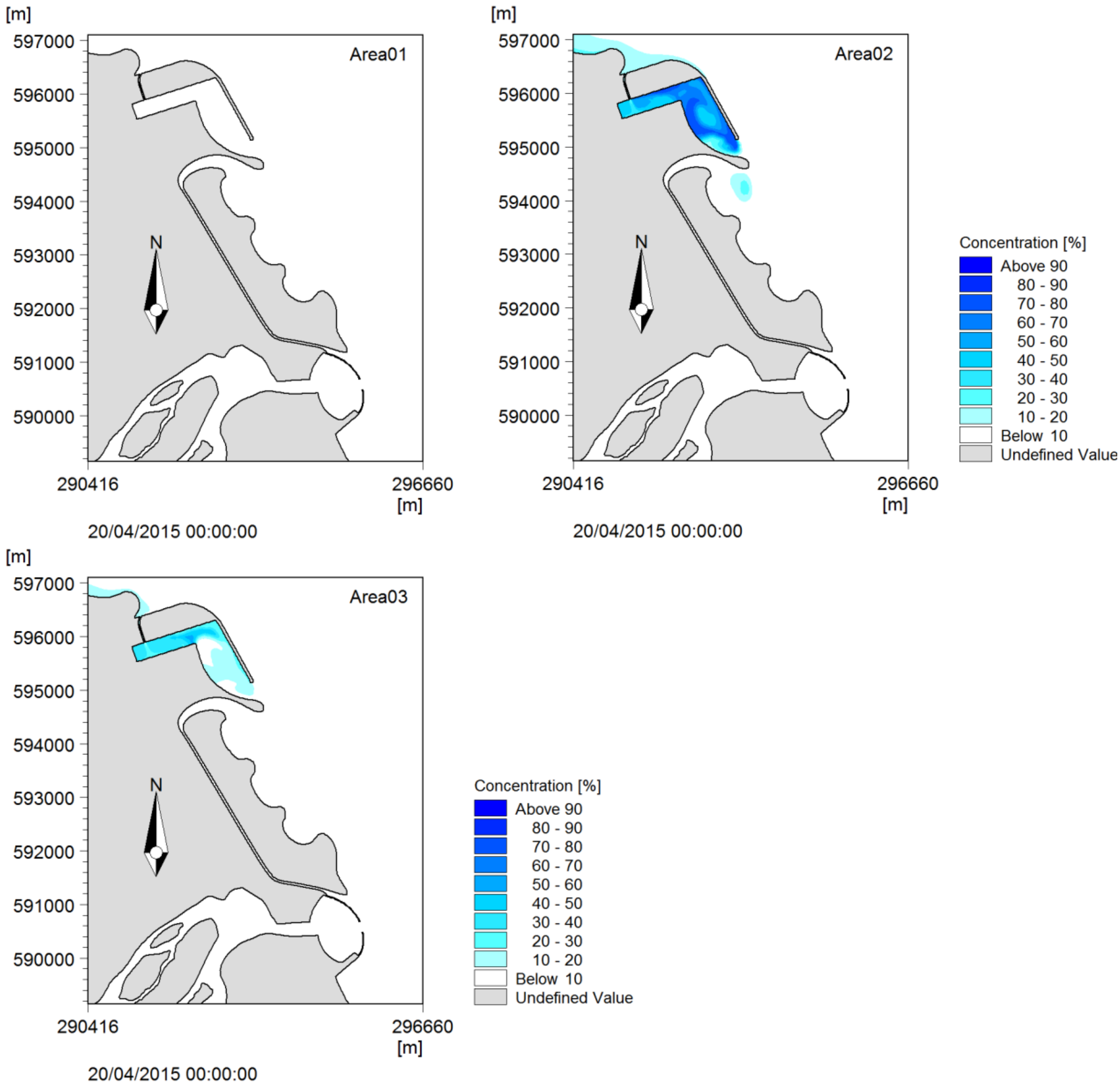

Figure 3.19 Layout 5 flushing – Day 2

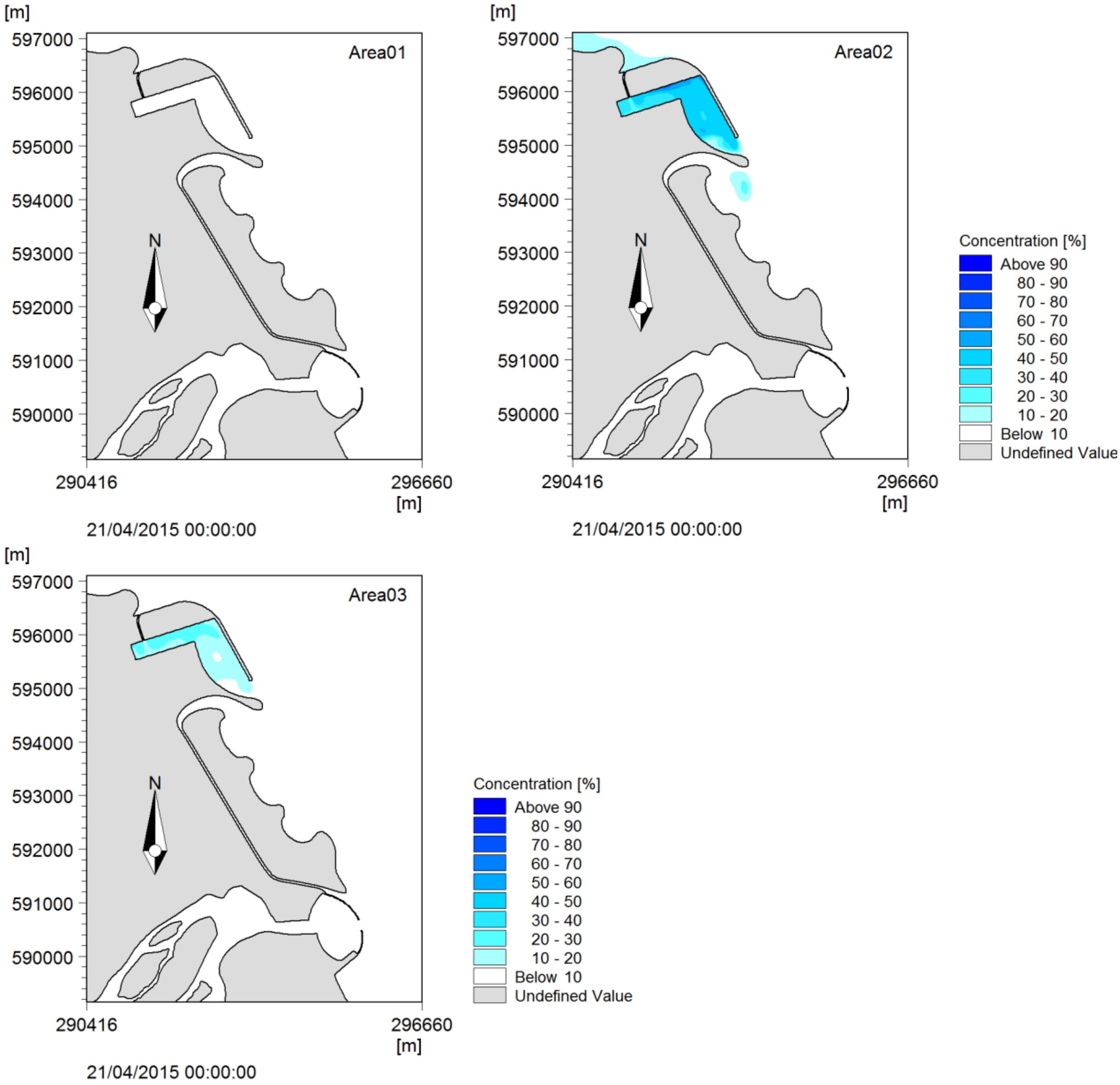

Figure 3.20 Layout 5 flushing – Day 3

3.6 Layout 8

A conservative tracer was placed in three locations for Layout 8 as shown in Figure 3.21, with the concentrations after 1, 2 and 3 days being shown in Figure 3.22 to Figure 3.25. These are intended to assess:

1 The flushing of the inner channel between the reclamation areas.
2 The flushing of the basin for the Cruise Terminal and ship repair area.
3 The risk of polluted water from Sg Terengganu affecting water quality at the development.

This layout is the final layout developed by BCT taking account of the previous modelling data. The modelling shows that relatively narrow inner channel with an irregular alignment has a relatively low flushing and there may be some water quality issues in this area. The discharge f polluted water from Sg Terengganu is not expected to significantly impact water quality in the development area.

The basin for the Cruise Terminal and ship repair facility does not include the northern channel and the water quality in this area may be poor.

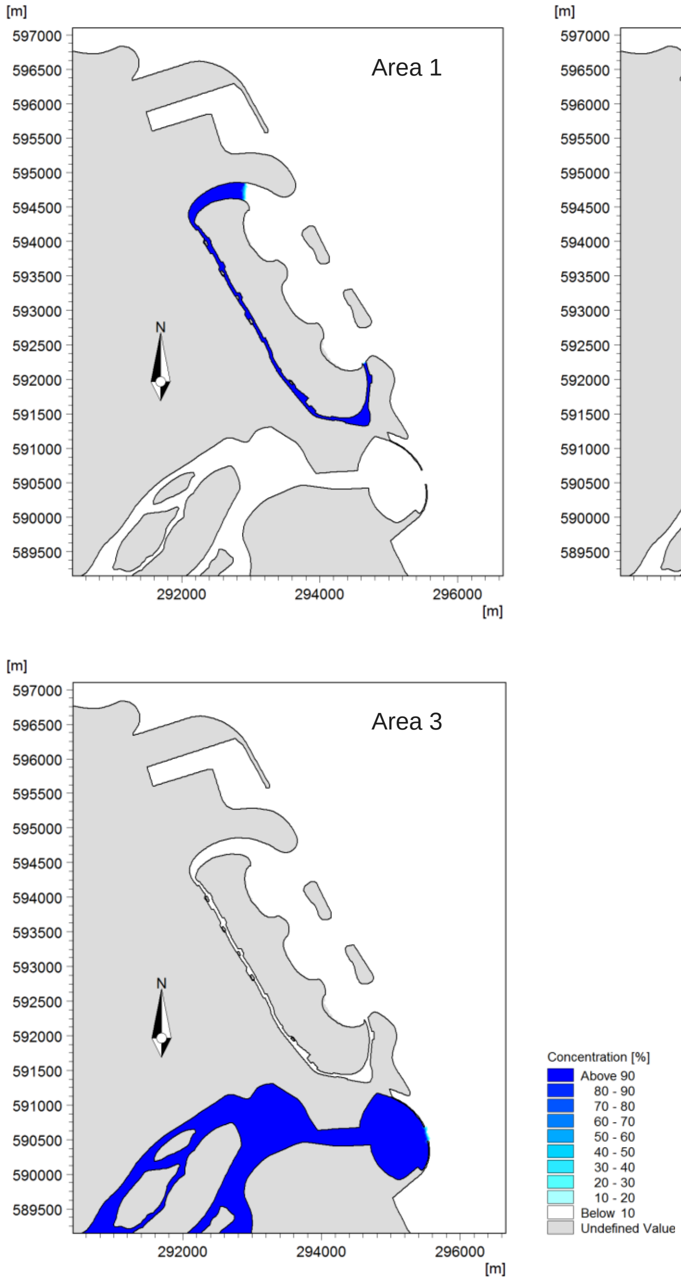

Figure 3.21 Layout 8 flushing – Day 0

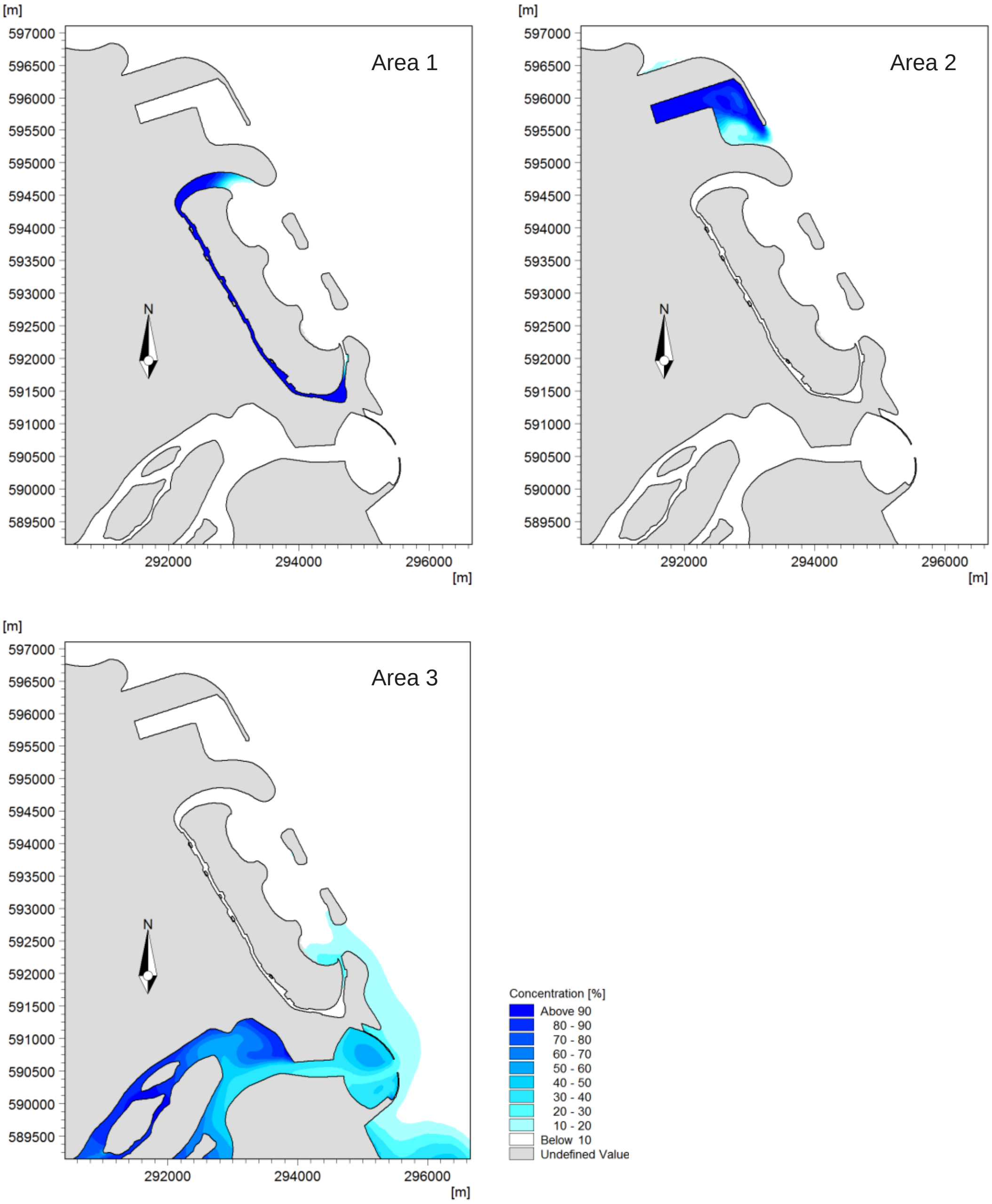

Figure 3.22 Layout 8 flushing – Day 1

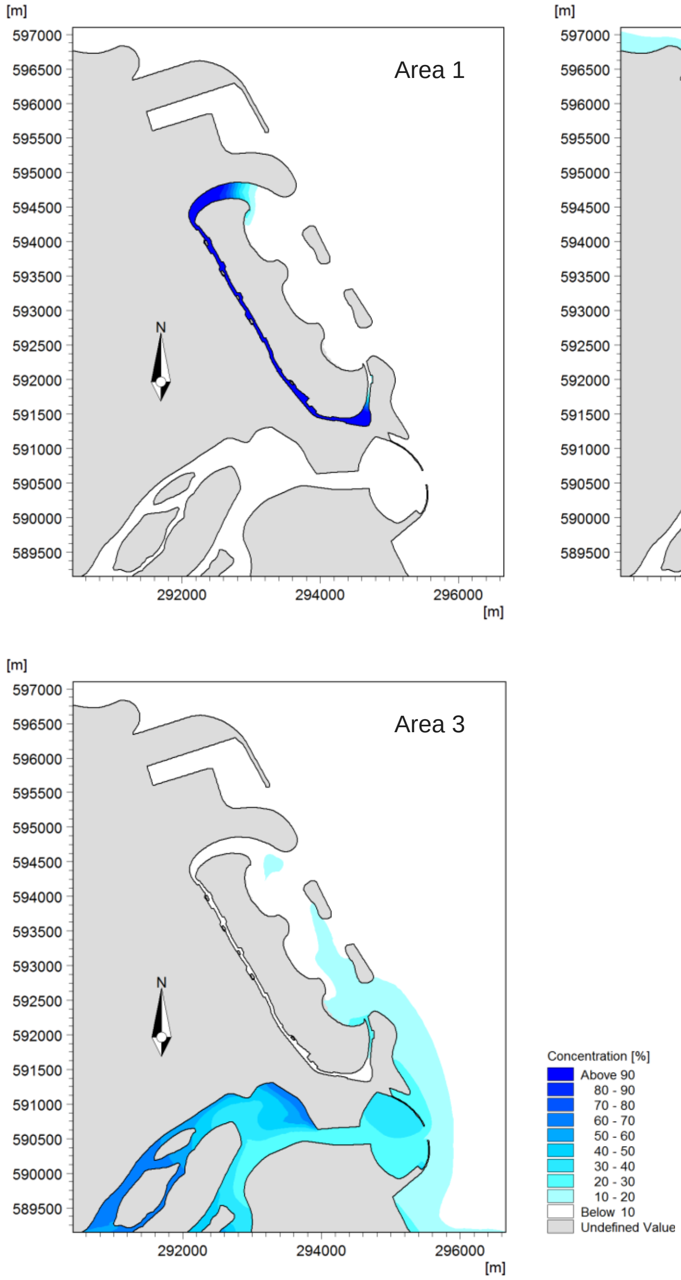

Figure 3.23 Layout 8 flushing – Day 2

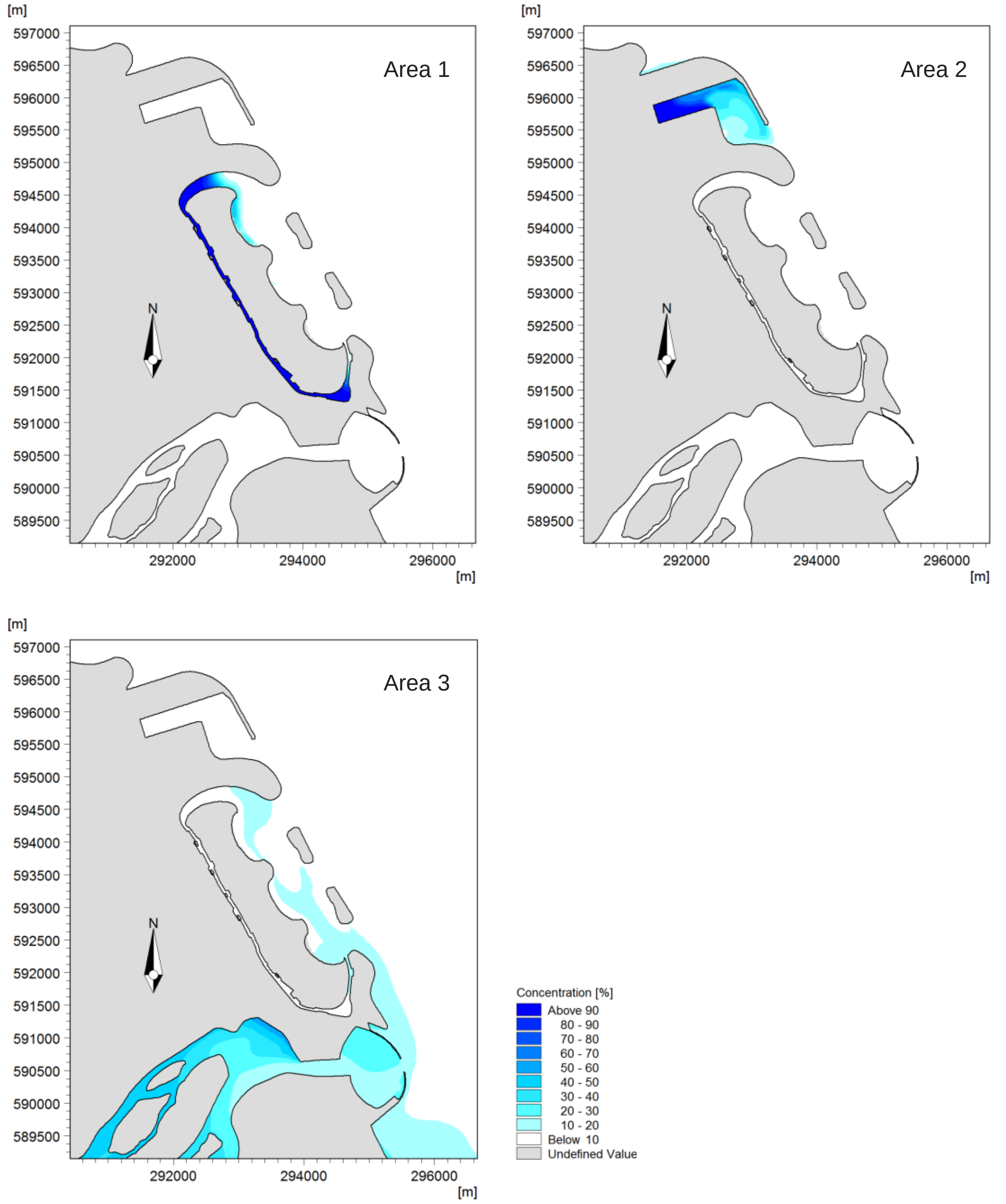

Figure 3.24 Layout 8 flushing – Day 3

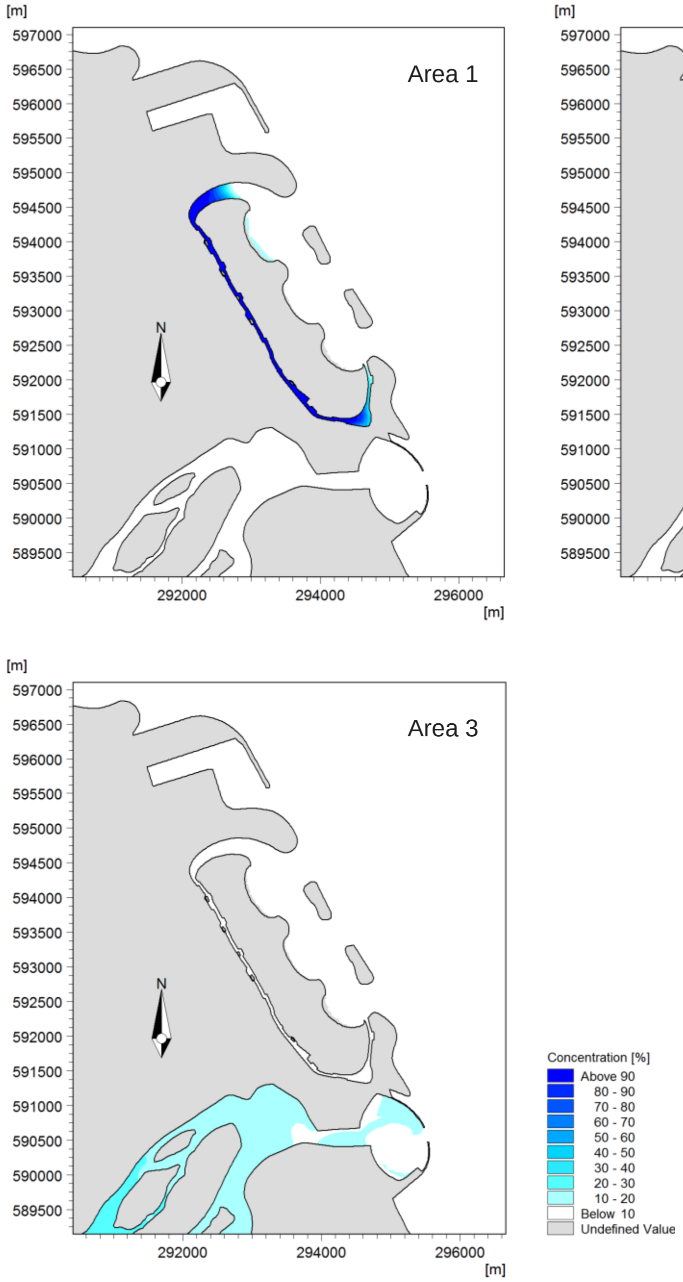

Figure 3.25 Layout 8 flushing – Day 7

3.7 Layout 9

A conservative tracer was placed in three locations for Layout 8 as shown in Figure 3.26, with the concentrations after 1, 2 and 3 days being shown in Figure 3.22 to Figure 3.30. These are intended to assess:

1. The flushing of the inner channel between the reclamation areas.
2. The flushing of the basin for the Cruise Terminal and ship repair area.
3. The risk of polluted water from Sg Terengganu affecting water quality at the development.

This layout is similar to Layout 8 except that the southern end of the inner channel us realigned to improve water flow through this channel. The flushing is the inner channel is improved by this change but this change is not sufficient to eliminate the risk of poor water quality in this area.

The basin for the Cruise Terminal and ship repair facility does not include the northern channel and the water quality in this area may be poor.

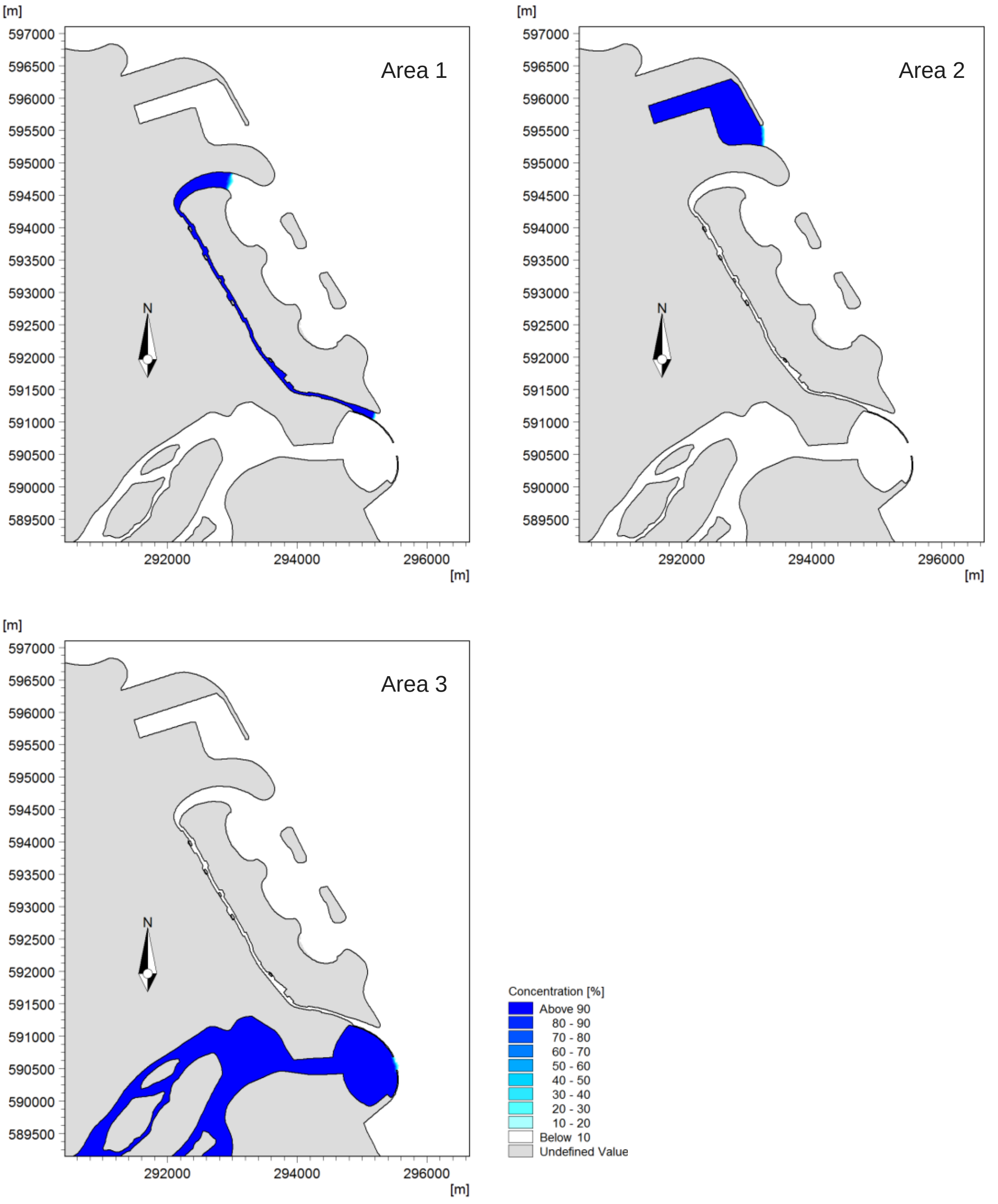

Figure 3.26 Layout 9 flushing – Day 0

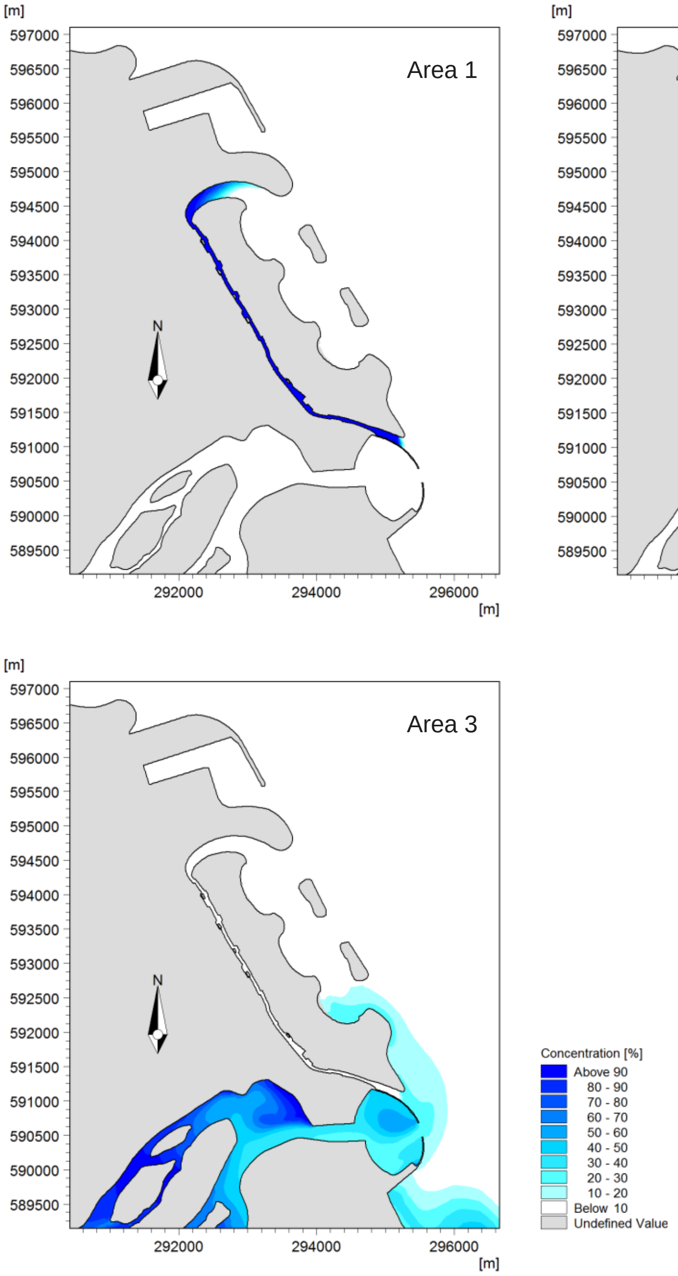

Figure 3.27 Layout 9 flushing – Day 1

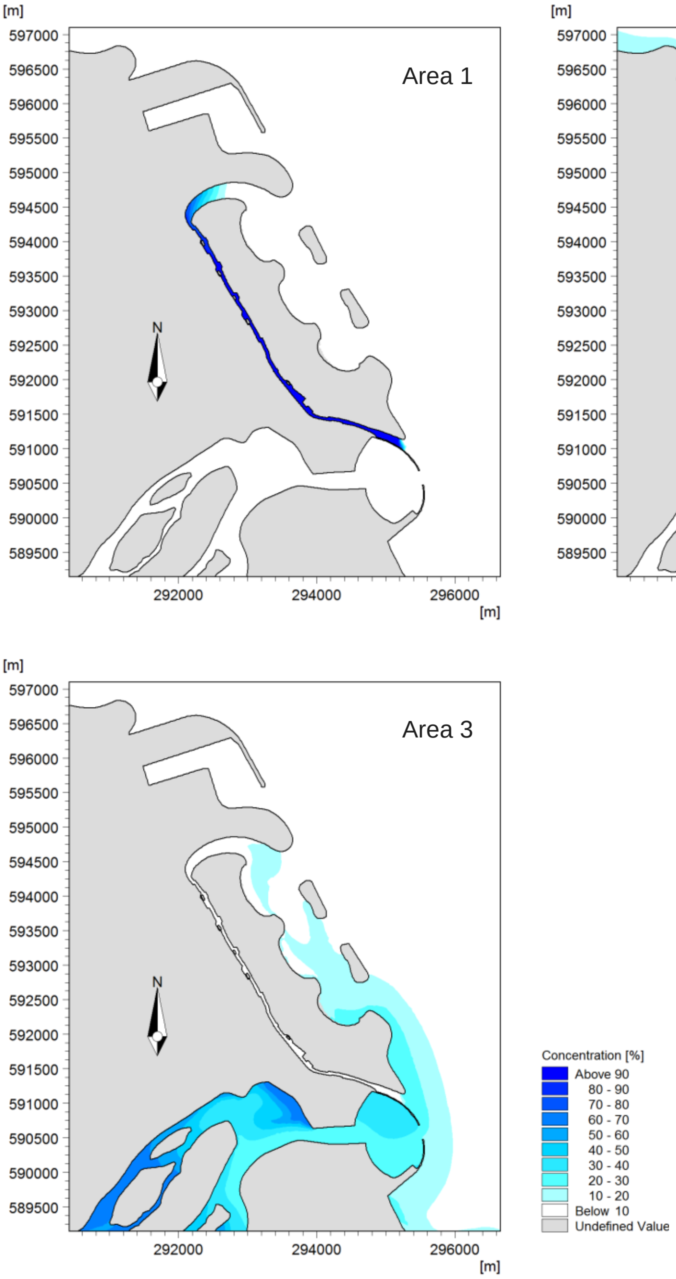

Figure 3.28 Layout 9 flushing – Day 2

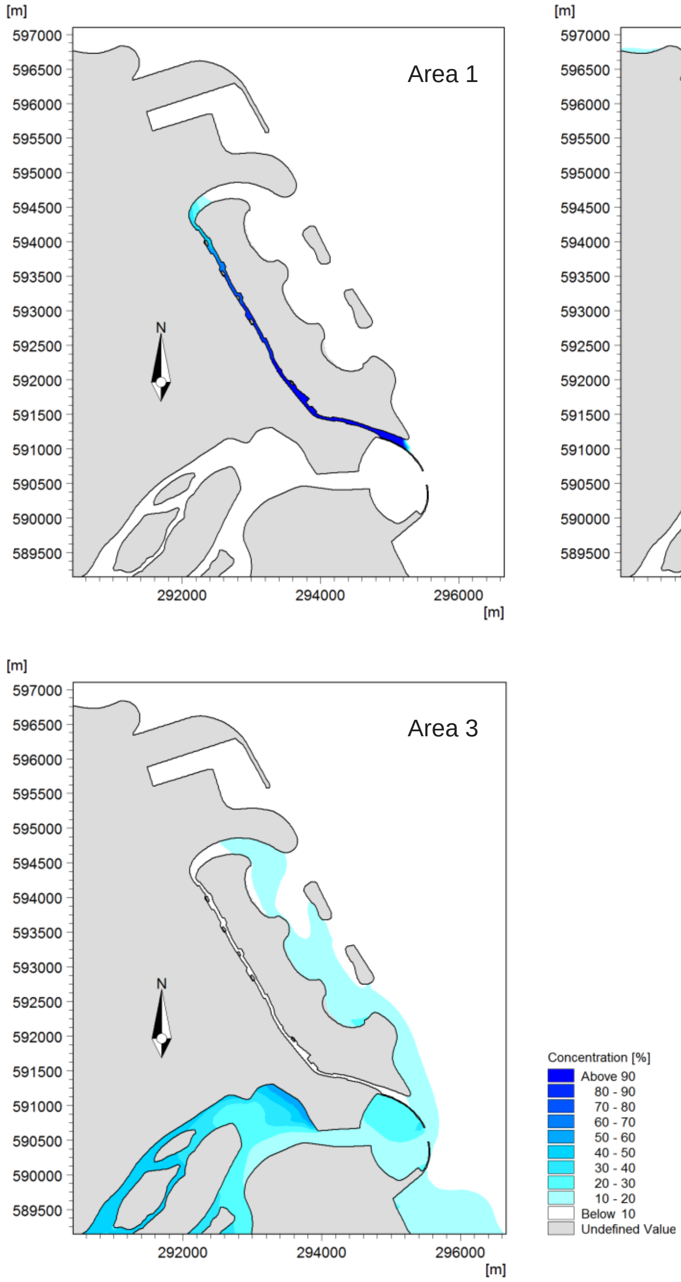

Figure 3.29 Layout 9 flushing – Day 3

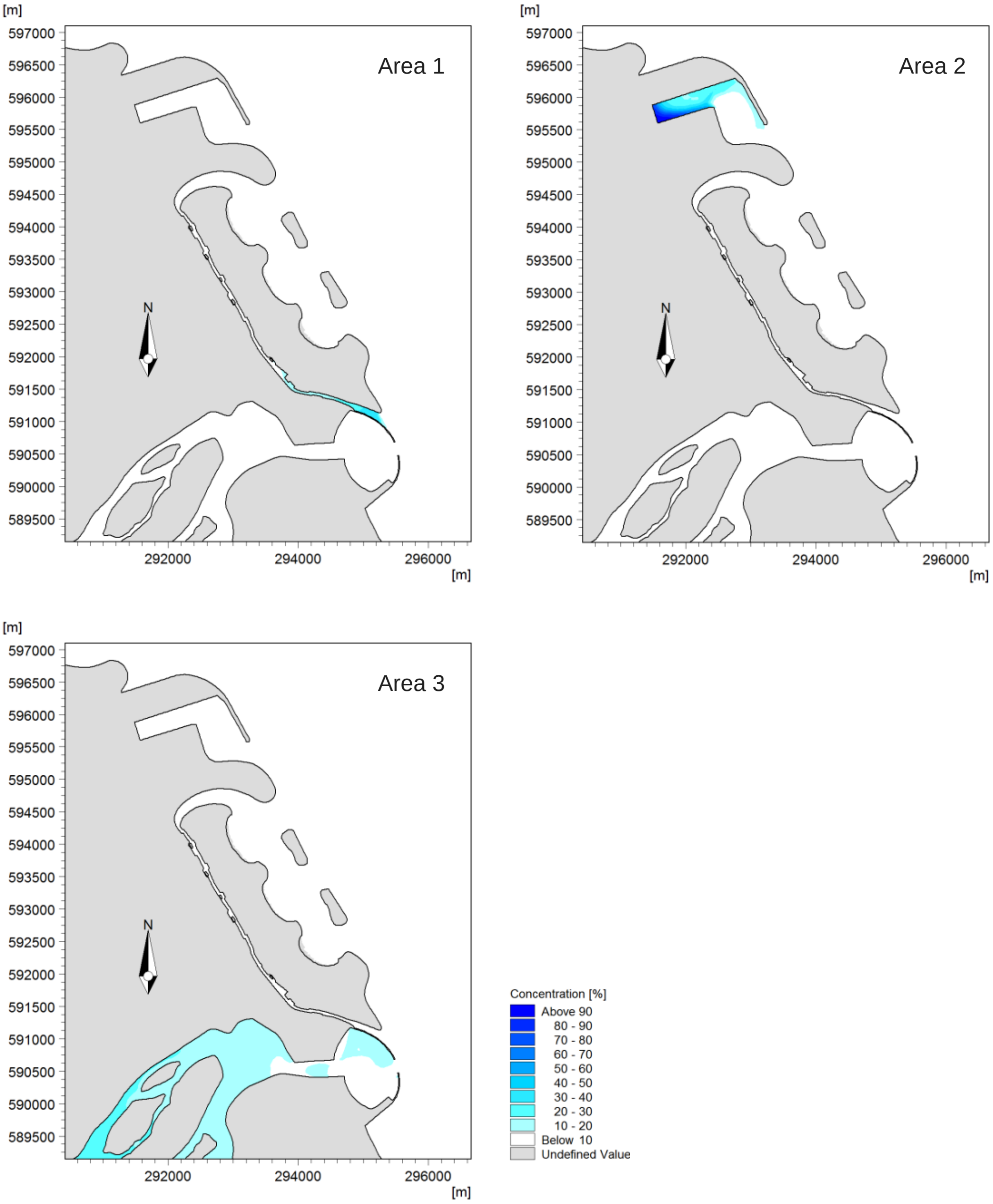

Figure 3.30 Layout 9 flushing – Day 7

4 Modelling of Wave Penetration

A key feature of the project is the breakwater that is required to protect the Cruise Terminal and Ship Repair areas from wave action. This breakwater is an expensive structure to construct, and it is therefore important that its length is kept to the minimum required for effective operation of the facilities it is protecting. The Cruise Terminal is located nearest the breakwater entrance and is therefore most exposed to wave action. The breakwater length has therefore been optimised by modelling of wave conditions at this berth for a range of breakwater configurations that meet the navigational requirement for this berth including allowance for a 600m diameter turning circle.

For the safe operation of this Cruise Liner berth is has been assumed that the significant wave height at the berth location should be less than 1m for normal operations.

4.1 Initial Modelling of Wave Penetration to the Cruise Terminal Area

The initial modelling of wave penetration to the berth area has been carried out using the spectral wave model MIKE 21 SW. This gives a reasonable representation of the expected wave conditions at the Cruise Terminal area although this model does not accurately include diffraction around the breakwater head.

By using a boundary condition with wave height of 1 m, the wave conditions determined along the breakwaters and inside the port can be viewed as wave disturbance coefficients, i.e. defining the wave height relative to the incident wave height. Hence, if a different incident wave height (but with same wave direction and wave period) is used at the boundary, the corresponding wave heights are found by multiplying the incident wave height and the wave coefficients.

The extent of the wave model is shown in Figure 4.1. The wave model was run for 15 incident wave directions between 0°N and 140°N. Each run used a 1m significant wave height and a wave period of 8.5 seconds at the offshore boundary so that the data can be interpreted as wave disturbance coefficients.

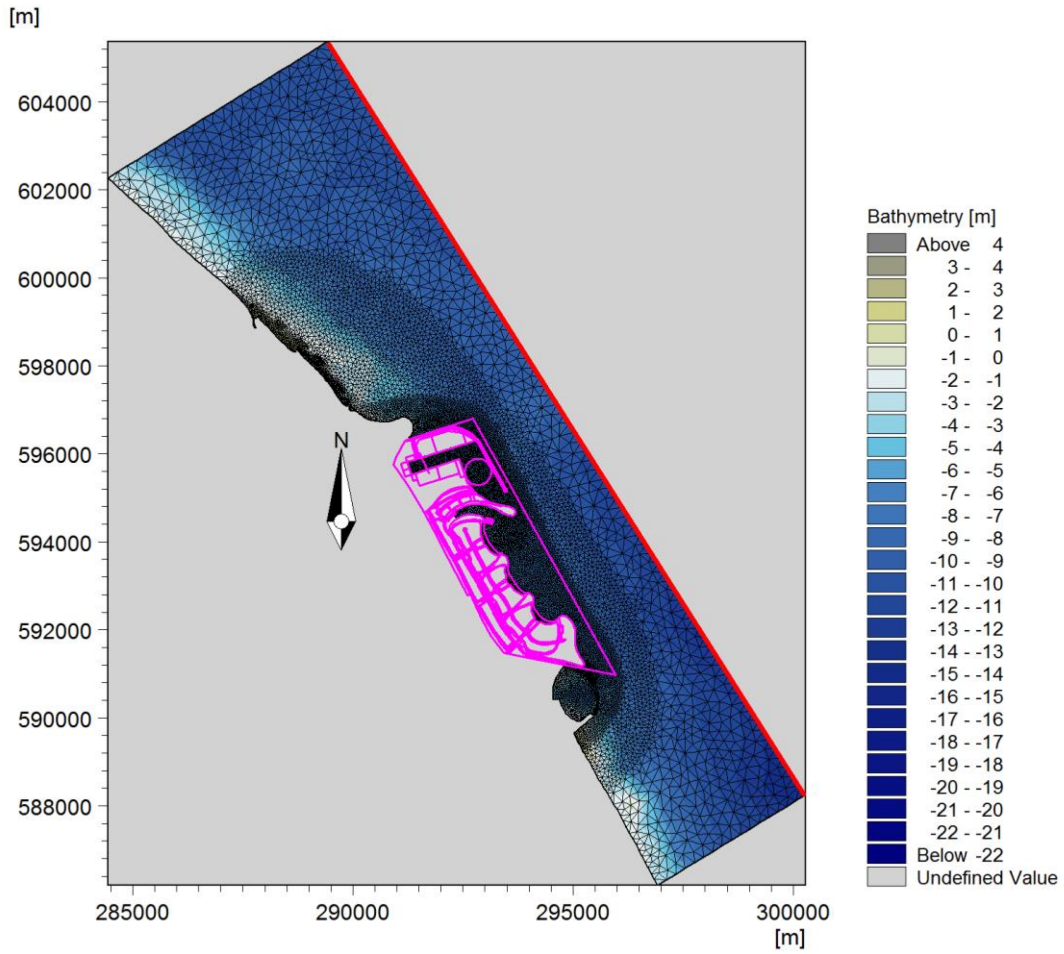

Figure 4.1 Coverage of the local wave model with unstructured mesh. Offshore boundary conditions is defined by the red line. Pink line denotes the Proposed Layout 5

4.1.1 Layout 5

Layout 5 includes a long breakwater based on an initial assumption of the required length and the spacing between berth and breakwater as shown on the base drawings received from EPSB. This layout together with a series of points where wave height data is extracted along the Cruise Terminal area is shown in Figure 4.2.

Figure 4.3 and Figure 4.4 show plots of the wave penetration for offshore wave directions 50°N (a typical direction during the NE monsoon period) and 130°N (a typical direction during the SW monsoon period). Table 4.1 sets out the wave disturbance coefficients at the data extraction points.

The modelling of this layout indicated that wave heights are very low at the proposed Cruise Terminal location indicating that the breakwater length can be reduced.

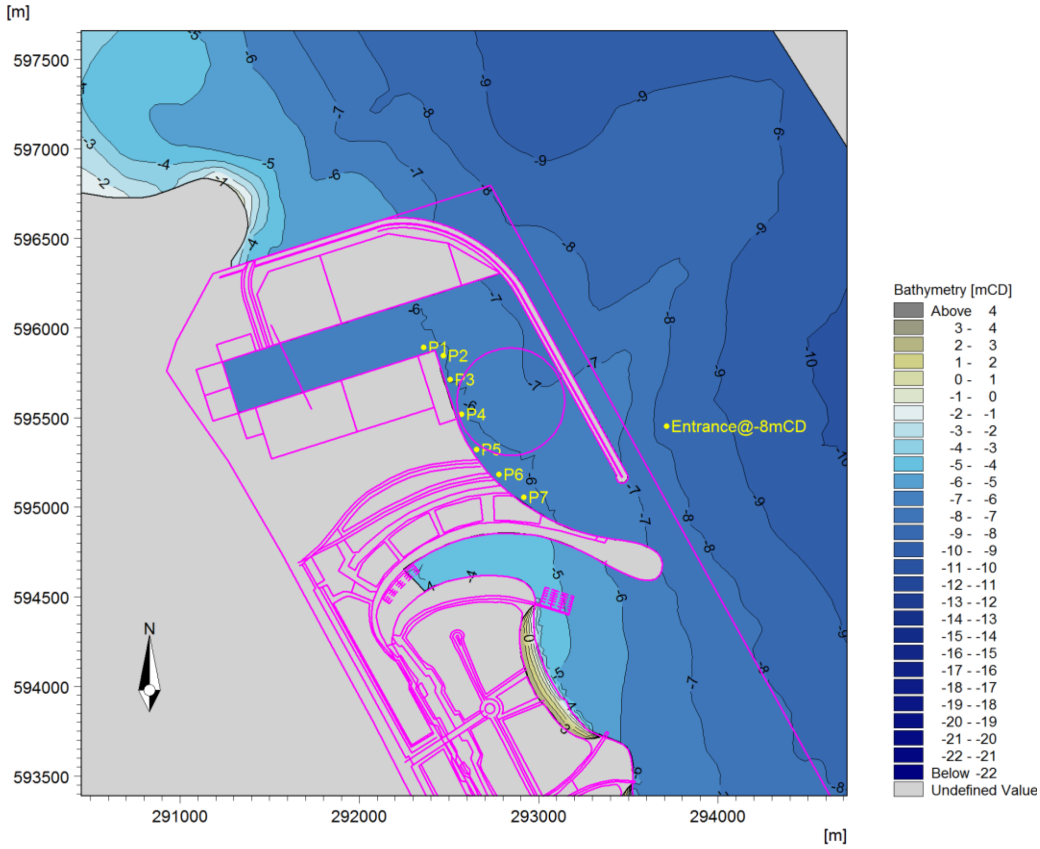

Figure 4.2 Proposed Layout 5 showing extraction points for wave data

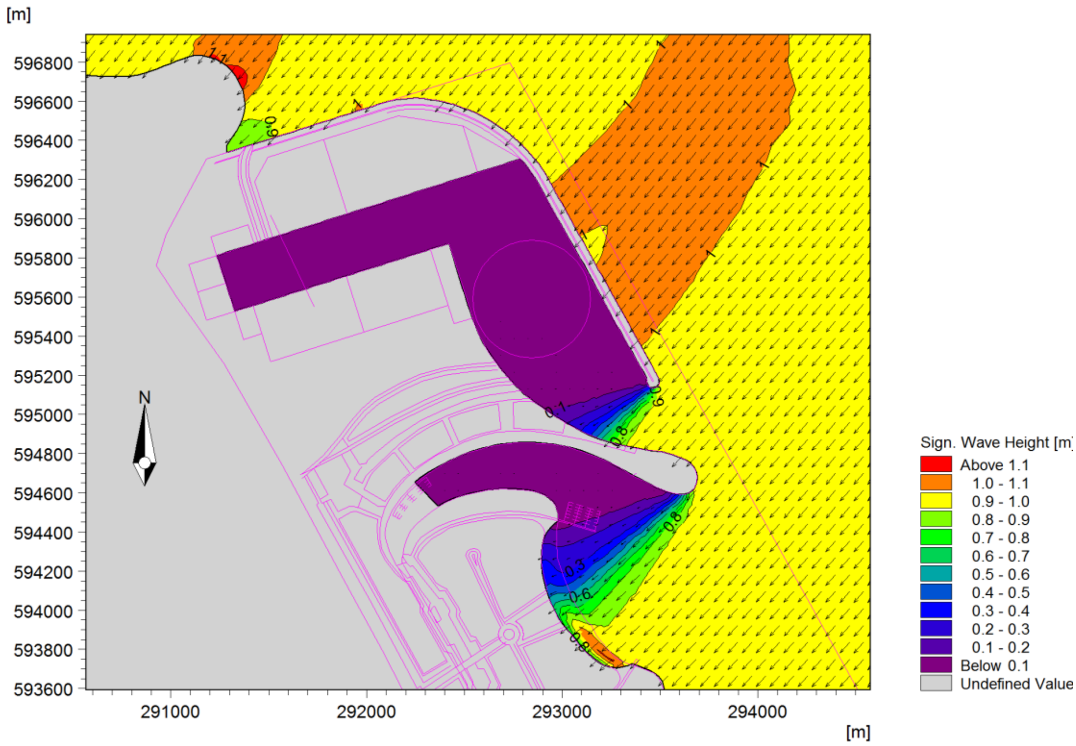

Figure 4.3 Significant wave height for incoming wave 50°N for Proposed Layout 5

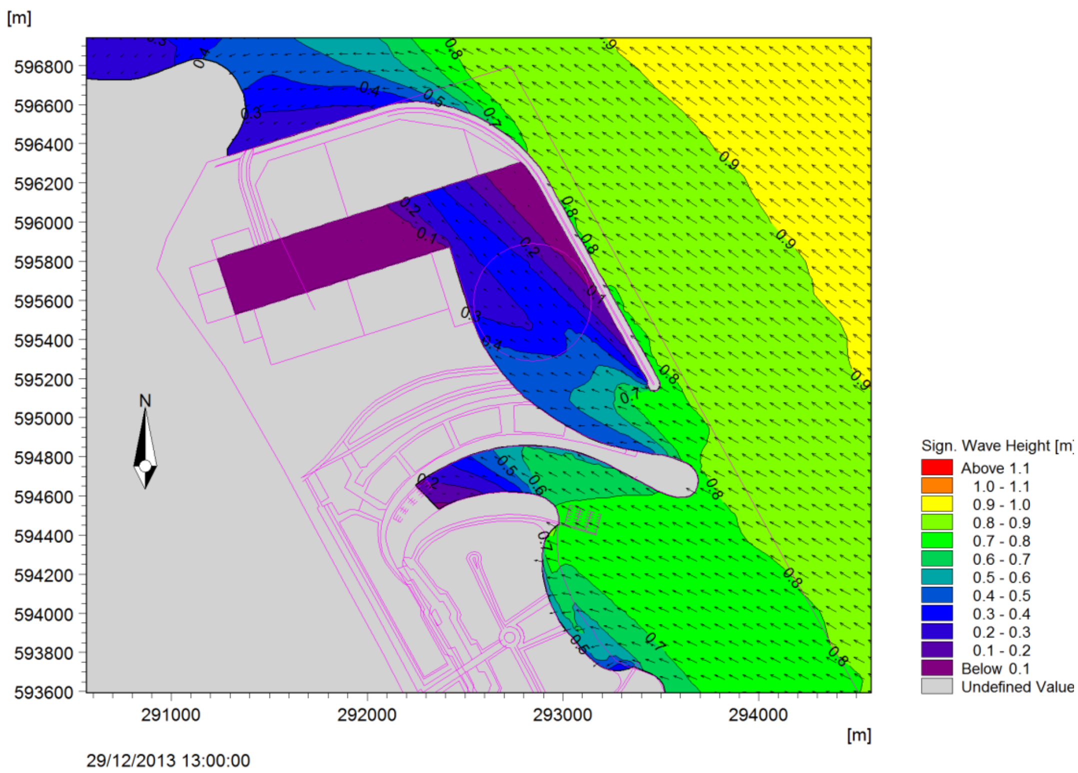

Figure 4.4 Significant wave height for incoming wave 130°N for Proposed Layout 5

Table 4.1 Significant wave height at the berthing area inside the port and outside the port entrance

Significant wave height: Layout 5									
MWD	P1	P2	P3	P4	P5	P6	P7	Entrance@-8mCD	Bnd02
MWD0	0.000	0.001	0.001	0.002	0.003	0.007	0.012	0.883	1
MWD10	0.000	0.001	0.001	0.003	0.004	0.009	0.016	0.912	1
MWD20	0.000	0.001	0.002	0.004	0.005	0.011	0.021	0.941	1
MWD30	0.001	0.001	0.002	0.005	0.006	0.015	0.029	0.958	1
MWD40	0.001	0.002	0.003	0.009	0.010	0.025	0.054	0.967	1
MWD50	0.001	0.003	0.004	0.010	0.012	0.030	0.066	0.967	1
MWD60	0.002	0.006	0.009	0.024	0.029	0.074	0.160	0.967	1
MWD70	0.003	0.007	0.011	0.029	0.037	0.101	0.206	0.968	1
MWD80	0.005	0.015	0.024	0.065	0.094	0.318	0.601	0.973	1
MWD90	0.008	0.025	0.040	0.110	0.158	0.413	0.762	0.978	1
MWD100	0.015	0.043	0.084	0.270	0.380	0.515	0.780	0.977	1
MWD110	0.027	0.077	0.146	0.474	0.669	0.673	0.711	0.951	1
MWD120	0.034	0.100	0.153	0.473	0.668	0.668	0.691	0.937	1
MWD130	0.094	0.258	0.211	0.304	0.412	0.417	0.442	0.807	1
MWD140	0.094	0.253	0.210	0.299	0.405	0.407	0.428	0.791	1

4.1.2 Layout 5A

Layout 5A is identical to Layout 5 except that the breakwater length has been reduced. This layout together with a series of points where wave height data is extracted along the Cruise Terminal area is shown in Figure 4.5.

Figure 4.6 and Figure 4.7 show plots of the wave penetration for offshore wave directions 50°N (a typical direction during the NE monsoon period) and 130°N (a typical direction during the SW monsoon period). Table 4.2 sets out the wave disturbance coefficients at the data extraction points.

The modelling of this layout indicated that wave heights likely to be acceptable at the proposed Cruise Terminal location indicating that the breakwater length is close to optimal.

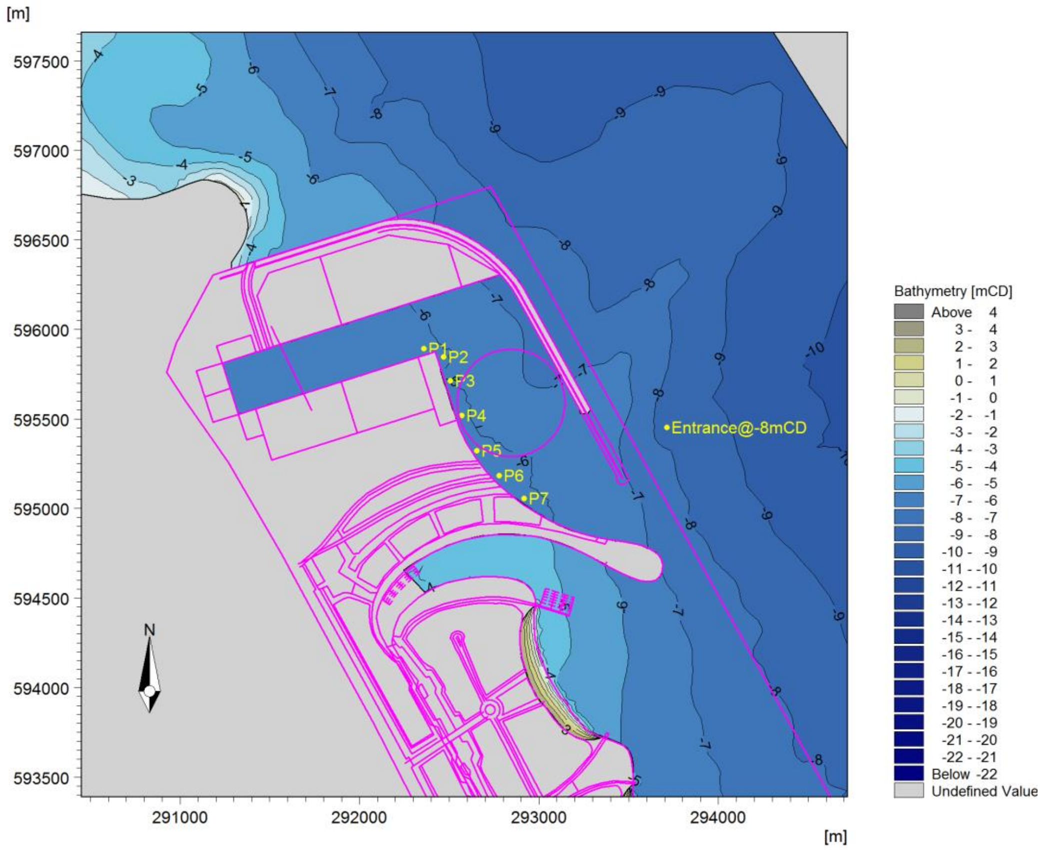

Figure 4.5 Proposed Layout 5A