with the shallower berth of the Ro-Ro at the eastern end of the development.

1.2.2 *'Interim refined scheme'*

It is also expected that in the first build out phase two container berths will be developed. The likelihood that the whole development would not be built as one phase was discussed in the EIA and it was recognised that the container berths would be built out in accordance with market demand. A scenario has therefore been modelled that considers two container berths plus protection, in the form of a revetment, along the remaining reclamation.

The initial refined scheme included modifications to the quay line at the eastern end – effectively providing a deep water quay along the full length of the reclamation and changes to the depth of the alongside berthing box. For the two eastern most berths a berthing box at -17m CD is proposed. Further westward the berths have not yet been completed and the whole of the manoeuvring area and berthing box are represented as being dredged to -14.5m CD (see Figure 2).

1.2.3 Relevance to Tidal Works Application and FEPA

The initial refined scheme represents the scenario at the start of port operations at the eastern end of the terminal and the situation where siltation has not built up at the western end and is relevant to the first Tidal Works application. In this scenario the quay line in the model represents container berths at the eastern end and a revetment protecting the reclamation material for the remainder of the length to the western end.

The final refined scheme is a representation of an anticipated final operating scenario where a Ro-Ro has been developed over a 400m length at the western end of the terminal and is relevant to the current FEPA application and subsequent Tidal Works applications.

1.2.4 Model representation of scheme refinements

A suite of numerical models were used to predict the effects of the original scheme on flows and sediment transport. The model representation of the manoeuvring area of the original scheme is shown in Figure 3. The representation of the initial refined scheme is shown in Figure 4. The final refined scheme is shown in Figure 5.

In addition to the changes described above there is a modification in the model bathymetry at the upstream end of the berthing area for the two refined schemes. The upstream end of the berthing box has been modified so as to extend slightly upstream and perpendicular to the quay line as compared to the original scheme. This representation, included in the refined model, is consistent with that presented in the EIA, the original representation was from an earlier layout used within the EIA process. As will be shown in Section 2.4, the predictions of siltation are particularly sensitive to the details of the layout in this area.

1.3 ENVIRONMENTAL ASSESSMENT

HR Wallingford were commissioned by London Gateway to advise on marine and coastal processes and in particular were responsible for the modelling of the impacts of the marine works to enable an understanding of impact to be developed.

Water Research Limited, were appointed to advise on water quality impacts, Marine Ecological Surveys on marine ecology impacts and Pisces Conservation on the fish resource.

The hydraulic studies play an important part in the EIA enabling the ecological team to assess the impacts on the environment. HR Wallingford have therefore led in modelling the impact of the scenarios and making a comparison of physical changes for the refined schemes against the original scheme presented in the EIA. Based on those results the specialist team have reviewed their parts of the environmental assessment to confirm that the impacts are within the envelope of the original environmental assessment. Their assessment is built into Section 4 of this report.

The approach used in the original environmental assessment has been used in comparing the scenarios to ensure continuity and a robust assessment that meets the standards of the regulatory requirements.

1.4 MITIGATION, COMPENSATION & MONITORING AGREEMENT

The Mitigation, Compensation and Monitoring Agreement sets out the measures that London Gateway will implement in order to minimise the risk of impact to the marine environment. The measures include the provision of a detailed dredge plan, mitigation during construction, management of dredging activities, monitoring during construction, provision of Sites A and X and the running of an Ecological Advisory Group (EAG). The measures are designed to protect wildlife, navigation and flood defence.

In considering the significance of scheme refinements it is therefore essential that as well as considering the environmental assessment it is important to consider measures set out in the MCM and check that these measures still apply.

1.5 OBJECTIVES

The objectives of this note are to:

- present and compare the hydraulic studies for the original scheme against the "interim" and "final" scheme refinements
- consider the implications of the hydraulic modelling results from the scheme refinements on the marine environment specifically navigation dredging, flood defence, ecology and fisheries
- assess the implications for water quality, intertidal invertebrates and organisms that depend upon them as a food resource (birds and fish) and determine whether:
  a) there is a need for further assessment relating to these disciplines
  b) there is a need to identify further measures not set out in the Mitigation, Compensation & Monitoring Agreement
  c) ultimately the assessment is within the envelope of the original London Gateway Environmental Impact Assessment

1.6 APPROACH

The modelling, analysis and interpretation described in this report is based on the methodologies originally employed in the hydraulic studies undertaken to support the EIA and has been undertaken by HR Wallingford.

HR Wallingford have direct responsibility for assessing the impacts on navigation dredging and flood defence. The conclusions regarding whether or not there are consequences arising that are different to those addressed in the EIA have been made in consultation with other experts as follows:

Responsibility	**Organisation**	**Individual**	**Position**
Marine Ecology	Marine Ecological Surveys Ltd	Dr Richard Newell	Chairman
Water and Sediment Quality	Water Research Centre	Dr Mike Gardner	Principal Environmental Chemist
Fish	Pisces Conservation Ltd	Dr Peter Henderson	Director

1.7 STRUCTURE OF THE REPORT

This report comprises five sections as follows:

Section 1 (this section)	Introduction
Section 2	2D flow modelling (to examine the effects of the refinements on an estuary wide scale),
Section 3	3D flow and mud transport modelling (to examine the local effects of the refinements)
Section 4	Discussion of the key conclusions of both the EIA and assessment of the scheme refinements and the significance of these refinements in relation to geographical areas of the Thames.
Section 5	Conclusions

2. Estuary wide effects of scheme refinement

The first step in the modelling to demonstrate the effects of the scheme refinements described in Section 1.2 was to rerun the 2D flow model for spring tide conditions to examine the effects of the refinements on an estuary wide scale.

2.1 FLOOD DEFENCE

The 2D flow modelling has shown that the impact of the initial refined scheme on upstream tidal propagation past the port is the same as for the original scheme. As a result there is no predicted change to flood risk as a result of the scheme refinements.

2.2 TIDAL CURRENTS

To demonstrate the effects of the original scheme a series of plots showing the difference in predicted current speeds in the area of the port were previously used in the EIA. In this report plots showing the difference between baseline conditions and the original scheme at times of peak flood and peak ebb currents are illustrated in the upper graphic of Figures 6 and 7. Similar plots showing the differences in current speed between the baseline and initial refined scheme are illustrated in the lower graphic of Figures 6 and 7. It can be seen that generally only in the immediate vicinity of the reclamation area are there any differences between the effects of the original and initial refined schemes.

The prediction of only very small differences between the effect of the initial refined scheme and that associated with the original scheme showed that testing the final refined scheme in the 2D model was not necessary and that all conclusions draw for the initial refined scheme can be applied to the final refined scheme.

2.3 SAND TRANSPORT

Since the 2D flow patterns are relatively unchanged it is expected that sand transport patterns and sand accretion for the refined schemes will be unchanged in the dredged areas compared to the original scheme. No modelling of sand transport for the refined schemes has been undertaken.

The original predictions of sand infill as presented in the EIA were 0.24Mm^3/year in the manoeuvring area and 0.24Mm^3/year in the navigation channel.

3. Local effects of scheme refinement

3.1 INTRODUCTION

The 2D flow modelling has demonstrated that there are some local changes to current speeds as a result of the scheme refinements in the area local to the container berths. In the EIA 3D flow and mud transport models were considered better tools to examine these changes in detail.

3.2 3D FLOW MODEL

The 3D flow model was run for spring and neap tide conditions to examine these changes and to provide the flow conditions to enable the mud transport simulations to be rerun. This was done for the interim and final scheme refinements.

The results of the 3D flow modelling for the original and initial refined schemes are shown in Figures 8 and 9 in terms of colour contours and vectors of current speed at times of peak flood and ebb currents. Figure 8 illustrates the flow conditions for the original scheme and Figure 9 those for the initial refinement scheme. The current vectors indicate the direction and speed of flow, the colour contours the speed of flow only. It can be seen that the peak speeds are generally comparable between the two schemes reflecting the fact that the differences are generally small. The main areas of difference are at the western and eastern ends of the berthing box.

Similar results are presented in Figure 10 for the final refined scheme. Again only very small differences can be seen between this test and the currents simulated for the original scheme (Figure 8).

Flow conditions at the eastern end of the quay were previously flagged up as being of concern because of the proximity of the adjacent downstream berths. Previously it was found that tidal currents on the flood tide were predicted to increase at this berth as a result of the development. Figures 11 and 12 illustrate the effects of both the original scheme and the refined scheme on predicted near surface (Figure 11) and near bed (Figure 12) tidal currents at the adjacent berth.

It can be seen that compared to the original scheme the impacts of the refined schemes on the tidal currents at the downstream berth are generally reduced. In particular the increases arising during the flood tide when near surface flows were predicted to approach 1.1m/s (over 2 knots) are reduced. The model predicts no difference between the initial and final refined scenarios in the locations considered.

It can be inferred from these results that if the interim scheme were modified to a scenario where three container berths had been built, there would be no further change to the flow regime at the adjacent downstream berth.

3.3 3D MUD TRANSPORT MODELLING

The 3D flow model was the basis for the predictions of mud transport and accretion patterns for the previous EIA. The model was run for spring and neap tide conditions.

3.3.1 Intertidal areas

Modelling of the original scheme showed that in terms of impacts on the adjacent intertidal areas it was the spring tide conditions that were important because these delivered the most fine sediment onto the intertidals as a result of the higher suspended sediment loads and greater degree of inundation. Figure 13 illustrates the predicted pattern of deposition for spring tide conditions in the proximity of the port for the original scheme as presented in the EIA.

These model results are reproduced for the initial refined scheme in Figure 14. It can be seen that the impacts on the upstream intertidal area of Mucking Flats are similar for the two schemes. However, compared to the original scheme the initially refined scheme leads to a slightly reduced footprint of impact on Mucking Flats. Figure 15 shows the same results for the final refined scheme again showing very similar behaviour to the initial refined scheme.

3.3.2 Maintenance dredging – London Gateway Port

Siltation in the manoeuvring area and berthing boxes for the original and refined schemes show a tendency for deposition at the upstream area of the berthing boxes. The siltation under spring tide conditions is reduced for the refined schemes for spring tide conditions compared to the original scheme (see Table 1). For the final refined scheme almost no accretion is shown in the upstream Ro-Ro berth pocket because of the reduced depths. In this scenario accretion is shown at the upstream limit of the -17m CD berth pocket adjacent to the Ro-Ro berth. This behaviour of accretion at the upstream edge of the deepest berth pocket is consistent with the understanding of the sedimentary processes at work in the port area gained in the EIA.

The previous studies demonstrated that siltation rates were higher on neap tides as a result of the weaker neap tide currents being unable to maintain high sediment loads in suspension in the deepened areas of the manoeuvring area. The 3D mud transport model was run for two conditions to represent neap tide conditions - one where an upstream boundary condition of 200mg/l was applied and one where this upstream boundary was increased to 300mg/l. There are significant differences in the amount of accumulation arising depending upon this boundary condition (see Table 1). In the EIA it was proposed that these differences represented the seasonal variability in suspended sediment concentrations in the Thames estuary and therefore that a combination of the results could be used to quantify the annual siltation in the dredged areas of the new port.

Further evidence for neap tide concentrations comes from the SEDIVIEW cross section at Coryton run as part of the EIA studies. This survey, from December 2002 showed average concentrations in the range less than 100 mg/l. Since the EIA studies a large scale survey of the suspended concentration in the Thames Estuary has been undertaken as part of the Environment Agency's Thames Estuary Flood Risk Management Study (TE2100). SEDIVIEW transects in the area of interest were observed at Southend, Coryton and Gravesend for spring tide conditions and at Gravesend and Southend for neap tides. These observations suggested average suspended solids concentrations at the lower end of the values used for the simulations presented in Table 1, however they were undertaken under low freshwater flow conditions when suspended concentration would be expected to be at the lower end of those occurring.

Table 1 Predicted Annual siltation rates in manoeuvring area of London Gateway Port (m^3/year)

	Original Scenario	Initial refined Scheme	Final refined Scheme
Springs	565,000	325,000	76,000
Neaps 200mg/l	195,000	155,000	71,000
Neaps 300mg/l	1,950,000	3,228,000	2,361,000
Waves	40,000 – 50,000	40,000-50,000	40,000-50,000
Total	**0.8–2.55 Mm^3**	**0.5-3.6 Mm^3**	**0.2 – 2.48 Mm^3**
Average Annual	**1.7 Mm^3**	**2.0 Mm^3**	**1.3 Mm^3**

The small differences in the model at the upstream end of the berthing box are responsible for the differences in predicted siltation. The siltation rates for the refined scenarios are predicted to vary between 20% higher for the initial refined scenario and 20% decrease for the final refined scenario. Compared to the original scheme presented in the EIA these changes will not significantly affect the approach to future maintenance dredging at the port. The proposal to recycle the accumulating fine sediment back into the estuary system so as to maintain sediment fluxes remains.

3.3.3 Maintenance dredging – North Shore Berths

Accretion predictions were also made for the development scenarios for the nearby berths, where navigation dredging is presently required. Two areas were analysed in the EIA – one covering berths at Coryton and one covering the berths on Canvey Island. Tables 2, 3 and 4 show the comparison of the predicted annual siltation rates for these two areas for the original and two refinement scenarios arising from the post construction scenario and additional siltation arising from maintenance dredging of London Gateway Port.

Table 2 Summary of predicted accretion in existing riverside berths – original scenario

<table>
<tr><th></th><th>Post-construction (m^3/yr)</th><th>Maintenance* (m^3/yr)</th></tr>
<tr><td>Shellhaven berths</td><td>-</td><td rowspan="3">40,000 – 130,000</td></tr>
<tr><td>Coryton berths</td><td>40,000 – 50,000</td></tr>
<tr><td>Canvey Island berths</td><td>10,000</td></tr>
</table>

Notes *Effect arises from agitation dredging of 0.8 – 2.55Mm^3 of mud

Table 3 Summary of predicted accretion in existing riverside berths – interim refined scenario

	Post-construction* (m^3/yr)
Shellhaven berths	-
Coryton berths	45,000 – 65,000
Canvey Island berths	9,000

Notes *In this scenario there would be no need to maintain the western end of the berthing area and there would be no additional contribution to infill from ongoing maintenance dredging.

Table 4 Summary of predicted accretion in existing riverside berths – final refined scenario

<table>
<tr><th></th><th>Post-construction (m^3/yr)</th><th>Maintenance* (m^3/yr)</th></tr>
<tr><td>Shellhaven berths</td><td>-</td><td rowspan="3">20,000 – 126,000</td></tr>
<tr><td>Coryton berths</td><td>43,000 – 68,000</td></tr>
<tr><td>Canvey Island berths</td><td>10,000</td></tr>
</table>

Notes *Effect arises from agitation dredging of 0.2 – 2.48Mm^3 of mud

For the original scenario the future operational maintenance dredging at the riverside berths (excluding London Gateway Port) including the effects of maintenance dredging for London Gateway Port are in the range 90,000 to 190,000 m^3/year (Table 2). In the interim refined scenario there would be no call for maintenance dredging of muddy material from the western end of the port and the maintenance dredging at the riverside berths would be in the range 54,000 to 74,000 m^3/year (Table 3). For the final refined scenario the maintenance dredging at the riverside berths would be in the range 73,000 to 204,000 m^3/year (Table 4). At the lower end of the predictions this final scenario represents a reduction in the future maintenance requirement of about 19% compared to the original scenario. At the upper end of the predictions this final scenario represents an increase in the future maintenance requirement of about 7% compared to the original scenario.

3.3.4 Accretion and erosion in Holehaven Creek

The 2D flow modelling (Figure 6) suggests a change in peak flow speeds on the flood tide in the mouth of Holehaven Creek. However, the 3D flow and mud transport modelling does not suggest a significant difference in accretion or erosion patterns in this area.

4. Discussion of the significance of scheme refinements

4.1 OVERVIEW

Generally as a result of the scheme refinements in the berthing area physical changes associated with the proposed development are comparable to or smaller than those presented in the original EIA.

The modelling predicts no change to the original assessment of hydraulic effects at an estuary wide scale. The localised effects were investigated in more detail and indicated a small reduction in footprint of impact arising as a result of the proposed scheme refinements on Mucking Flats. Predicted changes to the siltation rates in the berthing and manouevering area at London Gateway do not require an alternative approach to management of the muddy deposition. Siltation at the riverside berths between London Gateway Port and Holehaven Creek, where navigation dredging is currently required, is predicted to be comparable to that presented in the EIA.

Accordingly the implications for navigation dredging, flood defence, marine ecology, fish and water and sediment quality are as originally assessed.

This is discussed below in relation to geographical areas. There are a few exceptions where there is a divergence to the original EIA which have been discussed above and considered to be within the envelope of the original EIA. These exceptions are also discussed below.

4.2 UPSTREAM OF COALHOUSE POINT

No significant changes arise from the proposed scheme refinements. Monitoring as outlined in the MCM will provide a means of confirming this prediction.

4.3 LOWER HOPE REACH

No significant changes arise from the proposed scheme refinements. Monitoring as outlined in the MCM will provide a means of confirming this prediction.

4.4 MUCKING FLATS

The assessment of the original scheme predicted that large natural fluxes of sediment on and off the mudflats will lead to changes to the morphology of Mucking Flats after the construction of the western bund of the second stage of reclamation works. Increases in sediment supply from reclamation and dredging losses were assessed to contribute to the evolution. The EIA included highly precautionary assumptions about the loss of fines from the reclamation activity.

The new 3D mud transport modelling indicates a small reduction in footprint of impact arising as a result of the proposed scheme refinements. The impact assessment for the original scheme on ecology of both invertebrates and birds is therefore the same as for the refinements discussed in this report. Monitoring as outlined in the MCM will provide a means of confirming this prediction.

4.5 NORTH SHORE BERTHS IN SEA REACH

A reduction in impact on tidal currents at the berth immediately downstream of London Gateway Port is predicted as a result of the scheme refinements.

Siltation at the riverside berths between London Gateway Port and Holehaven Creek, where navigation dredging is currently required, is predicted to be comparable to that presented in the EIA.

4.6 HOLEHAVEN CREEK

No significant changes arise from the proposed scheme refinements. Monitoring as outlined in the MCM will provide a means of confirming this prediction.

4.7 BLYTH SANDS

No significant changes arise from the proposed scheme refinements. Monitoring as outlined in the MCM will provide a means of confirming this prediction.

4.8 CHAPMAN SANDS, SOUTHEND AND LEIGH FLATS

No significant changes arise from the proposed scheme refinements. Monitoring as outlined in the MCM will provide a means of confirming this prediction.

4.9 MAPLIN SANDS AND FOULNESS

No significant changes to the hydrodynamic, suspended sediment or morphological regimes of Maplin Sands and Foulness were predicted in the EIA. This is not changed by the proposed scheme refinements. Monitoring as outlined in the MCM will provide a means of confirming this prediction.

4.10 BERTHING AND MANOEUVRING AREA

The scheme refinements are within the original footprint put forward in the EIA. The scheme refinements described here have a negligible effect on the total volumes of material to be dredged. Consequently no effects arise on the losses of material from the dredging activity as originally assessed in the EIA. The MCM provides a means for control of the dredging activity.

It is intended that the construction impact on flows in Sea Reach will be managed through broadly maintaining the cross-sectional area of the estuary as the construction proceeds. This is a matter of phasing reclamation, construction of the bunds and dredging of the adjacent cross-section. This was a condition of the original submission and is not changed by the refinements presented in this report. Monitoring as outlined in the MCM will provide a means of confirming this prediction.

The future rates of accumulation of muddy material at the western end of the berthing and manouevernmg area are predicted to be 2.0 Mm^3/year for the initial refined scheme and 1.3 Mm^3/year for the final refined scheme – which includes the shallower berths of the Ro-Ro at the eastern end. The original prediction for mud deposition was 1.7 Mm^3/year. These siltation rates do not require an alternative approach to management of the muddy deposition.

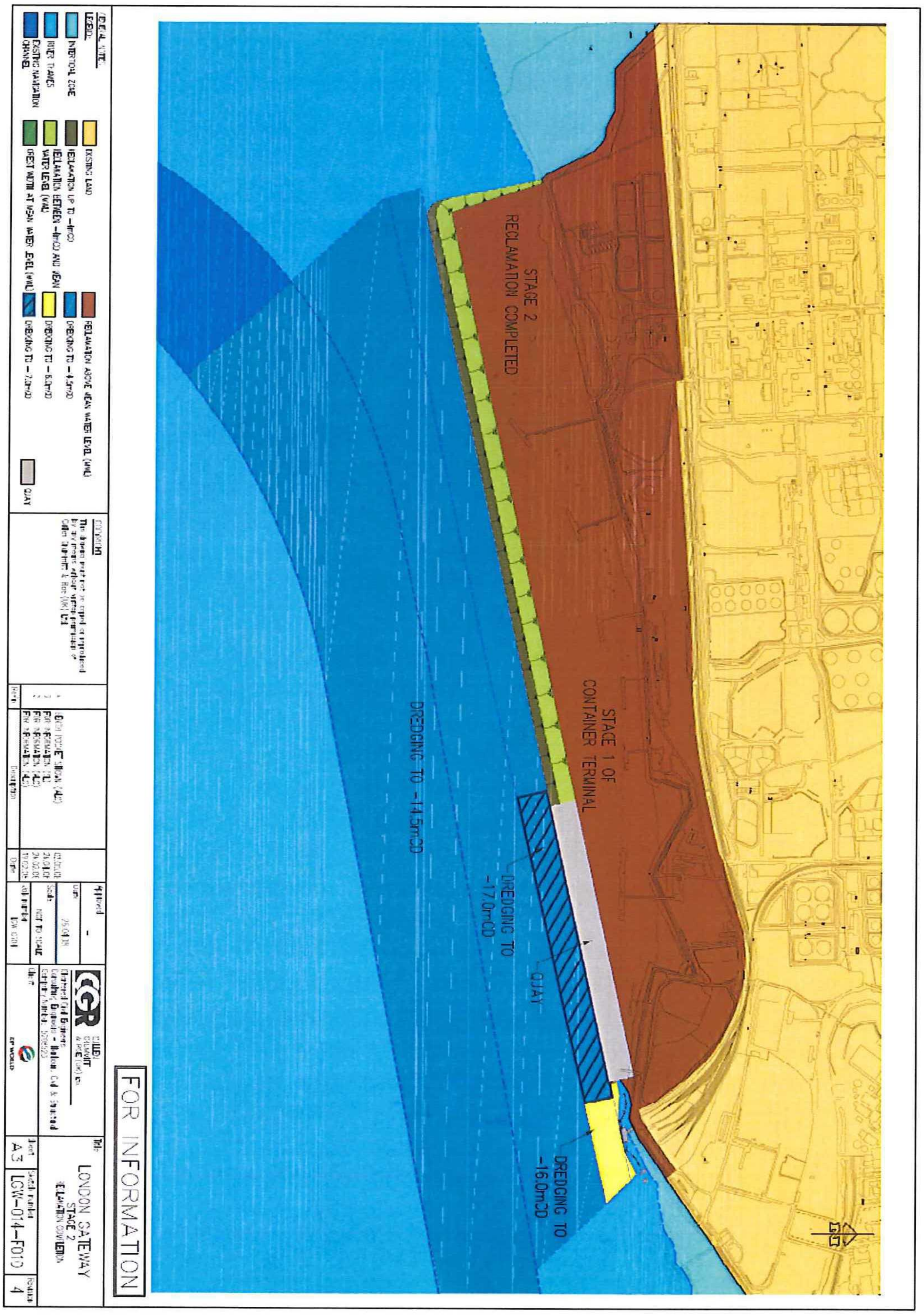

Figure 2 Interim refined scheme

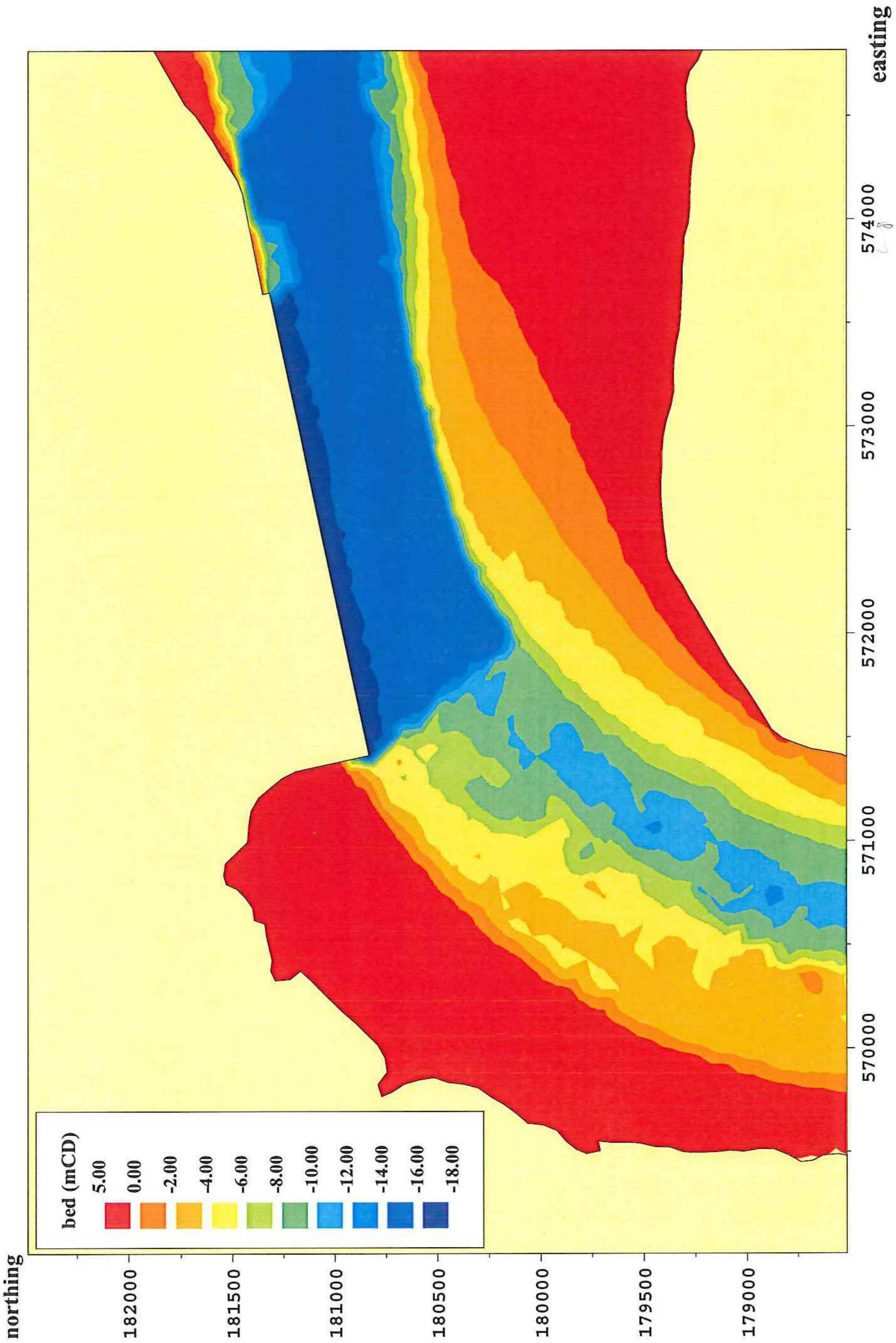

Figure 3 Model representation of bathymetry for original scheme as assessed in EIA

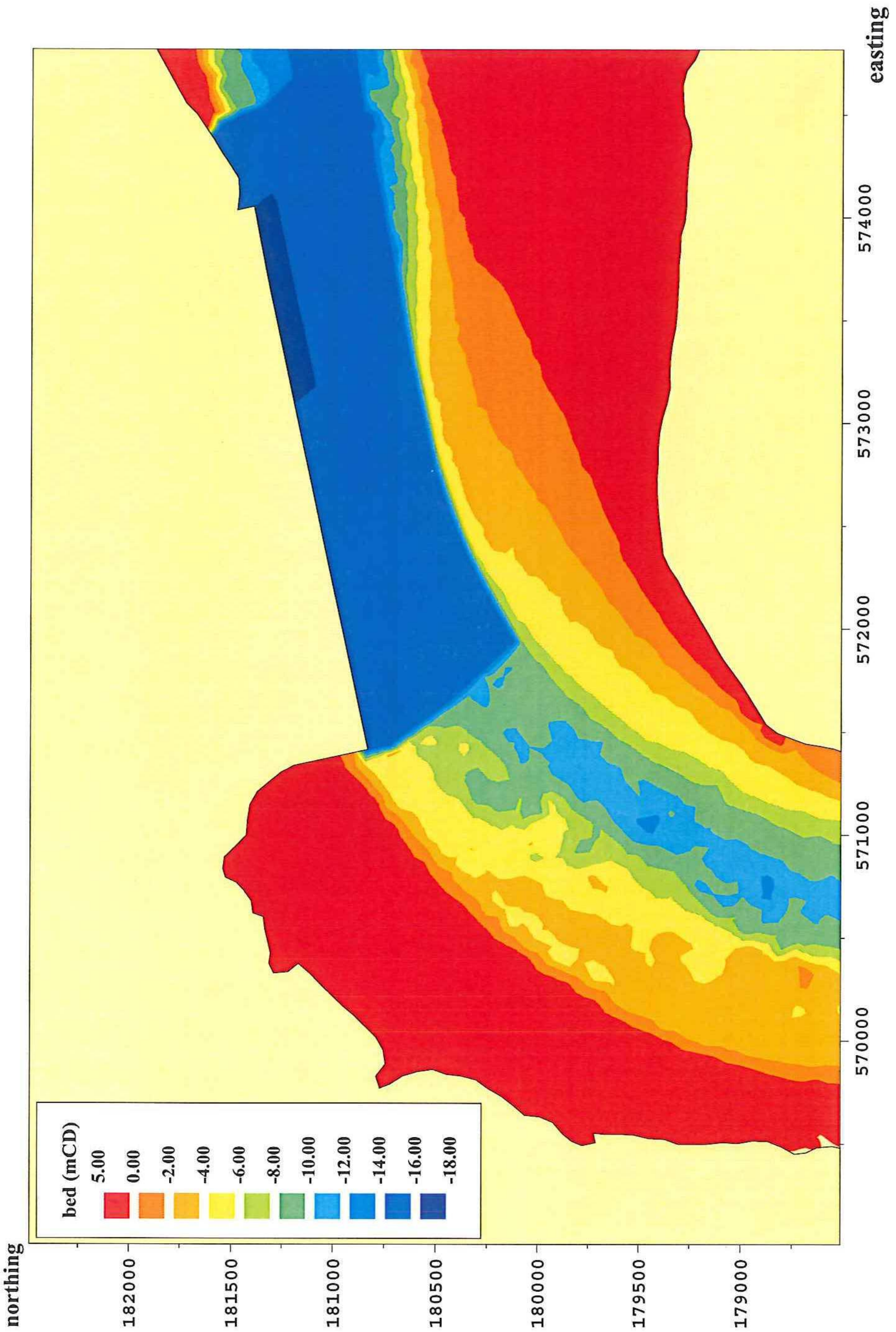

Figure 4 Model representation of bathymetry for initial refined scheme – longer straight line quay, eastern end of berthing box at -17m CD and western end at -14.5m CD

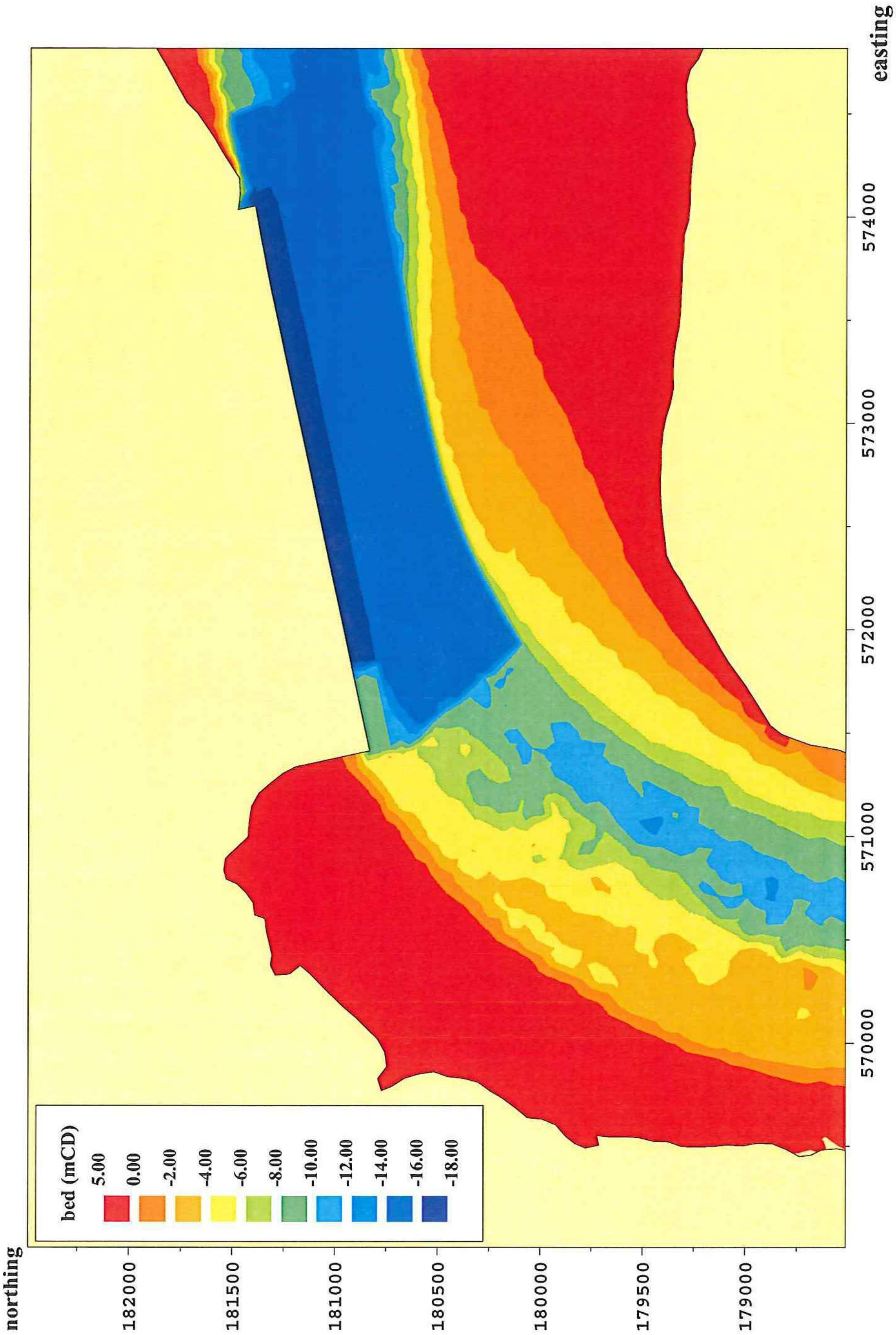

Figure 5 Model representation of bathymetry for final refined scheme – longer straight line quay, RoRo berth at western end of scheme at -10m CD and berthing box along entire quay line at -17m CD

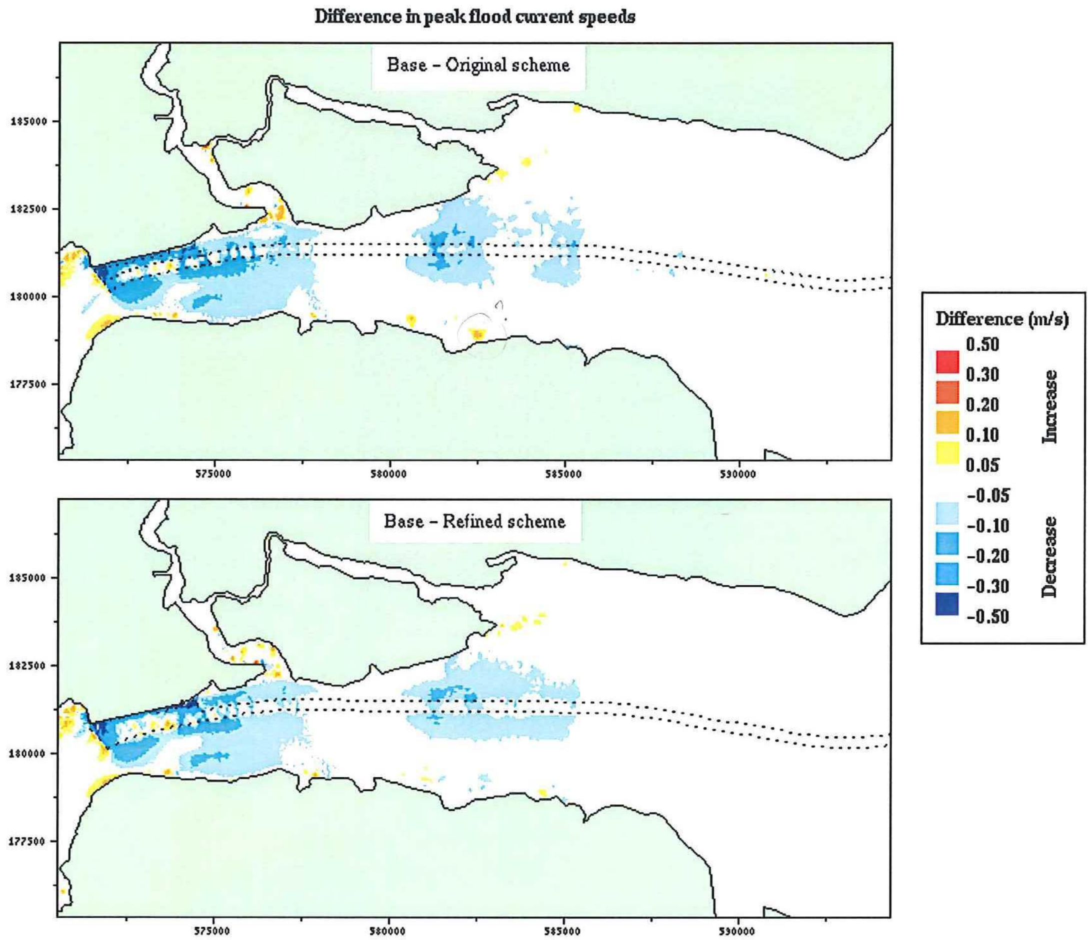

Figure 6 **Differences in peak flood current speeds between baseline and original (upper figure) and baseline and initial refined (lower figure) schemes. Blue contours indicate areas of reduced speed and yellow/red areas of increased speed**

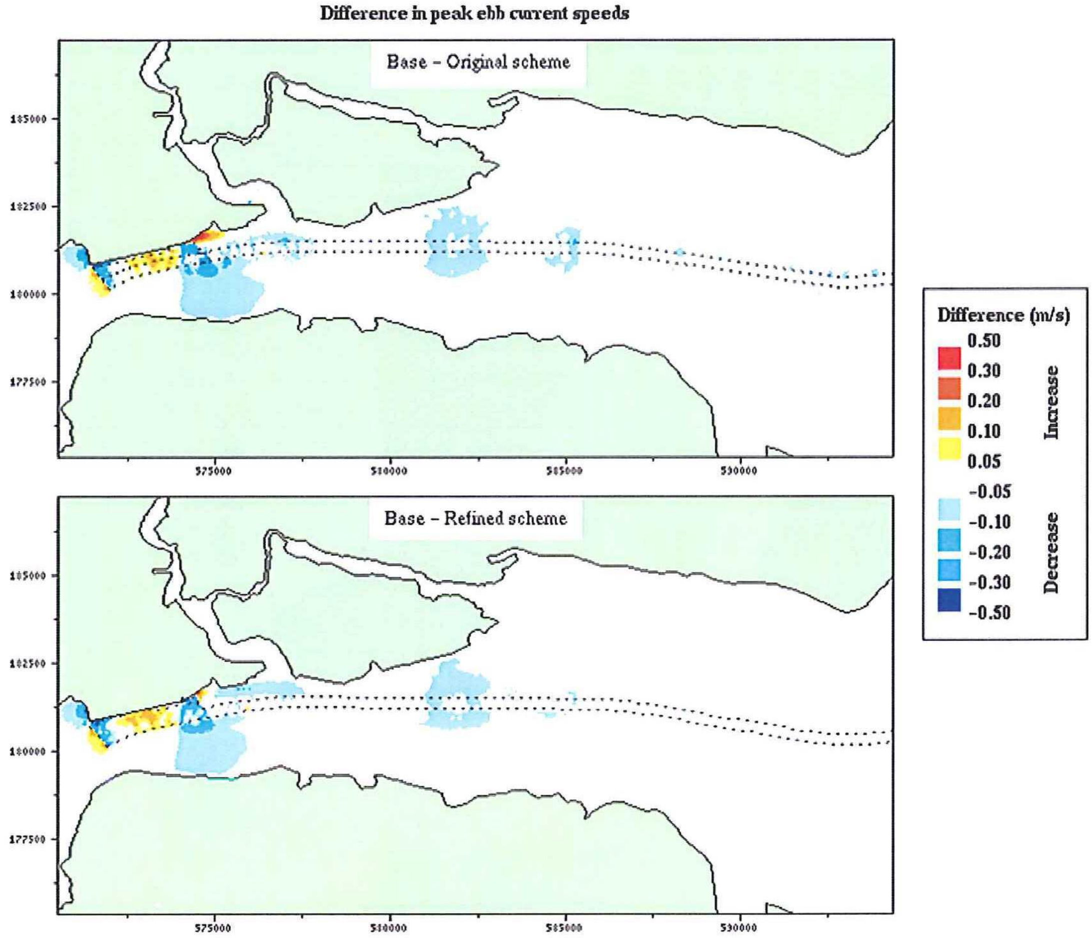

Figure 7 **Differences in peak ebb current speeds between baseline and original (upper figure) and baseline and initial refined (lower figure) schemes. Blue contours indicate areas of reduced speed and yellow/red areas of increased speed**

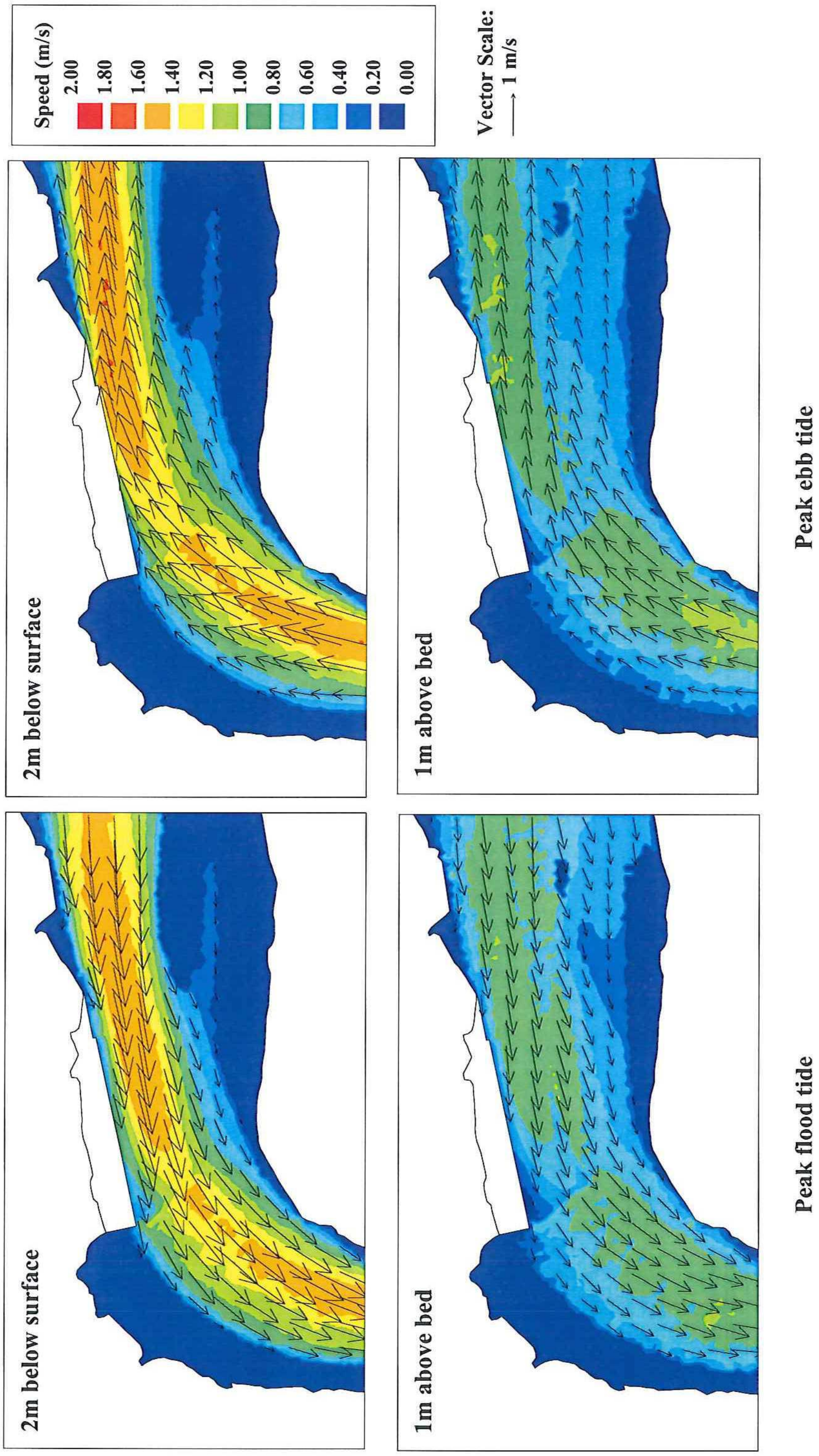

Figure 8 Near surface and near bed predicted currents local to the port for original scheme at times of peak flood and ebb tides

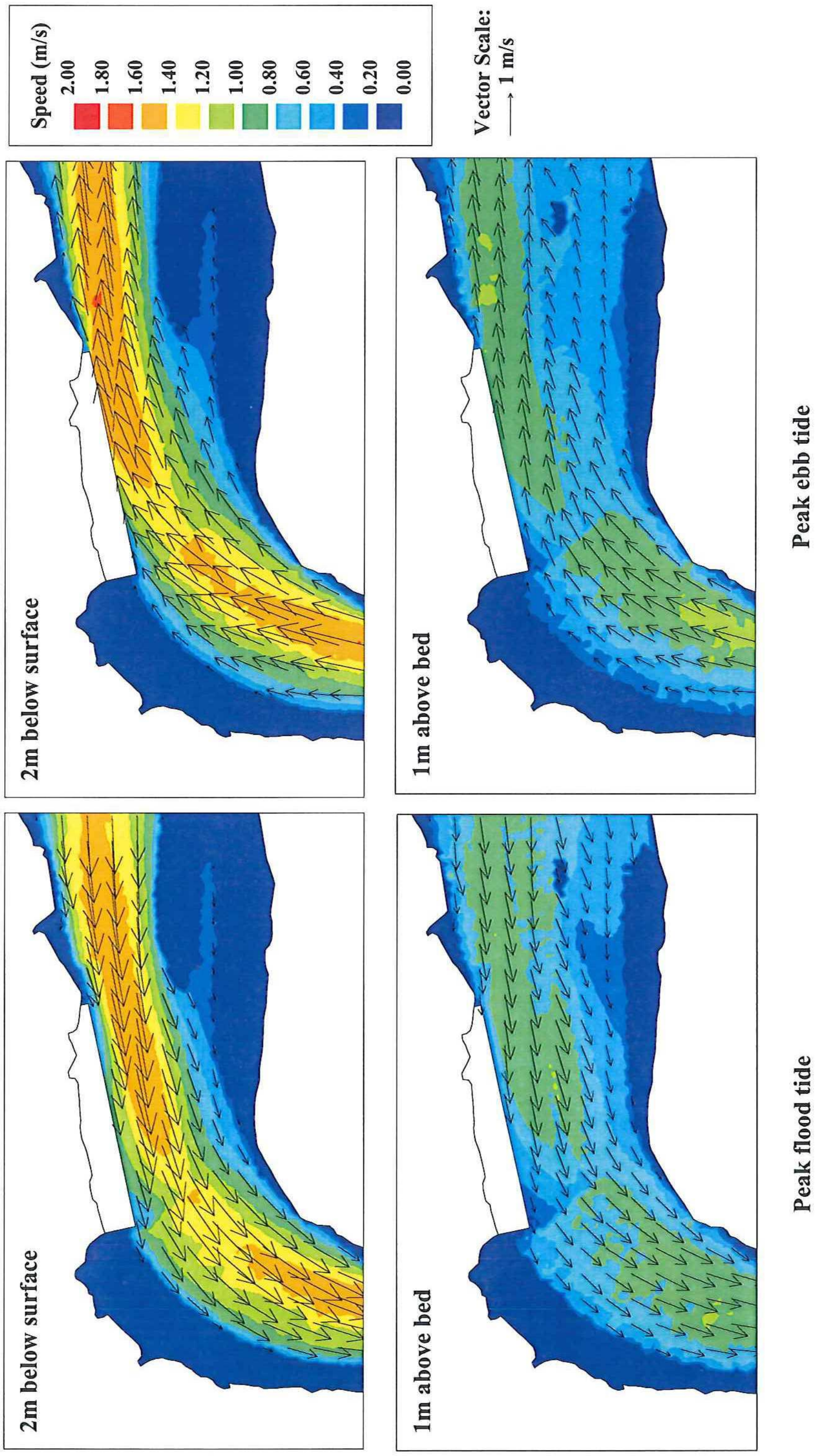

Figure 9 Near surface and near bed predicted currents local to the port for initial refined scheme at times of peak flood and ebb tides

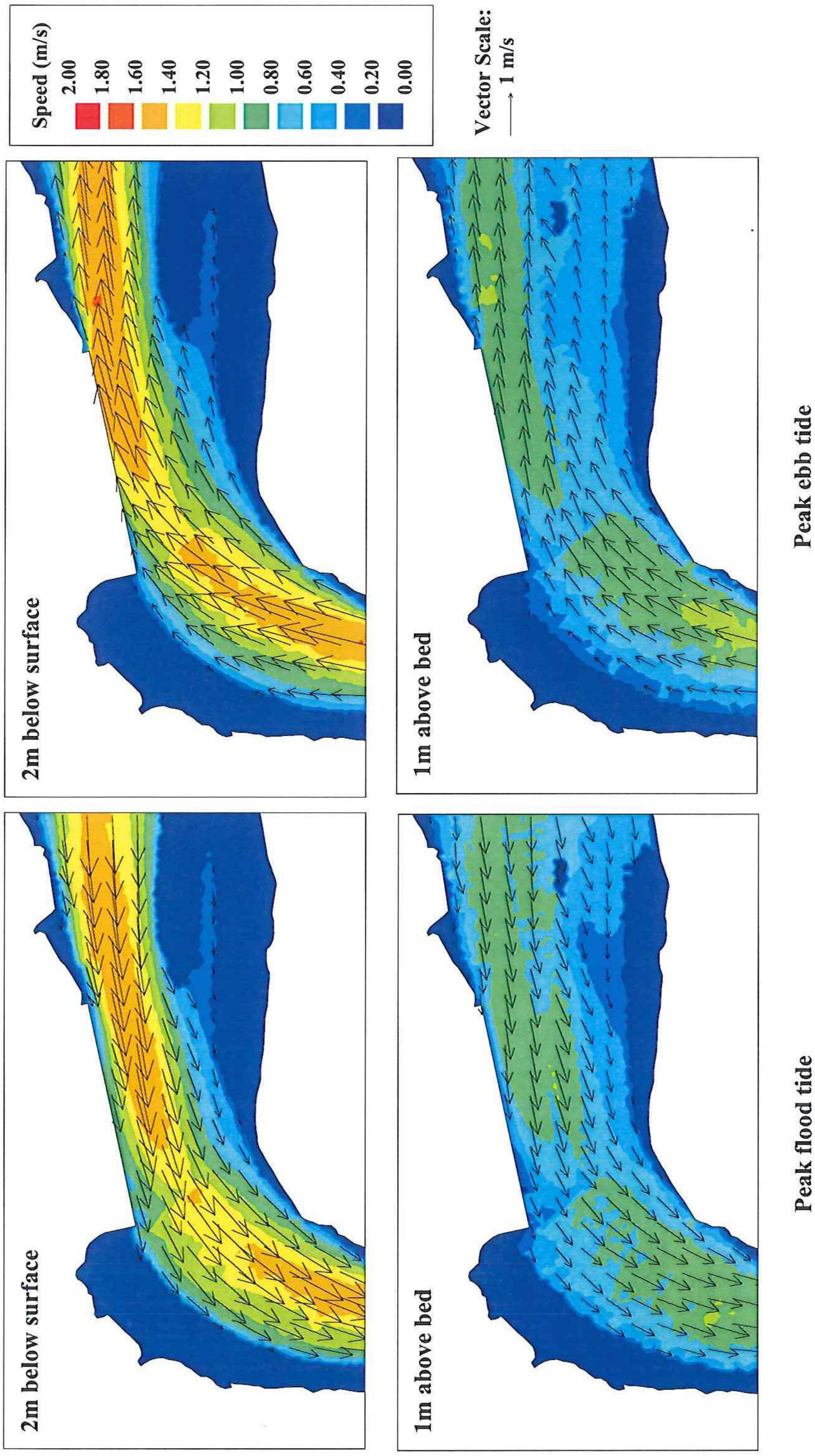

Figure 10 Near surface and near bed predicted currents local to the port for final refined scheme at times of peak flood and ebb tides

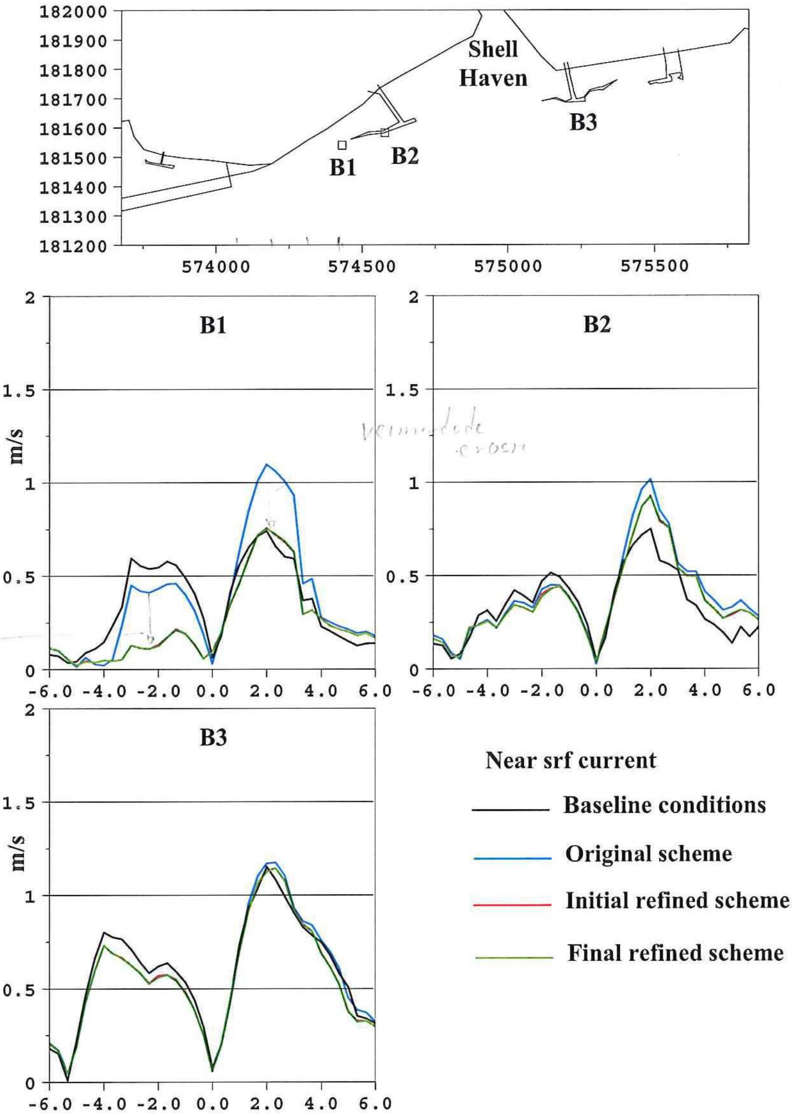

Figure 11 **Time series of predicted near surface tidal currents at adjacent berths (Hours after HW)**

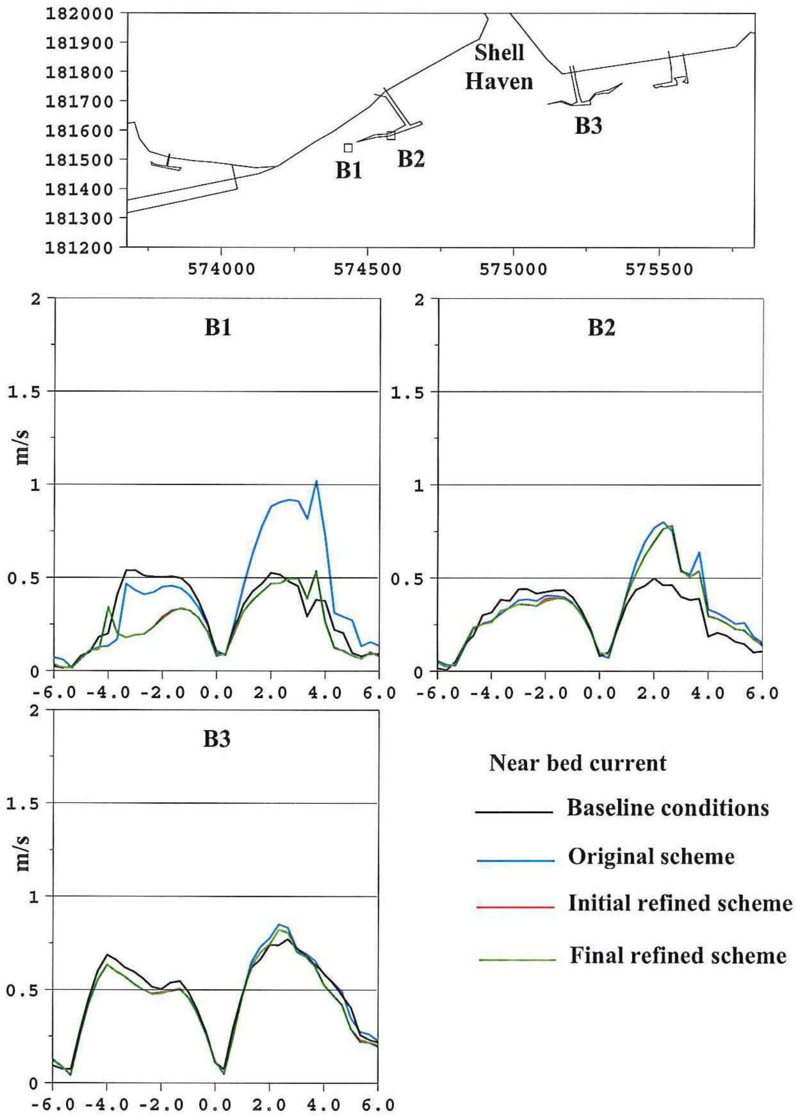

Figure 12 Time series of predicted near bed tidal currents at adjacent berths (Hours after HW)

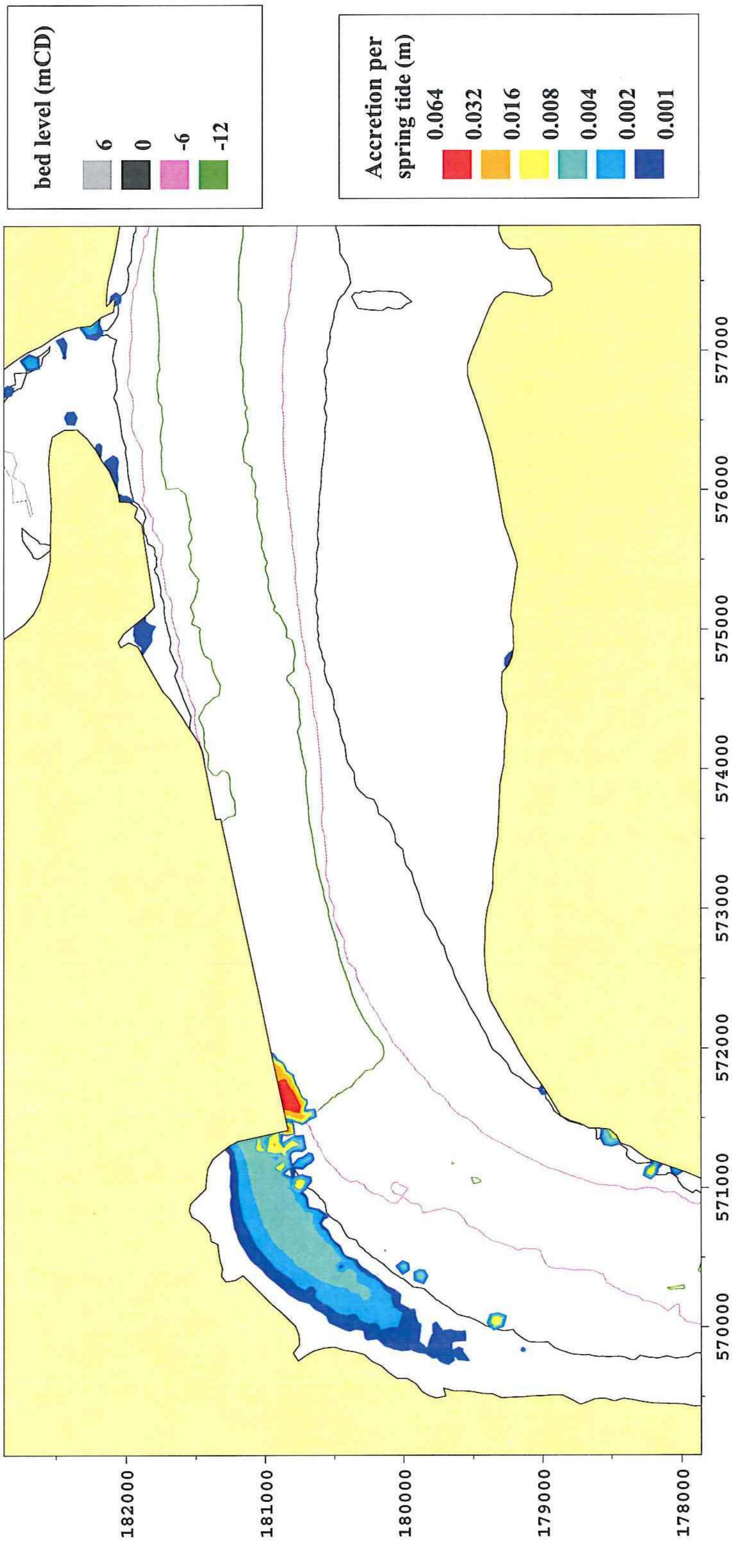

Figure 13 Spring tide siltation patterns, original scheme

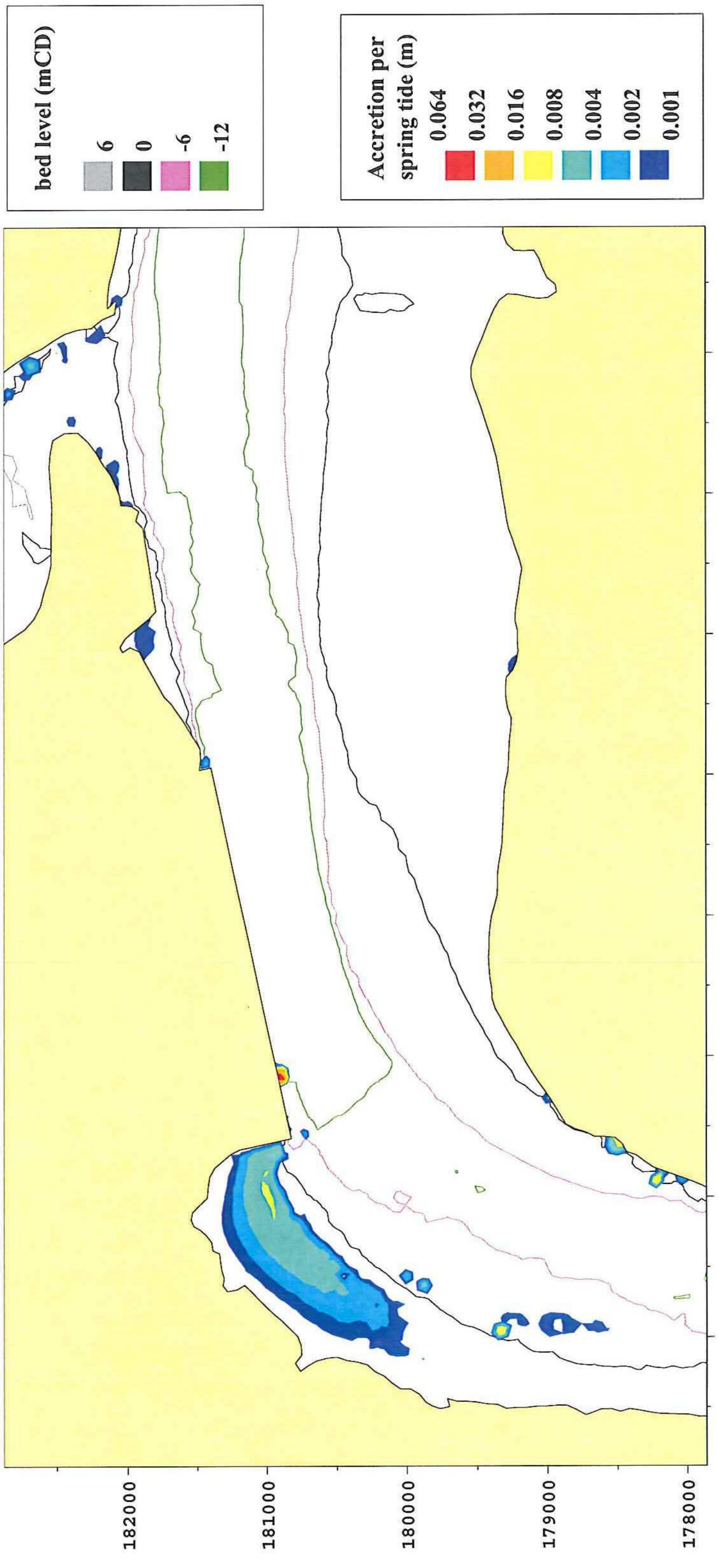

Figure 15 Spring tide siltation patterns, final refined scheme