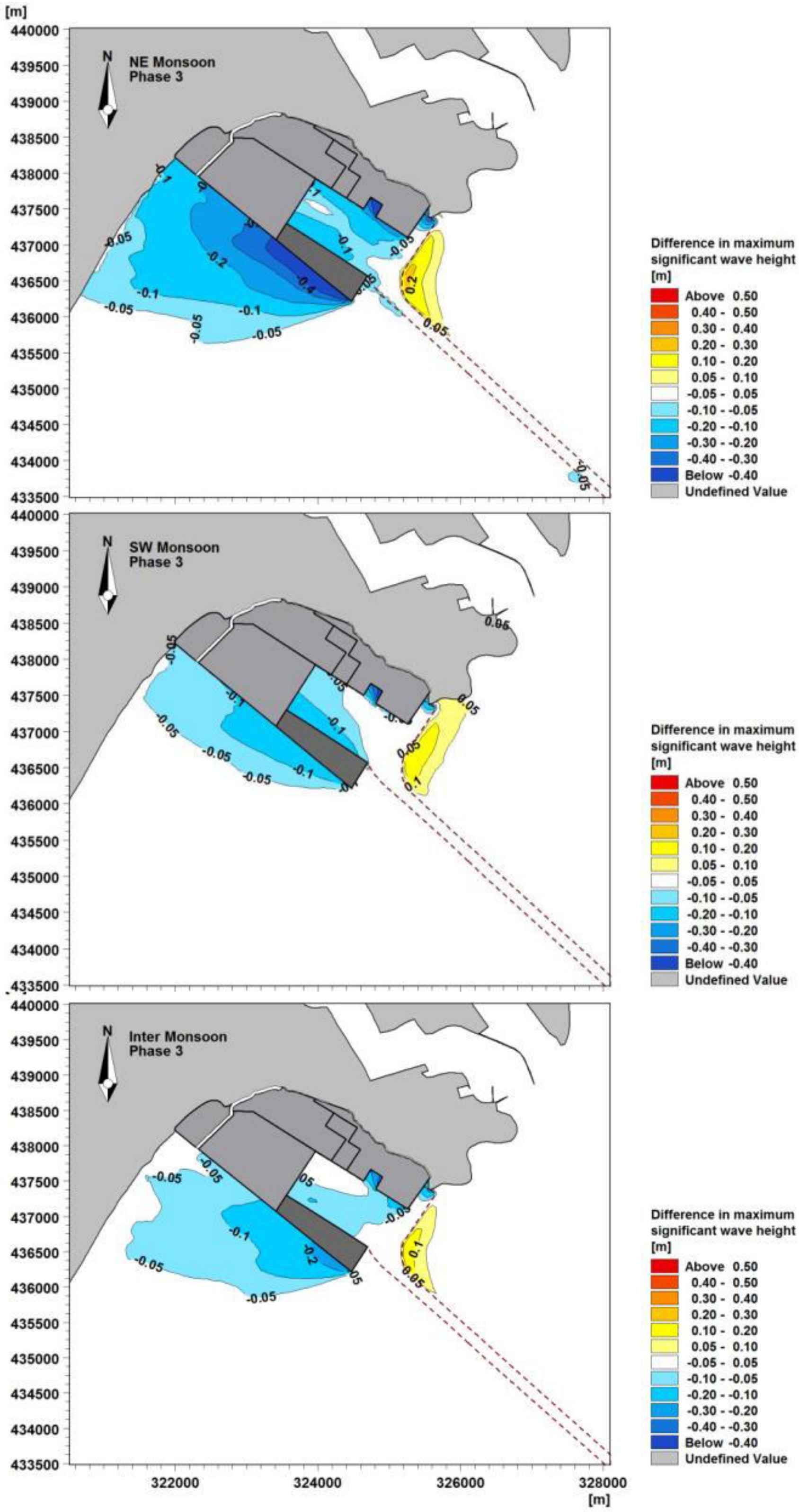


Figure 7.2.67: Phase 3. Predicted changes in max significant wave height between existing during NE (top), SW (middle) and Inter (bottom) monsoons.

7.2.2.2.4 Water Levels in Waterways

As illustrated in **Figure 7.2.68**, the proposed development will be located in front of the outlets of three existing waterways. These are:

- Sg. Pengorak,
- Drain from Rumah Pangsa LPK, and
- The storm culvert drain of the Kuantan Port area.

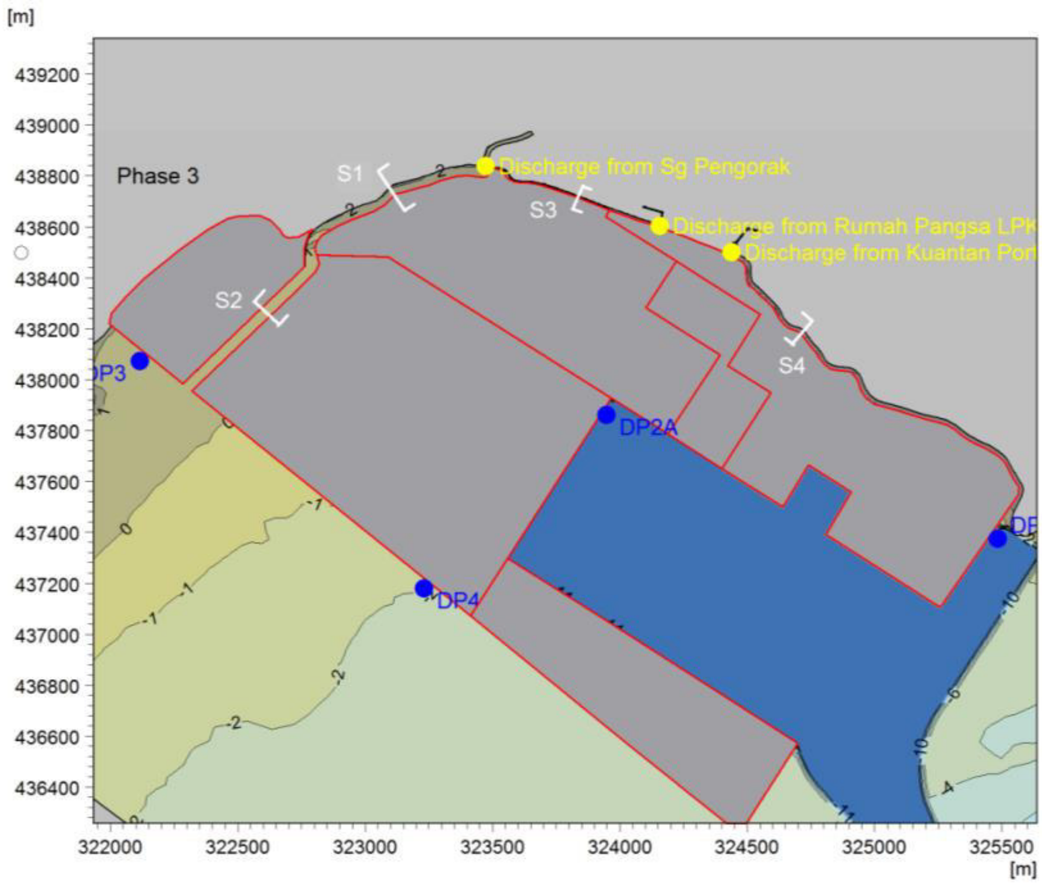


Figure 7.2.68: Overall proposed design channel alignment at the project development

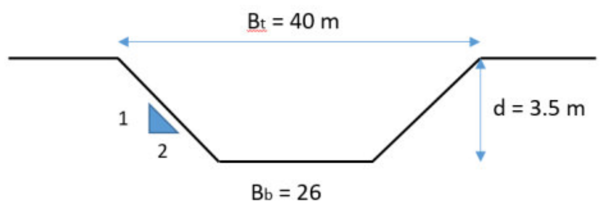
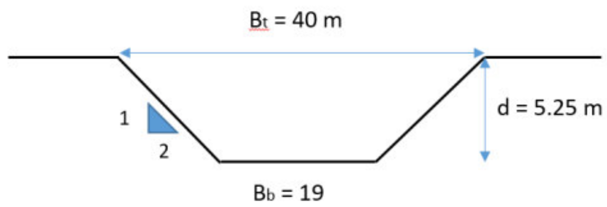
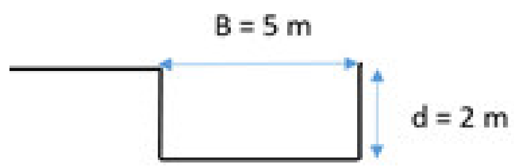
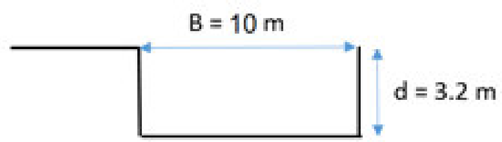
In the following, the impacts of the reclamation on flood levels in the existing waterways as well as in the new artificial waterways (waterway extensions), and thus the ability of these waterways to retain the draining capacity during severe rainfall events, are presented.

7.2.2.2.4.1 Modelling Scenarios

The conveyances of severe floods in the three (3) waterways are simulated before and after the project have been implemented using the MIKE 21 HD. The simulations provide the basis for assessing the impacts of the project on the upstream flooding (i.e. impacts on flood levels upstream of the existing outfalls). The following elements of the artificial channel (created behind and running across the reclamation) include:

- The proposed alignment (trace) of the artificial waterways (see **Figure 7.2.68**)
- The proposed cross-sections of the artificial channels (see **Table 7.2.21**)

Table 7.2.21: Design details of the proposed artificial river and drainage

Cross Section	**Channel Dimensions**
S1 – Extended channel for Sg. Pengorak The channel will be constructed as an earth drain with constant side slopes down to existing seabed. The outlet will be close to the existing shoreline.	
S2 – Extended channel for Sg. Pengorak during Phase 2 The channel will be constructed as an earth drain with constant side slopes down to existing seabed. The exit of the channel will be located on the south-western side of the reclamation near the existing 0 m CD depth contour.	
S3 – Extended channel for culvert outlet (from Rumah Pangsa LPK) The channel will be constructed as a concrete drain with minimum width of 5m. The channel links to the extended channel for Sg. Pengorak.	
S4 – Extended channel from Kuantan Port outlet The channel will be constructed as a concrete drain (minimum width of 10m) with an outlet near the headland.	

The flooding assessment is based on:

- Discharge events with a 100 year return period as follows (see also **Table 7.2.22**):

  - Sg. Pengorak: 96.4 m^3/s

  - Storm water drain from Kuantan Port: 51.1 m^3/s

  - Drain from Rumah Pangsa LPK: 8.8 m^3/s

Table 7.2.22: Extreme event discharge calculated (source: Muhibbah Engineering (M) Bhd).

Return Period	**Discharge (m^3/s)**		
	Sg Pengorak	**Kuantan Port**	**Rumah Pangsa LPK**
100-years event	96.42	51.11	8.75

The 100-year return period discharges have been provided by Muhibbah Engineering (M) Bhd.

- The 100 year return period discharges peak concurrently (in the three waterways).
- Tidal variations according to that presented in **Figure 7.2.69**. It can be seen that the MHWS is accomplished within the simulation period (the key tidal characteristic is given in **Table 7.2.23**).
- A combined/dynamic flow between river discharge and tidal variations (spring tide). To capture all stages of a spring tide, the discharge is taken to be constant in the model throughout a three-day simulation period. In separate simulations, the upstream flood were shown to attain its level of equilibrium approximately 15 mins after the onset of the extreme discharge, implying that the upstream water levels in the three-day simulations are in a quasi-equilibrium with the tidal level.
- A simplified river description upstream of the Sg. Pengorak river mouth and the two existing culverts. It is noted that the existing waterways are represented by a constant width, which has been determined from satellite images and site visit photos. The topography of the river and the hinterland is not known in detail.

In addition to the upstream water levels, the water levels in/along the artificial channels have been derived.

Table 7.2.23: Tidal elevations at Tg. Gelang as in MSL

Tidal Levels	Values (m MSL)	Values (m CD)
Highest Astronomical Tide, HAT	+1.92	+3.84
Mean High Water Spring, MHWS	+1.42	+3.34
Mean Low Water Spring, MLWS	+0.36	+2.28
Mean Sea Level, MSL	0.00	+1.92
Mean High Water Neap, MHWN	-0.35	+1.57
Mean Low Water Neap, MLWN	-1.42	+0.50
Lowest Astronomical Tide, LAT	-1.92	0.00

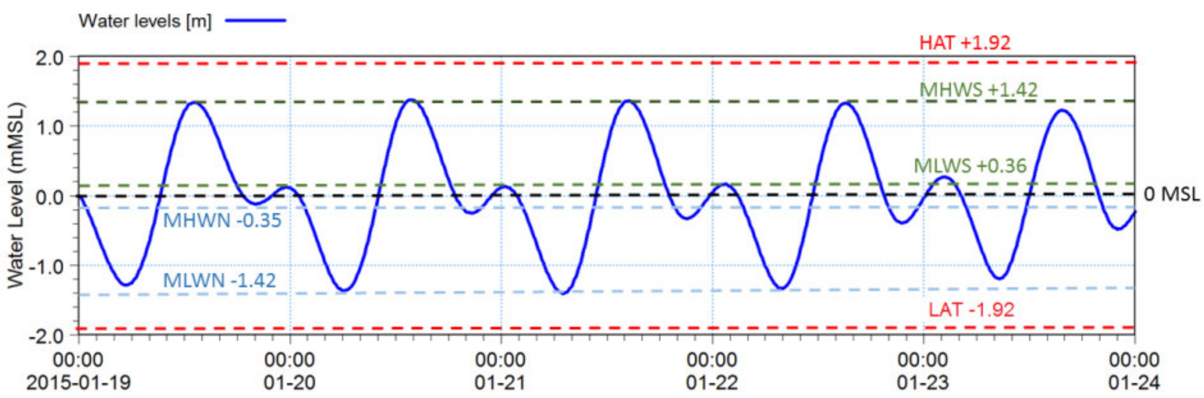


Figure 7.2.69: Predicted water levels in the study area

7.2.2.2.4.2 Upstream Water Levels

The impacts on water levels upstream of the existing outlets (upstream flood levels), and thus the potential for flooding impacts, can be assessed by considering the changes induced by the reclamation to the water levels (i.e., by the extension of the existing waterways offered with the artificial channels).

Consequently, water levels were extracted as follows (see also **Figure 7.2.70**):

- At eight (8) locations within Sg. Pengorak (P1 to P8),
- At four (4) locations within Rumah Pangsa LPK existing culvert drain (S1 to S4), and
- At five (5) locations within the Kuantan Port existing culvert drain (R1 to R5).

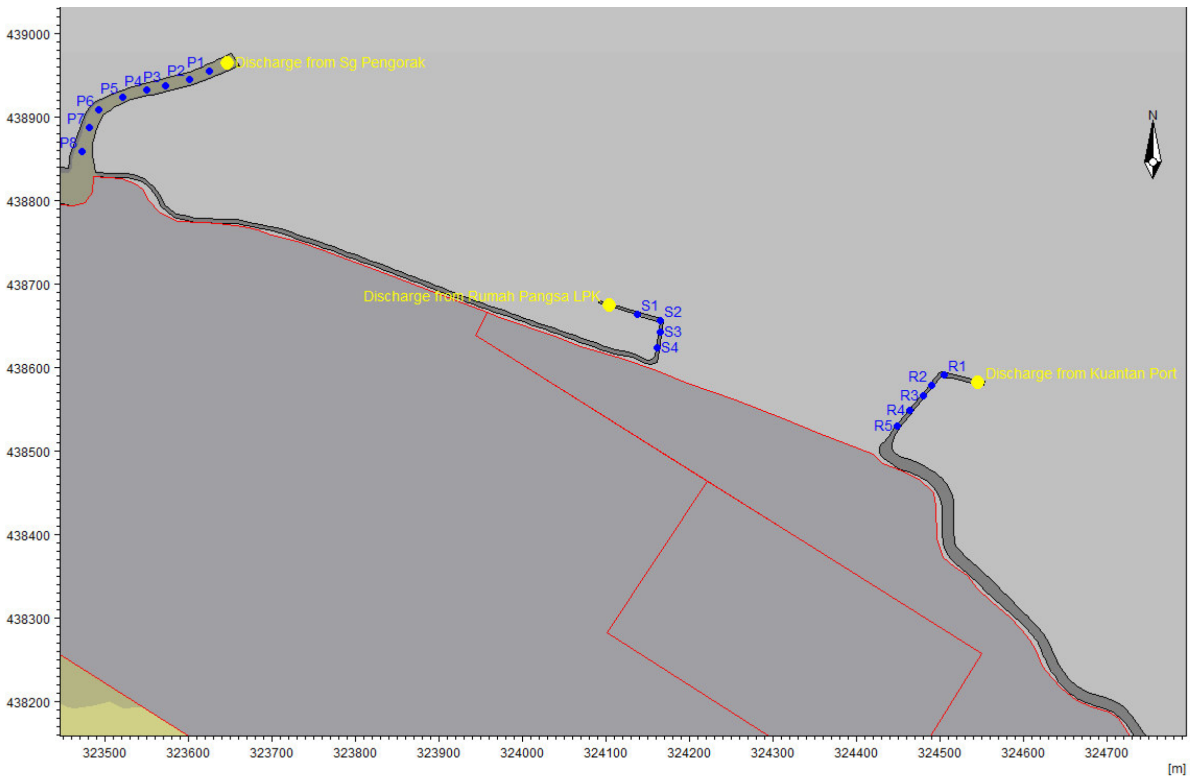


Figure 7.2.70: Location of water level extraction points during post development conditions

The maximum water levels for the pre and post development during the 100-year discharge events have been tabulated in **Table 7.2.24** together with the maximum difference in water levels. The modelling results show that:

- The water levels in the rivers are particularly elevated during spring high tides, in which a minimum head is offered.
- Changes in the maximum water levels upstream of Sg. Pengorak river mouth is less than 0.01 m during the 100 year return period flow.
- An increase up to 0.94 m is observed at the existing river mouth. This is partly due to the sudden bend created at the section joining the new channel and the existing Sg. Pengorak river mouth and partly a result of the additional discharge flow from Rumah Pangsa LPK extend channel as in **Figure 7.2.71**.
- The upstream water levels in Rumah Pangsa LPK, are elevated by up to 0.07 m.
- A 0.25 m difference in water level is observed at the existing shoreline in the bend created at the section joining the onset of the extended channel and the existing channel outlet. (**Figure 7.2.71**).
- Changes in maximum upstream water levels in storm water drain from Kuantan Port is less than 0.01 m during 100-year return period flow, which will not impose flooding problems in the hinterland.

- An increase of 0.17 m in the water levels is observed at the shoreline in the bend of the channel created at the section joining the onset of the extended channel and the existing channel outlet.

Table 7.2.24: Pre and post development water levels in Sg. Pengorak, Rumah Pangsa LPK channel and Kuantan Port channel during a 100-year return period flow.

Points	Maximum water level (m MSL) during 100-yr return period flow		Maximum difference in water level (m) [Post development minus existing]
	Existing waterways	Extended waterways as per Phase 3	
Sg. Pengorak			
P1	2.22	2.22	<0.01
P2	2.16	2.16	<0.01
P3	2.13	2.13	<0.01
P4	2.02	2.02	<0.01
P5	1.53	1.53	<0.01
P6	1.15	1.45	+0.30
P7	1.48	1.69	+0.21
P8	0.84	1.78	+0.94
Storm-Water Drain from Rumah Pangsa LPK			
S1	3.14	3.16	+0.02
S2	3.08	3.11	+0.03
S3	2.75	2.82	+0.07
S4	2.26	2.51	+0.25
Storm-Water Drain from Kuantan Port			
R1	5.18	5.18	<0.01
R2	4.29	4.29	<0.01
R3	3.96	3.96	<0.01
R4	3.79	3.79	<0.01
R5	3.63	3.80	+0.17

Figure 7.2.71: Zoom-in of water levels during the 100-year return period flow. Note the levels in the bend of the channel.

7.2.2.2.4.3 Risk of Inundation of Reclamation

The water levels within the artificial channels can be assessed with the same model set-up and hydraulic scenarios as used above to determine the upstream flood levels. With the design platform level of the Kuantan Maritime Hub reclamation being equal to +5.25 m CD, the water levels should stay below this platform level to avoid an inundation of the reclamation.

Maximum water levels encountered during the 100 year return period flow were extracted at a few locations along the artificial channels, including:

- From Sg. Pengorak river mouth to the exit of the artificial channel (as dotted in cyan colour in **Figure 7.2.72**),
- From Rumah Pangsa LPK existing outlet to Sg Pengorak river mouth (as dotted in blue colour in **Figure 7.2.72**), and
- From Kuantan Port outlet to the headland (as dotted in purple colour in **Figure 7.2.72**).

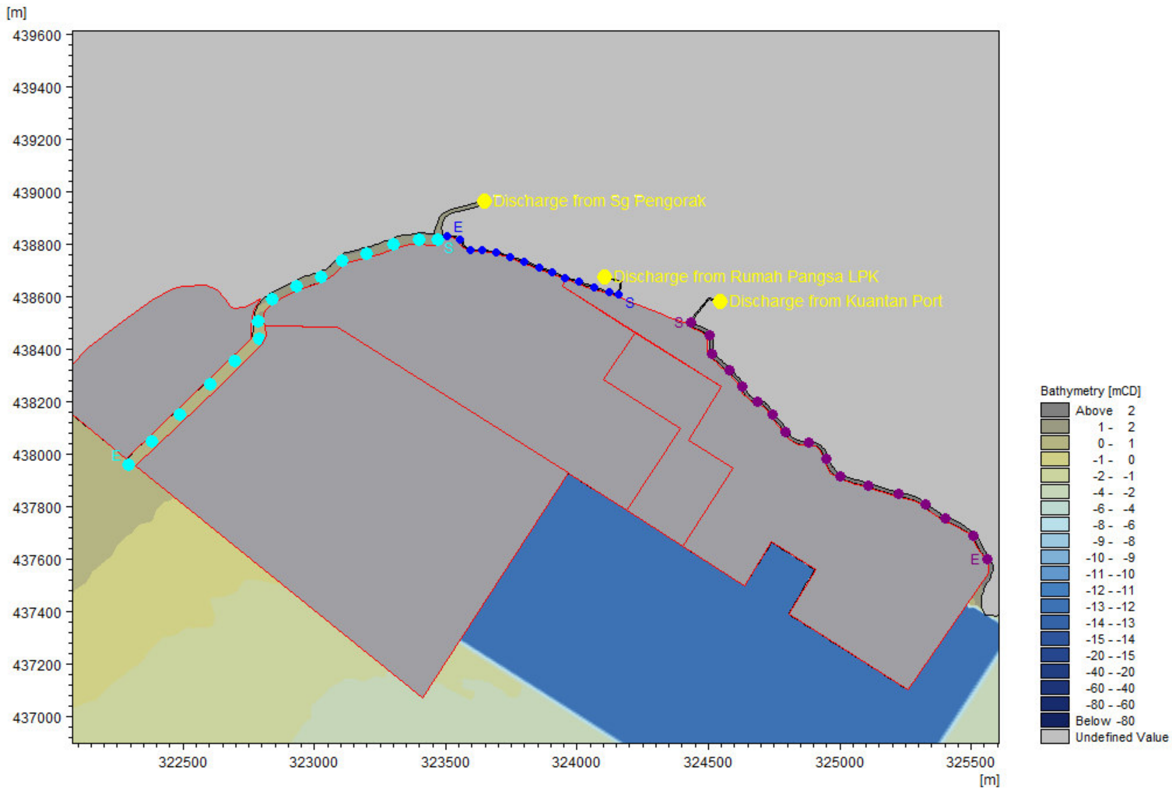


Figure 7.2.72: Key locations for analysis of water level changes

Not surprisingly, the maximum water levels in the artificial channels occurred during the high tide. The maximum water levels encountered during the simulations are presented in **Figure 7.2.73** to **Figure 7.2.76**. The figures show that:

- Sg. Pengorak extension channel: - the maximum water levels during a 100-year return period flow are in the range of 3.5 to 4.0 m CD on a tide with MHWS. The maximum water levels do not exceed the platform level of the reclamation.
- Rumah Pangsa LPK extension channel: - the maximum water levels during a 100-year return period flow are up to 4.8 m CD on a tide with MHWS. The maximum water levels will be below platform level of the reclamation with adequate clearance.
- Kuantan Port extension channel: - the maximum water levels during a 100-year return period flow are in the range of 3.4 to 5.1 m CD on a tide with MHWS. If tidal level reaches HAT, the water levels in the channel may exceed the platform level of the reclamation. This scenario is however not likely given the period of recurrence of the HAT.

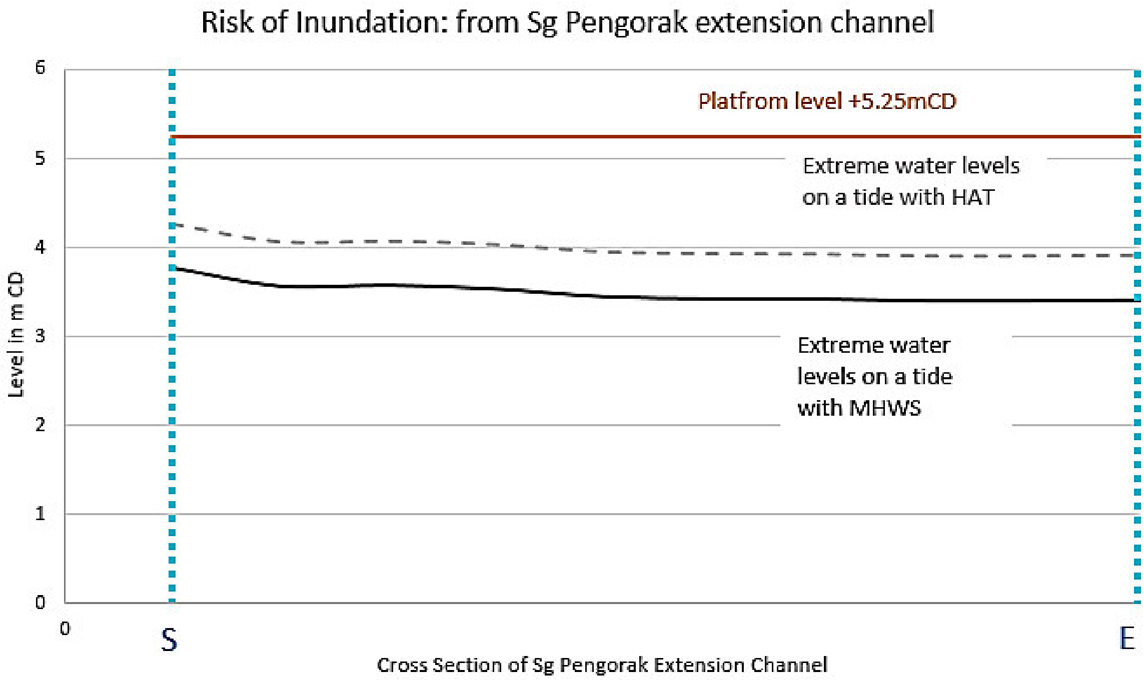


Figure 7.2.73: Water level profiles for Sg. Pengorak extension channel

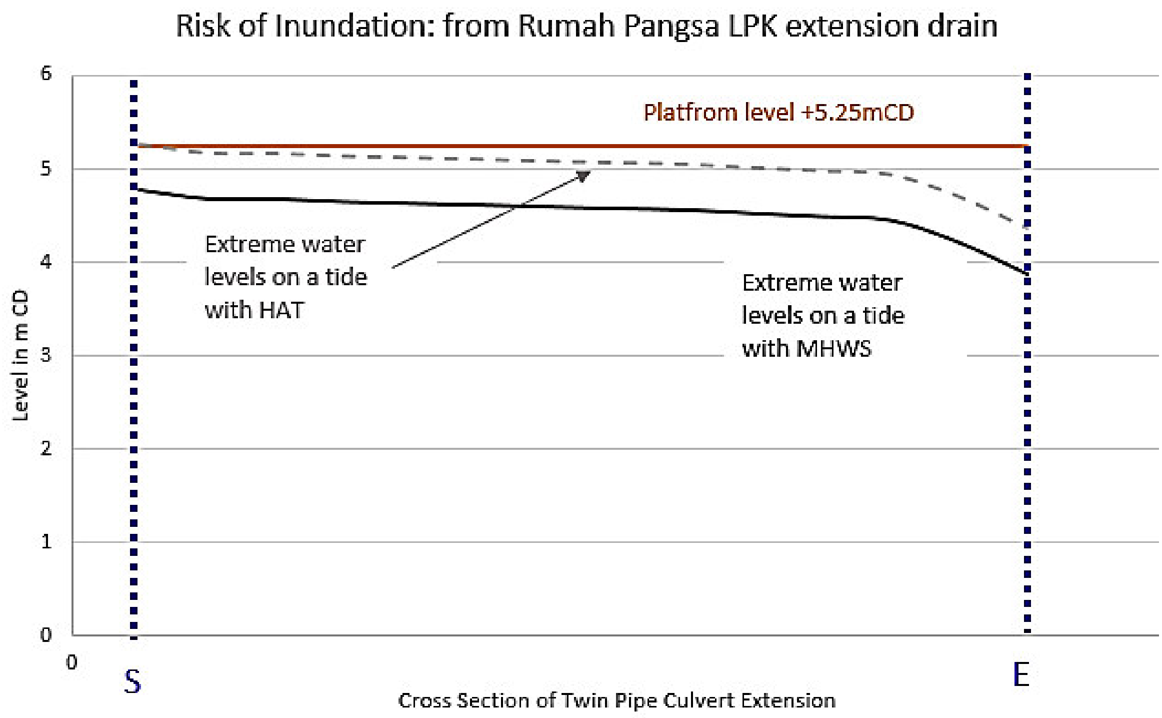


Figure 7.2.74: Water level profiles for Rumah Pangsa LPK extension channel

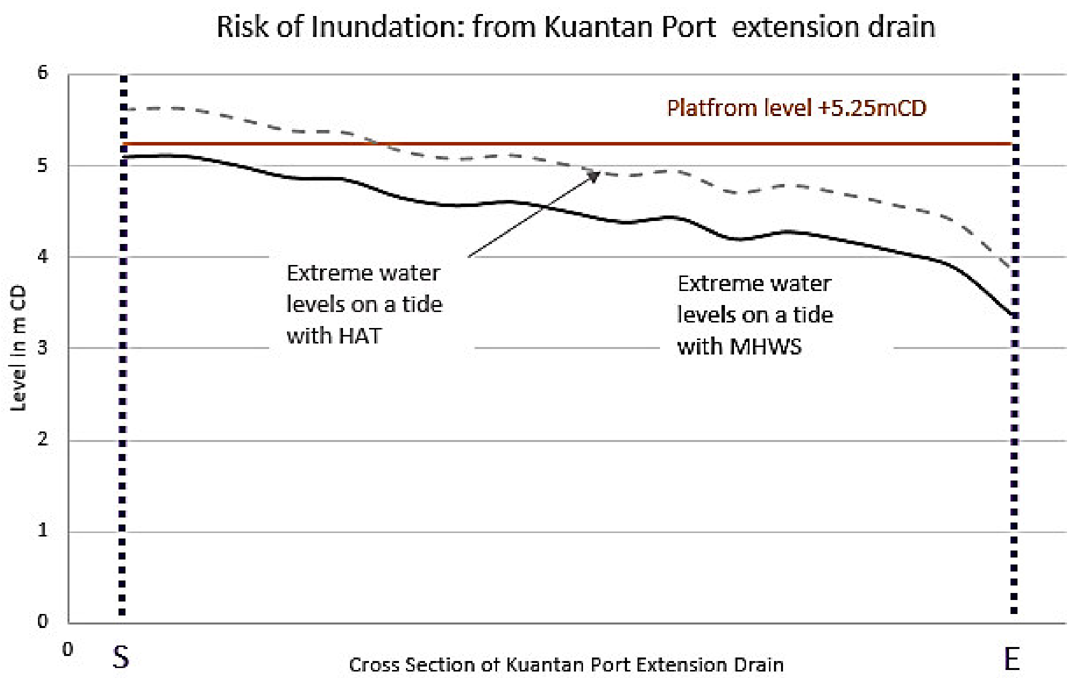


Figure 7.2.75: Water level profiles for Kuantan Port extension channel

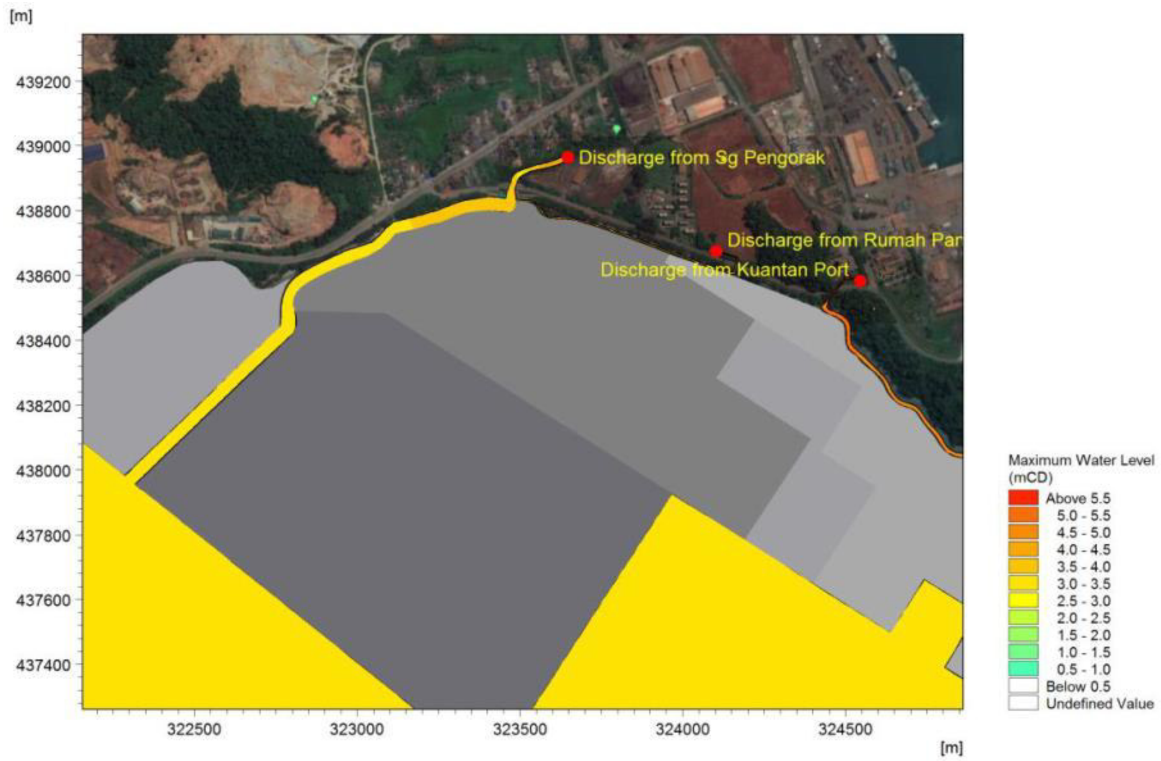


Figure 7.2.76: Maximum water level during 100-year event

7.2.2.2.4.4 Alterations to the Internal Waterways to Improve Flood Conveyance

To enhance the capacity of the channels to convey floods, a few alterations to the proposed waterways have been tested and discussed below.

<u>Streamlining of Sg Pengorak River Extension</u>

Smoothening of the bend in the new channel at the existing Sg. Pengorak river mouth. The channel alignment is streamlined as proposed in **Figure 7.2.77**.

The impacts on the upstream flood levels have been re-assessed using the streamlined channel at the existing Sg. Pengorak river mouth and the maximum water level at the locations upstream of Sg. Pengorak have been extracted and compared to existing condition.

As **Table 7.2.25** show, the reclamation-induced increase in the maximum water level at Sg. Pengorak river mouth is up to 0.65 m. This, however, corresponds to approximately 0.25 cm to 0.29 cm drop in water level compared to the “pre-streamlined” channel.

oi

Figure 7.2.77: Previous (top) and recommend (bottom) realignment in front of Sg. Pengorak river mouth.

Table 7.2.25: Simulated maximum water level and difference in maximum water level at upstream Sg. Pengorak during 100-year extreme event.

Points upstream of Sg. Pengorak	Maximum water level (m MSL) during 100-yr ARI conditions		Maximum difference in water level (m) [Post development minus existing]	
	Existing	Straightened	Proposed Alignment	After Straightening
P1	2.22	2.22	<0.01	<0.01
P2	2.16	2.16	<0.01	<0.01
P3	2.13	2.13	<0.01	<0.01
P4	2.02	2.02	<0.01	<0.01
P5	1.53	1.53	<0.01	<0.01
P6	1.15	1.18	+0.30	+0.03
P7	1.48	1.51	+0.21	+0.03
P8	0.84	1.49	+0.94	+0.65

Straightening of Kuantan Port Drain Extension

Smoothening of the sharp reclamation corner at the exit of river channel. A smoother reclamation frontage will eliminate a bottleneck for flooding. This has already been incorporated in the model and the results of the modelling as well as the KMH masterplan – see also **Figure 7.2.78**.

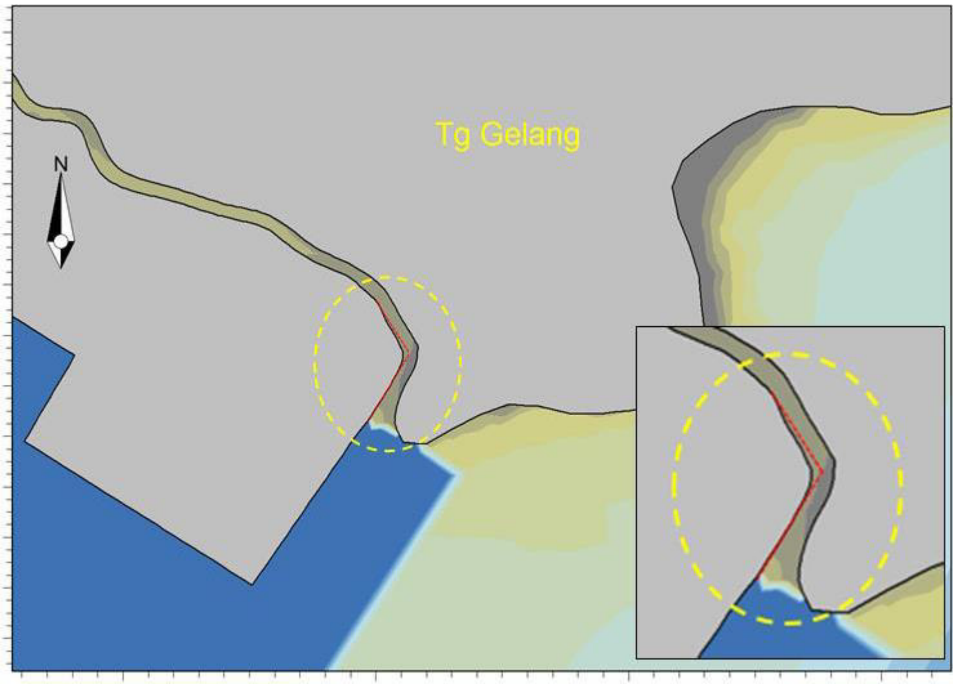


Figure 7.2.78: Rounded reclamation corner at the exit (red dotted lines indicates previous layout).

Straightening of the alignment of the U-culvert channel to avoid head losses from several kinks and bends in the channel. Alternatively, retaining the proposed alignment but introduce the earth drain (i.e.

using the L-shaped rather than the U-shaped box culvert). In this case, the effective width of the waterway is increased as the drain will be bounded by the edge of the reclamation and the existing land boundary.

Figure 7.2.79 shows the changes to the alignment of the Kuantan Port drain extension for reducing the total head loss, and thus water levels, in the waterway. In the given alignment, the three locations highlighted in the (left side of) figure have pronounced kinks. These kinks are removed (see right side of figure). Partly this gives a slightly shorter channel and partly the channel is straighter; which both acts as to reduce the head loss.

Figure 7.2.79: Straightening (and shortened) of Kuantan Port Drain extension. Removal of three channel kinks at locations highlighted.

The effects of the straightening on the upstream water levels are given in **Table 7.2.26**. It can be seen that the straightening results in a 5 cm drop in water levels during the critical 100-year discharge event. The water levels in the Kuantan port drain extension is also reduced with the straightening. The water levels for the unlikely event of the 100year river discharge coinciding with HAT are below the platform level of the reclamation.

Table 7.2.26: Upstream water levels in Kuantan Port drain during a 100-year return period flow for the pre and post development with the straightened drain extension.

Points upstream of Kuantan Port Drain	Maximum water level (m MSL) during 100-yr ARI conditions		Maximum difference in water level (m) [Post development minus existing]	
	Existing	Straightened	After Straightening	Proposed Alignment (from Table 7.2.20)
R1	5.18	5.18	<0.01	<0.01
R2	4.29	4.29	<0.01	<0.01
R3	3.96	3.96	<0.01	<0.01
R4	3.79	3.79	<0.01	<0.01
R5	3.63	3.75	+0.12	+0.17

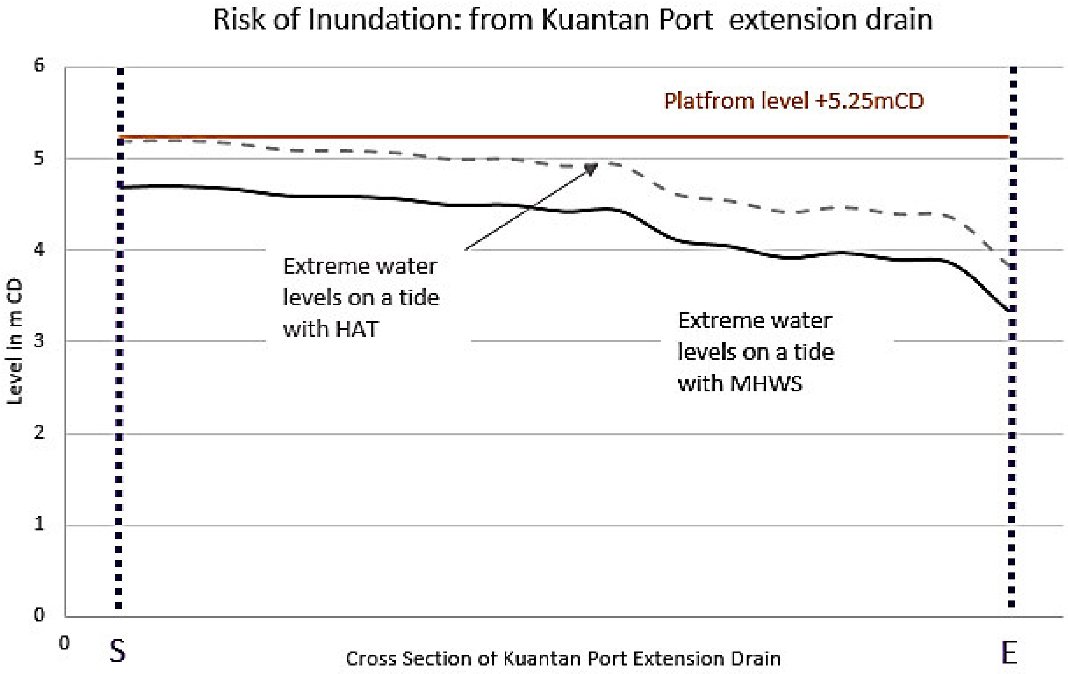


Figure 7.2.80: Water level profiles for Kuantan Port extension drain after straightening (please compare with lower part of Figure 7.45).

Earth Drains for Kuantan Port and Rumah Pangsa LPK Drain Extensions

The impacts on flood levels are assessed for the cases where L-shaped cross sections (rather than the U-shaped cross-sections) for the Kuantan Port and Rumah Pangsa LPK drain extensions are used. The L-shaped cross-sections are shown in **Figure 7.2.81** whereas the U-shaped drains was presented in **Table 7.2.21**. The channels are shown in **Figure 7.2.82**

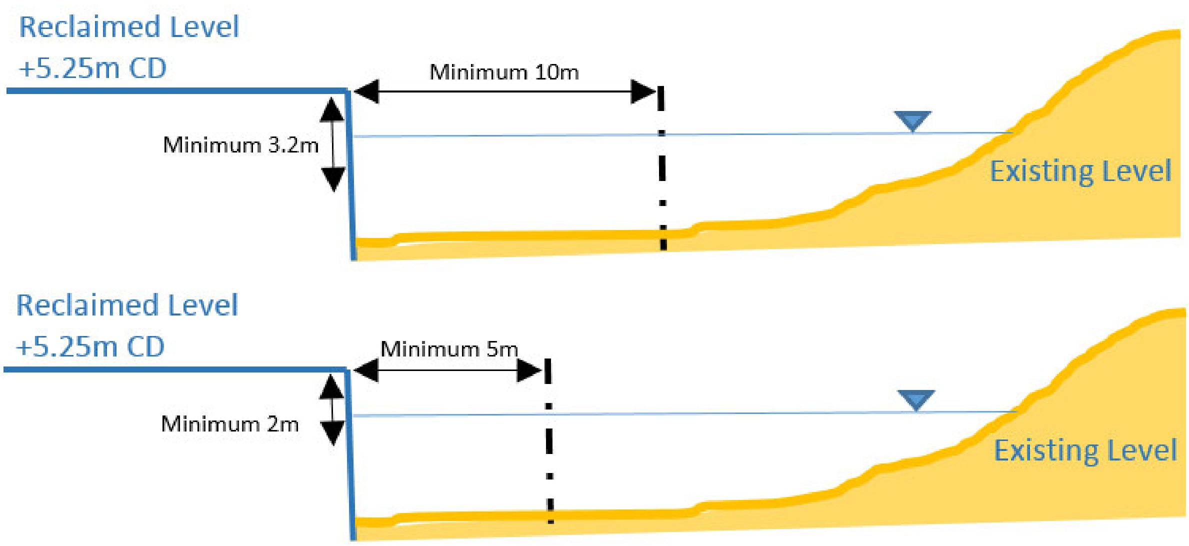


Figure 7.2.81: Cross-sectional profile of the drain extensions (L-shaped). Upper: Kuantan port drain. Lower: Rumah Pangsa LPK Drain.

The use of L-shaped cross-sections for the Kuantan Port and Rumah Pangsa LPK drain extensions reduces the upstream flood levels. This is shown in **Table 7.2.27** and **Table 7.2.28**. Also, the water levels along the artificial drains with the L-shaped cross-sections entail lower water levels during the 100-year critical event discharges compared to drains with the U-shaped cross-sections. Results are presented in **Figure 7.2.83** and **Figure 7.2.84.**

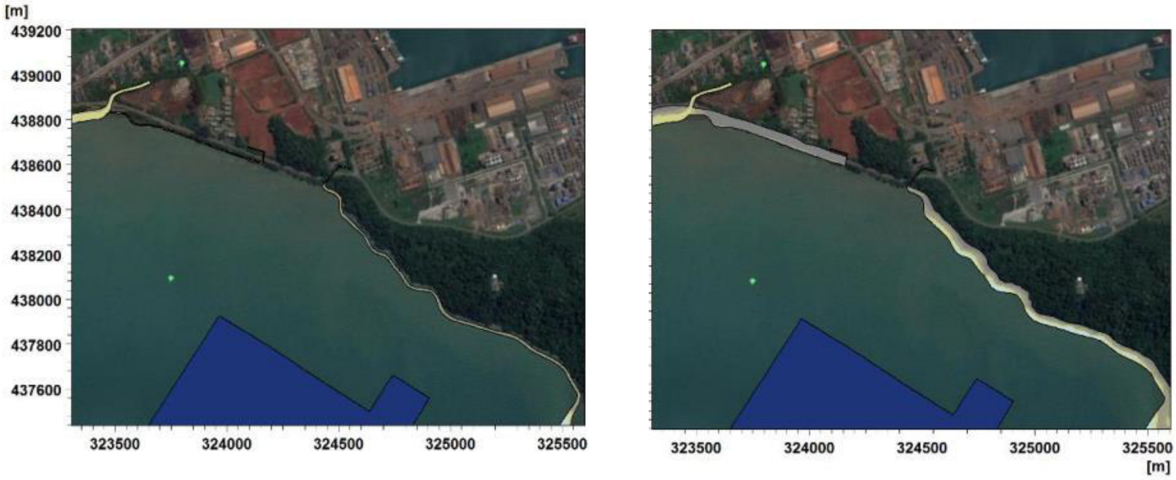


Figure 7.2.82: Channel with Left: U-shaped profile and Right: L-shaped profile

Table 7.2.27: Simulated maximum water level and difference in maximum water level at upstream Kuantan Port channel during 100-year extreme event.

Points upstream of Kuantan Port Drain	Maximum water level (m MSL) during 100-yr ARI conditions		Maximum difference in water level (m) [Post development minus existing]	
	Existing	With L-shaped Drain	With U-shaped Drain (from Table 7.2.21)	With L-shaped Drain
R1	5.18	5.18	<0.01	<0.01
R2	4.29	4.29	<0.01	<0.01
R3	3.96	3.96	<0.01	<0.01
R4	3.79	3.79	<0.01	<0.01
R5	3.63	3.75	+0.17	+0.10

Table 7.2.28: Simulated maximum water level and difference in maximum water level at upstream LPK drain during 100-year extreme event.

Points upstream of Kuantan Port Drain	Maximum water level (m MSL) during 100-yr ARI conditions		Maximum difference in water level (m) [Post development minus existing]	
	Existing	With L-shaped Drain	With U-shaped Drain (from Table 7.2.21)	With L-shaped Drain
S1	3.14	3.16	+0.02	+0.02
S2	3.08	3.11	+0.03	+0.03
S3	2.75	2.82	+0.07	+0.07
S4	2.26	2.42	+0.25	+0.16

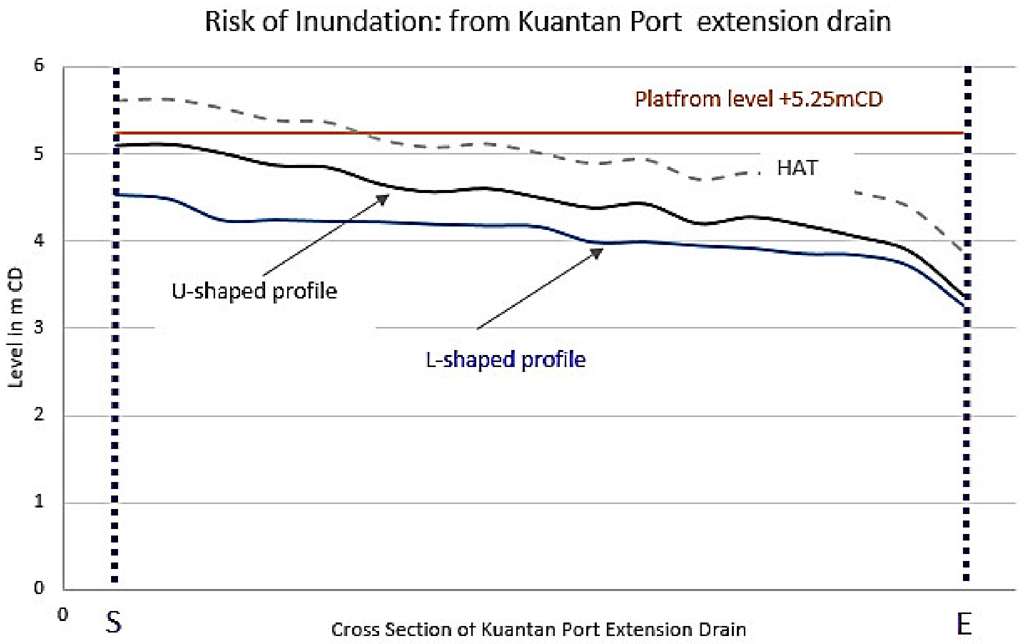


Figure 7.2.83: Water level profiles for Kuantan Port extension drain compared between U-shaped and L-shaped drains

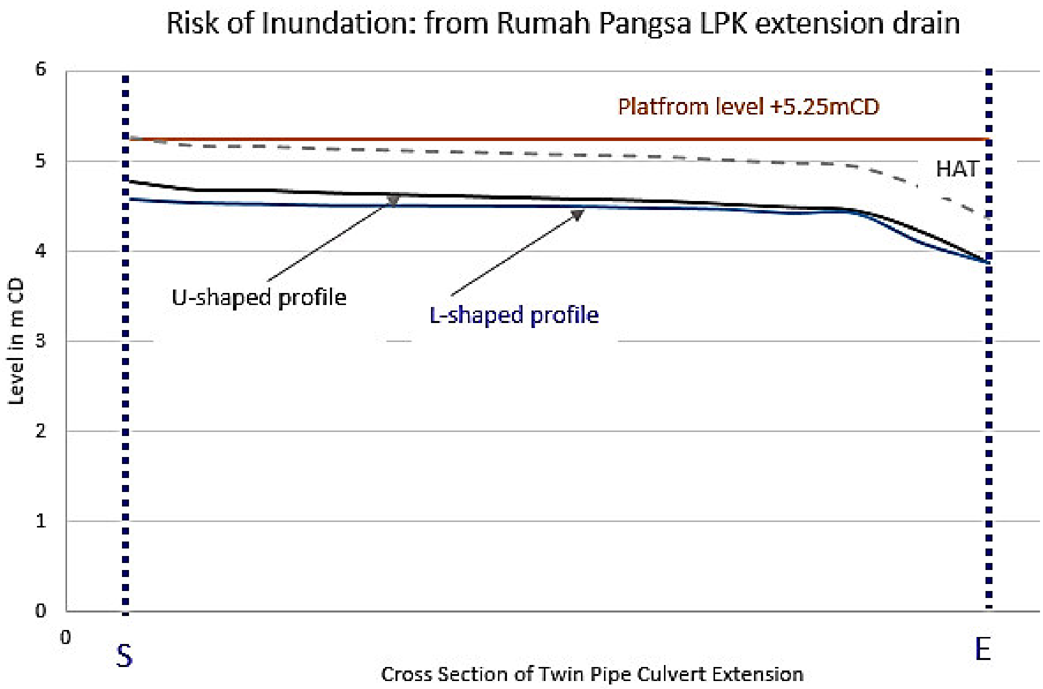


Figure 7.2.84: Water level profiles for Rumah Pangsa LPK extension drain compared between U-shaped and L-shaped drains

7.2.2.2.5 Retention Time in Water Channel

The artificial channels together with drainage system are proposed in between reclaimed land and mainland for the diversion of the existing flows to the open sea. One element that is important is to determine the natural water exchange capacity of the water channel. The water exchange is related to the amount of water flowing in and out of a system, if this is large enough to be able to exchange the total existing volume of water within the system in a short period of time then the water exchange is defined as good. Conversely, if the amount of water is small compared to the volume of water in the system the water exchange is characterised as poor.

Simulations to assess the flushing capacity have been carried out to determine the natural water exchange capacity for pre-development (existing) conditions and final post development. The simulations have been carried out by applying the 2D advection-dispersion model to describe the dispersal of conservative tracer that represents any type of pollution. Tracers have been released as 100% at the first time step after the warm-up period. They are being released in three (3) areas:

- Sg Pengorak extension channel
- Rumah Pangsa LPK extension drain
- Kuantan Port extension drain

Sg. Pengorak Extension Channel

The initial tracer release is shown in **Figure 7.2.85** for existing and final phase. Modelling results for Tracer 1 have shown that the extent of the dispersal plume between post-development and existing conditions after 6 hours from the release are of insignificant difference, as shown in **Figure 7.2.86**. After 12 hours of the release, most of the plume in post-development will be dispersed out of the extension channel and flowing offshore. The concentration does not change significantly in post-development phase from the existing conditions, so the flushing capacity of Sg Pengorak extension channel is as good as existing condition and the impacts to the flushing capacity due to the proposed development is unlikely

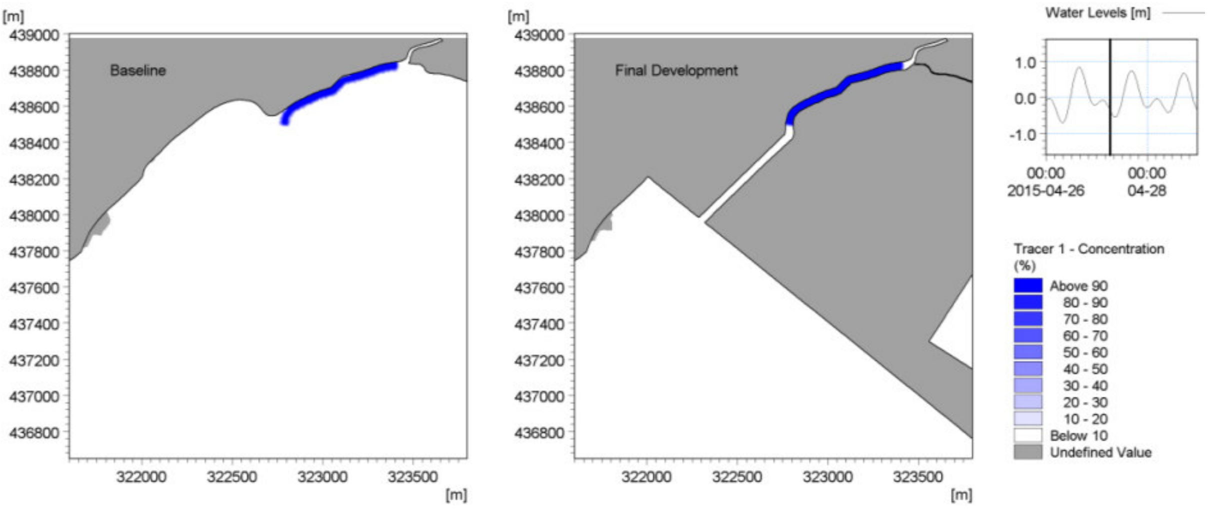


Figure 7.2.85: Tracer 1: Concentration of conservative tracer in Sg Pengorak extension channel before the start of the simulation for existing and final phase.

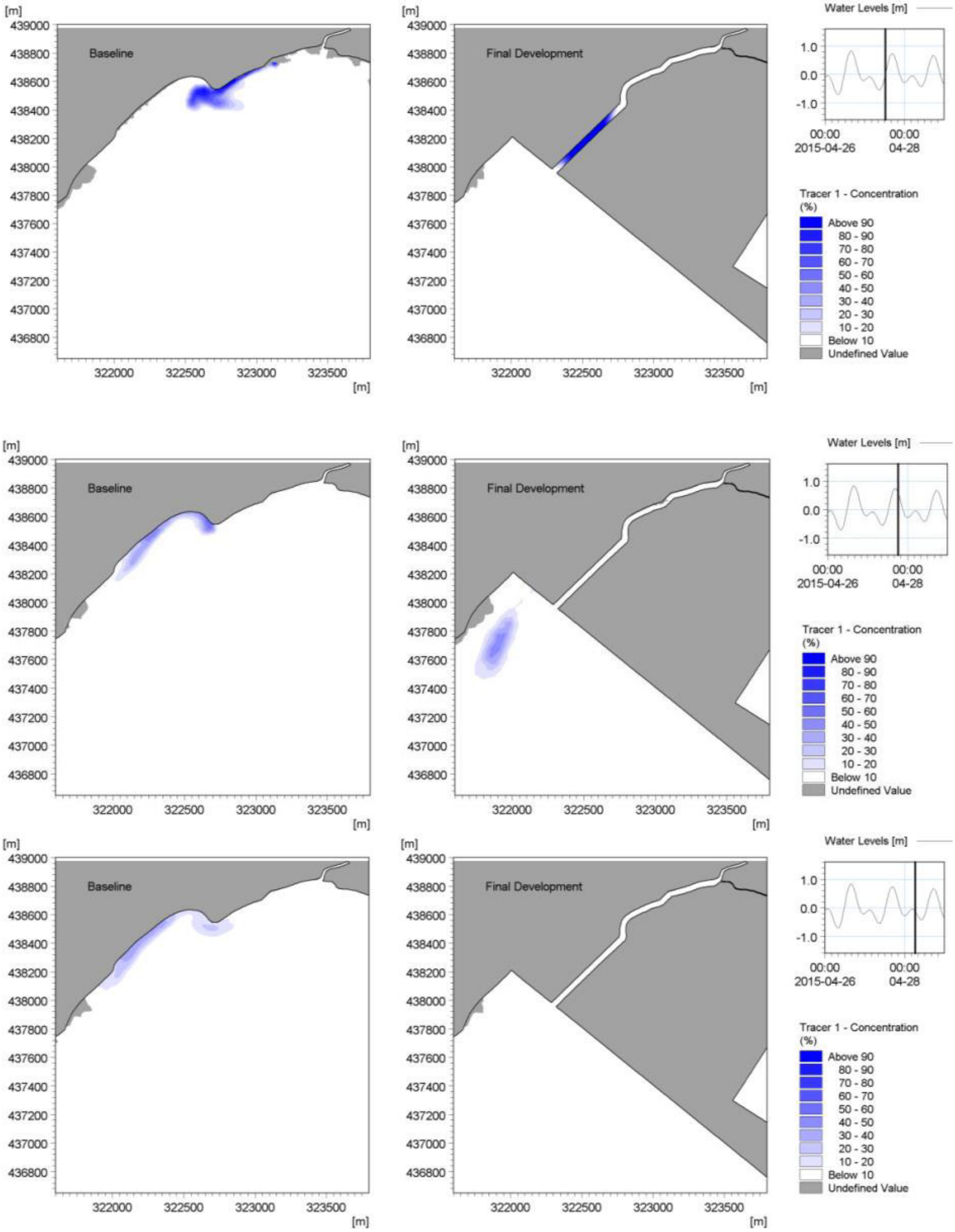


Figure 7.2.86: Tracer 1: Concentration of conservative tracer in Sg Pengorak extension channel after (Top) 6 hours, (Middle) 12 hours and (Bottom) 24 hours from the start of simulation for existing and final phase.

Rumah Pangsa LPK Extension Drain

The initial tracer release is shown in **Figure 7.2.87** for existing and final phase. Tracer 2 is located in an open area in existing conditions but will be restricted by Rumah Pangsa LPK extension drain after project completion. The predicted tracer dispersion results are shown in **Figure 7.2.88**. The proposed development tends to direct the tracer to the Sg Pengorak extension channel after 1 hour of the release. The concentration does not change significantly in post-development phase from the existing conditions, so the flushing capacity of Rumah Pangsa LPK extension drain is good and the impacts to the flushing capacity due to the proposed development is unlikely.

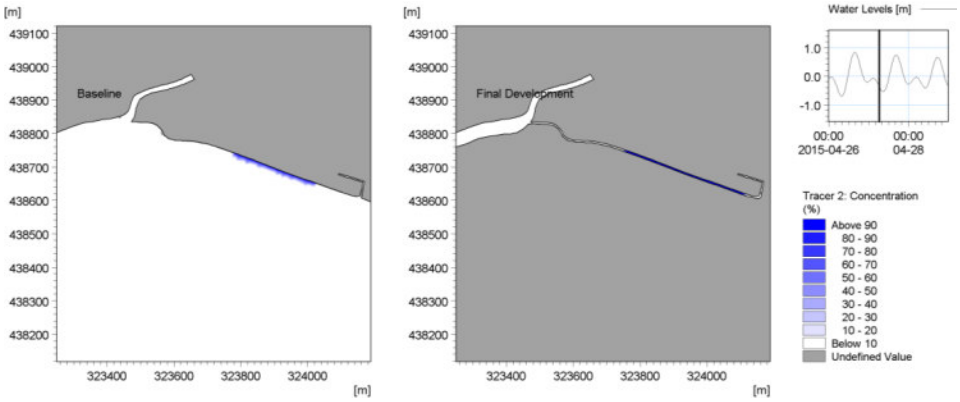


Figure 7.2.87: Tracer 2: Concentration of conservative tracer in Rumah Pangsa LPK extension drain before the start of the simulation for existing and final phase.

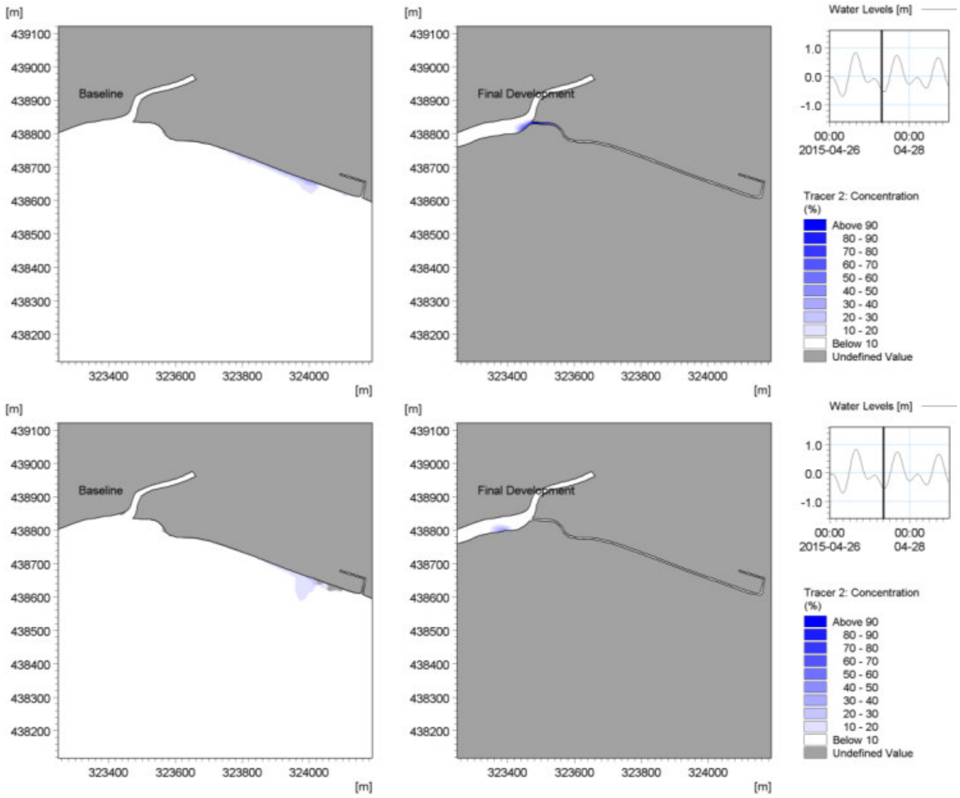


Figure 7.2.88: Tracer 2: Concentration of conservative tracer in Rumah Pangsa LPK extension drain after (Top) 1 hour and (Bottom) 2 hours from the start of simulation for existing and final phase.

Rumah Pangsa Kuantan Port Extension Drain

The initial tracer release is shown in **Figure 7.2.89** for existing and final phase. Tracer 3 is located in an open area in existing conditions but will be restricted by Kuantan Port extension drain after project completion. The predicted tracer dispersion results are shown in **Figure 7.2.90**. The proposed development tends to direct the tracer to offshore after 4 hours of the release. The concentration does not change significantly in post-development phase from the existing conditions, so the flushing capacity of Kuantan Port extension drain is good and the impacts to the flushing capacity due to the proposed development is unlikely.

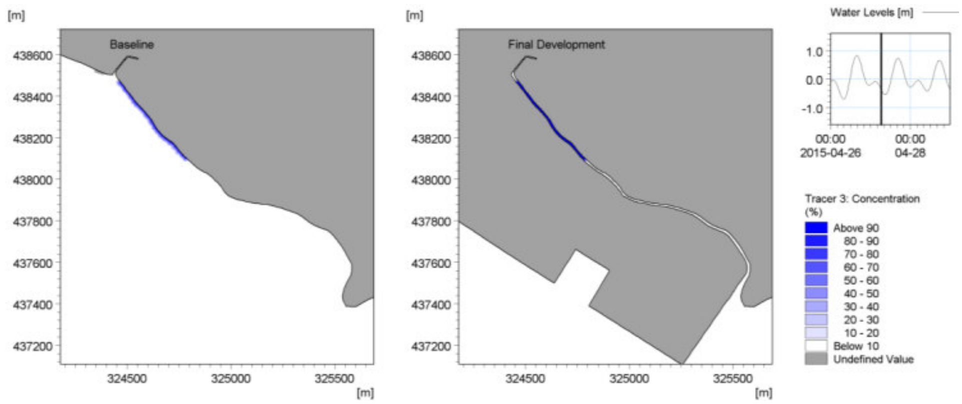


Figure 7.2.89: Tracer 3: Concentration of conservative tracer in Kuantan Port extension drain before the start of the simulation for existing and final phase.

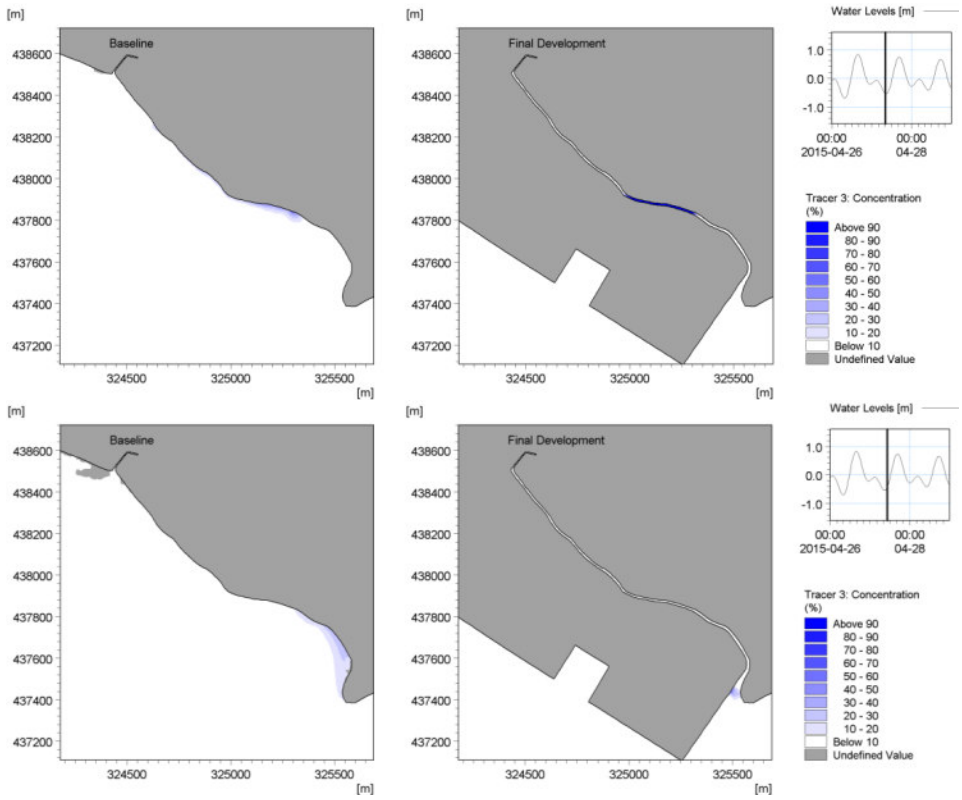


Figure 7.2.90: Tracer 3: Concentration of conservative tracer in Kuantan Port extension drain after (Top) 2 hours, and (Bottom) 4 hours from the start of simulation for existing and final phase.

7.2.2.2.6 Adjacent Coastline and Sediment Transport

The annual net littoral drift north of Tg. Gelang is approximately 50,000 m^3 to the south. The existing Kuantan Port, i.e. its breakwaters, basins and access channel, blocks the passage of the littoral drift and thus have a significant impact on the sediment budget south of Kuantan Port and thus on the coastline morphology south of Tg. Gelang. At present, the littoral drifts of sediment towards the Kuantan Port from the north are:

- Either trapped north of the breakwater,
- Or transported along the breakwater, in which case they are:
  - Flushed and deposited offshore (outside the coastal zone) and thus lost from the coastal sediment budget, or
  - Transported to the port entrance and the access channel by the combined waves and tidal currents where they will be trapped and later removed from the coastal system as part of maintenance dredging.

The bypass of sediments around the Tg. Gelang is, in other words, brought close to zero with only temporary sediment reserves present in the existing seabed just south of the port being available for the bypass. The reduced bypass causes a shortage of sediment along the coastline south of the Kuantan Port; a shortage which manifest itself in coastal erosion. The stretches of moderate erosion, which has been observed in the bay immediately south of Tg. Gelang, is likely the result of previous as well as ongoing Kuantan Port developments.

For the present study, the proposed KMH development is located immediately south of Tg. Gelang. The following coastal impacts are expected:

- The KMH development will have no impacts on the littoral transport and coastal morphology north of Tg. Gelang and thus north of Kuantan Port.
- As the bypass around Tg. Gelang is already brought close to nearly zero, the KMH development cannot impact (reduce) the bypass. The overall sediment budget for the coastline south of Tg. Gelang is thus not altered.
- Although the overall sediment budget is not altered by the KMH development, the KMH development will cause a change in the existing coastal erosion/deposition pattern observed along the coastline south of Tg. Gelang. It is expected that the current erosion/deposition pattern is shifted southwards. The alongshore shift in the erosion/deposition patterns will correspond to the width of the completed project development.
- The proposed navigation channel which is aligned with the anchorage zone and Kuantan Mega Port navigation channel will trap all north-going sediment transport. The trapped sediment would otherwise have been transported further north and trapped in the Kuantan Port access channel and basins. The proposed navigation channel for the KMH development will thus indirectly benefit the Kuantan Mega Port navigation channel through reduced sedimentation and maintenance dredging volumes.

The anticipated southward shift in the erosion/deposition patterns is further demonstrated by the coastal sediment transport modelling, i.e. the coupled model linking the Sand Transport Module, the Hydrodynamic Module and the Spectral Wave Module. The sediment transports during two extreme wave conditions, NE, and SW monsoons have been simulated for the situation without the KMH development and for the situation in which the project is in place. Results of the simulations are presented in **Figure 7.2.91** and **Figure 7.2.92** for NE monsoon, and **Figure 7.2.93** and **Figure 7.2.94** for SW monsoon.

The simulations of the sediment transport show that:

- The sediment transports during NE monsoon is more active than those occurring during SW monsoons.
- During NE monsoon, a reduction of sediment transport is predicted in the dredged basin and channel, due to the increased water depth and reduced current velocities.
- Along the nearshore areas just south of project site, the transport is decreased due to sheltering and wave blocking effects implying that the erosion patterns will shift southward as postulated above.
- During SW monsoon, there is no major changes are predicted along the shoreline areas due to the lower transport rate. The transport also slightly decreased during this monsoon in the dredged channel.

Based on the model simulations, the moderate erosion/deposition patterns currently observed along the coastline south of Tg. Gelang is found to be shifted further south. The shift will correspond to the width of the project development, which can be explained by the fact that the KMH development will shelter the coastline to the south from NE monsoon waves in a way similar to that of the existing headland. It should be noted that the actual coastal erosion/deposition rates are highly dependent on the monsoonal wave climate and wind conditions. Therefore there is always some uncertainty involved in the estimation of erosion rates and its alongshore patterns.

Consequently, it is proposed that shoreline monitoring is undertaken to determine the critical areas susceptible to changes in the coastline. The monitoring of the coastline should be done along the critical stretch in **Figure 7.2.95** as well as at key recreational areas and along the front of beach resorts located just south of Kuala Balok.

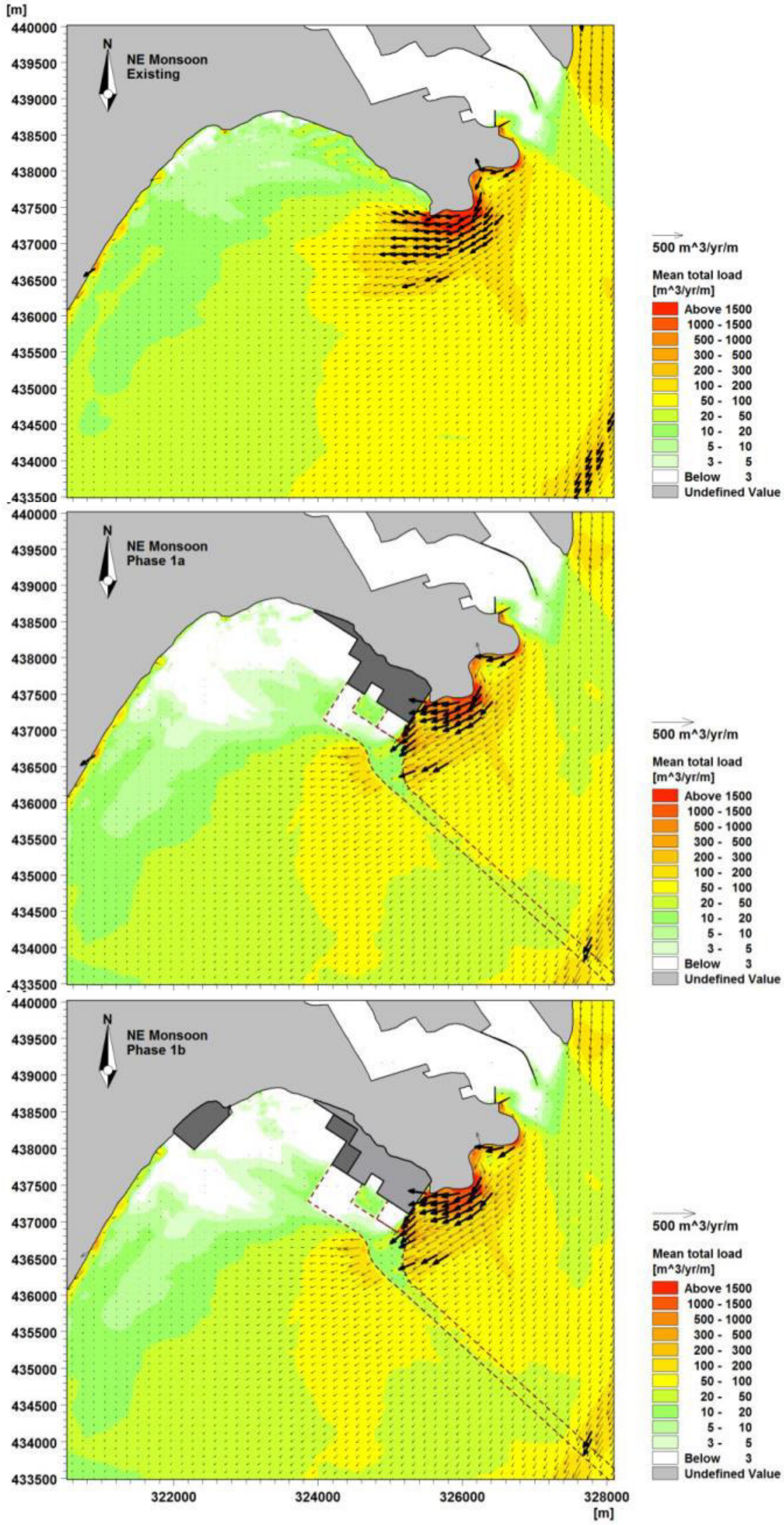


Figure 7.2.91: Extreme NE wave condition: Averaged sediment transport for existing (top), Phase 1a (middle) and Phase 1b (bottom).

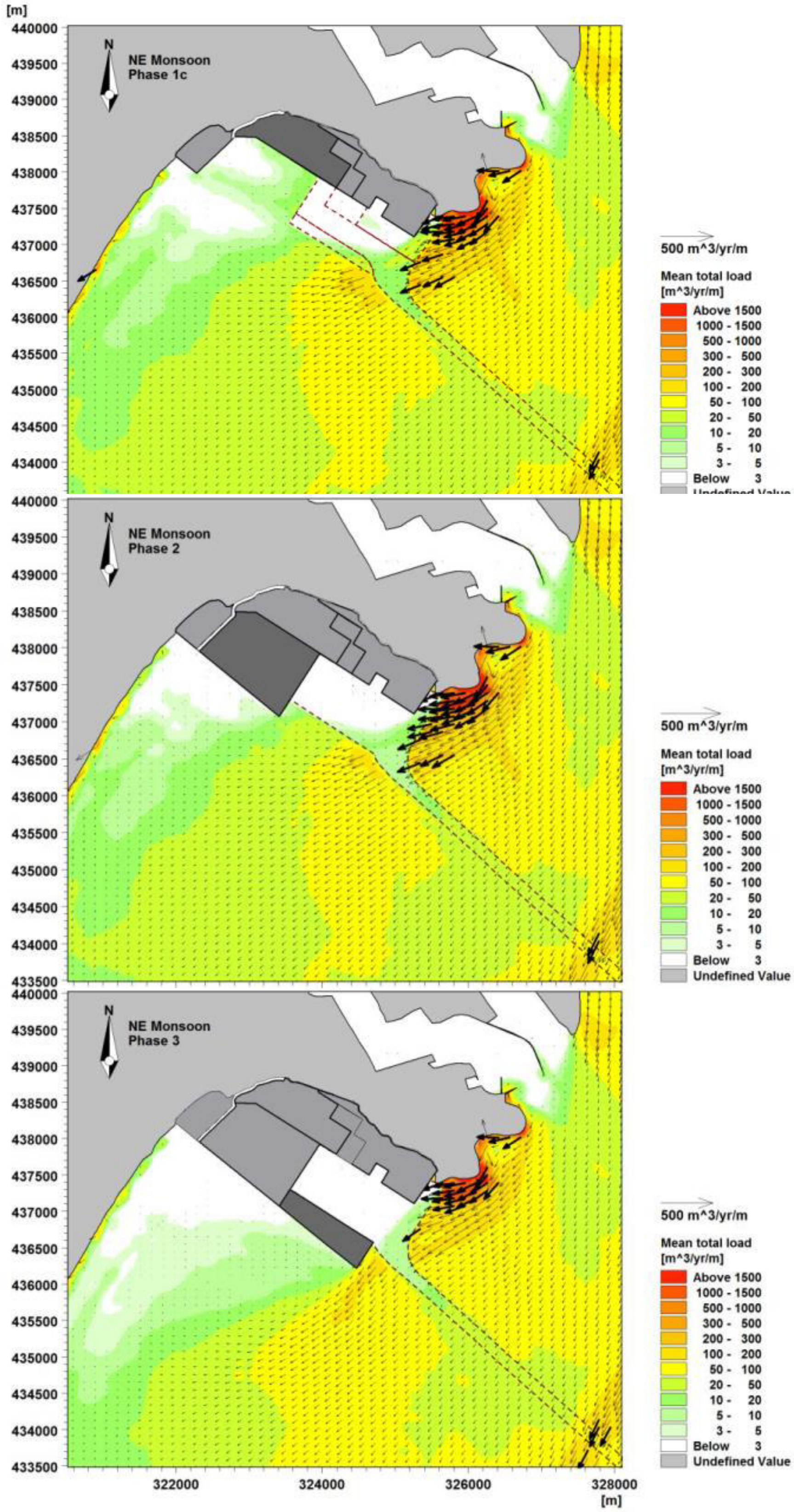


Figure 7.2.92: Extreme NE wave condition: Averaged sediment transport for Phase 1c (top), Phase 2 (middle) and Phase 3 (bottom).

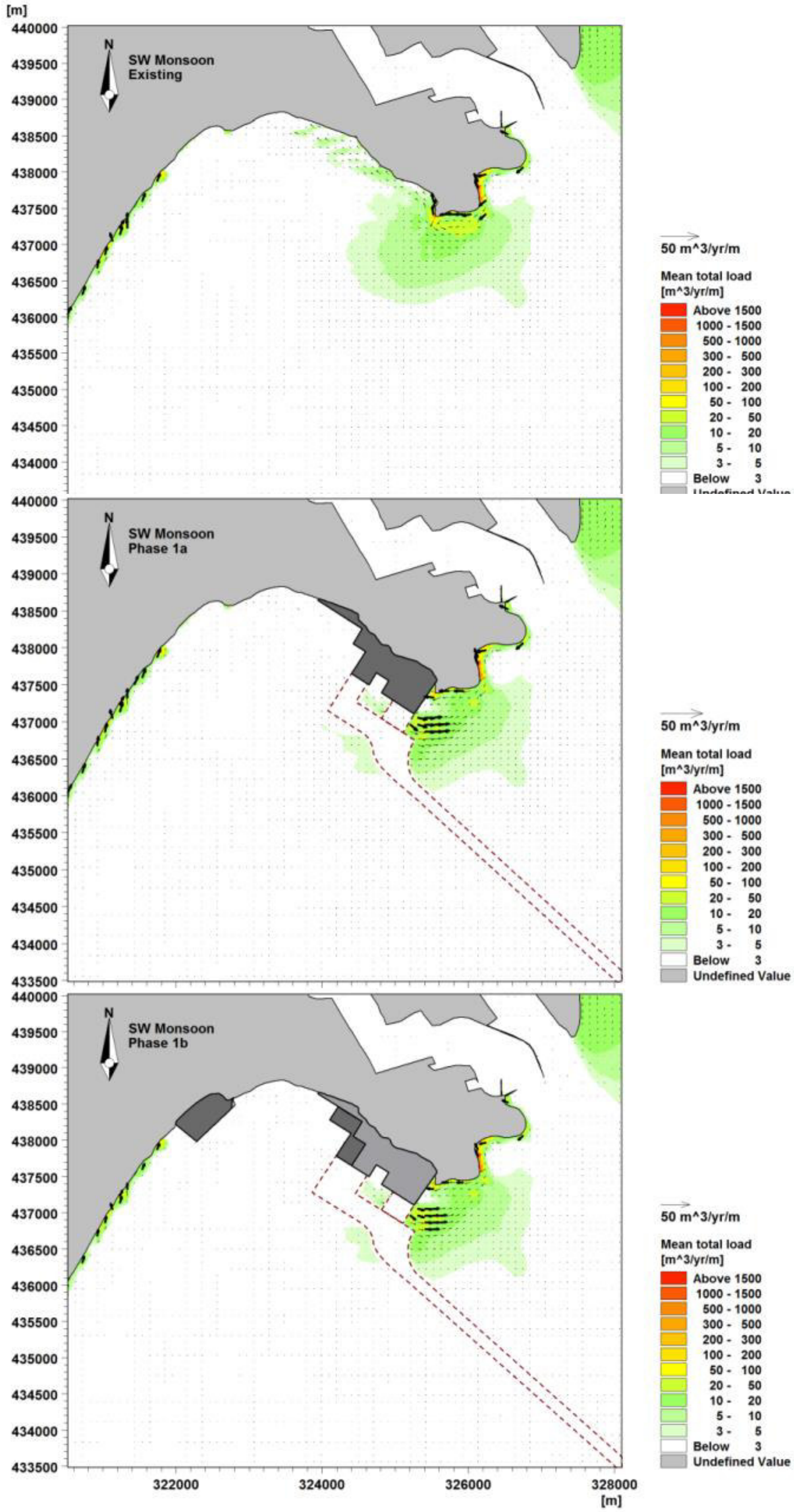


Figure 7.2.93: Extreme SW wave condition: Averaged sediment transport for existing (top), Phase 1a (middle) and Phase 1b (bottom).

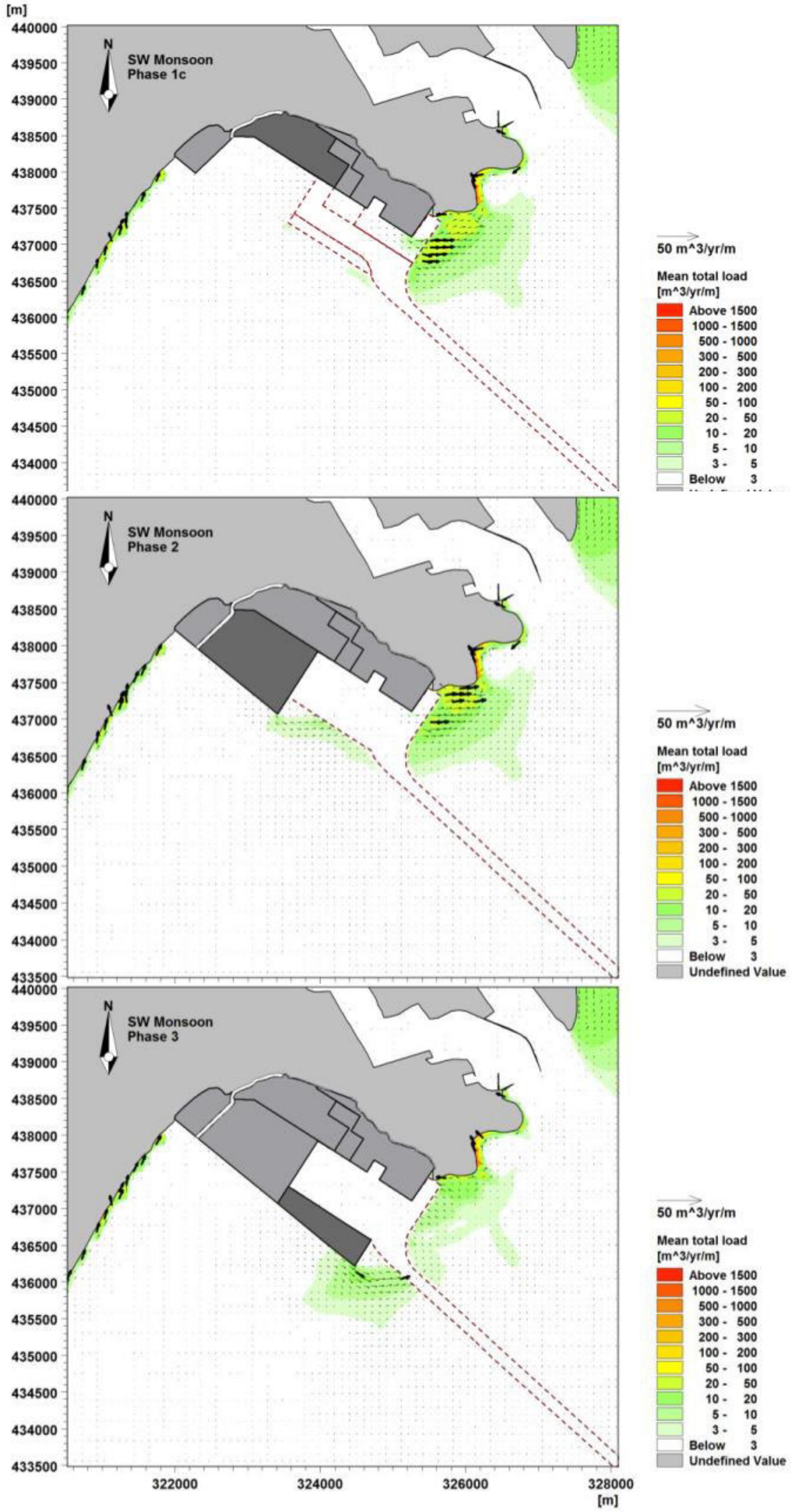


Figure 7.2.94: Extreme SW wave condition: Averaged sediment transport for Phase 1c (top), Phase 2 (middle) and Phase 3 (bottom).

Figure 7.2.95: Predicted potential coastline changes after the completion of project

7.2.2.2.7 Water Quality Change by STP Discharge

A flushing capacity assessment is carried out to identify the possible impacts from proposed STP outfall. The locations of STP for every phases have been presented in Chapter 5 of this EIA report. A 100% concentration of tracer with corresponds discharge rate from the design STP outfall has been simulated for 14 days excludes 2 days warm up period. **Table 7.2.29** below summarized the discharge for every phases.

Table 7.2.29: STP discharge for phases

Phases	Discharge Point	Discharge (m^3/s)
1a	DP 1	0.0026
1b	DP 1	0.0045
1c	DP2, DP 3	0.0064, 0.02
2	DP 4	0.024
3	DP 4	0.032

To quantify the flushing capacity at the respective locations, mean and maximum statistical analyses are computed over 14-days duration which included spring and neap tides. The results are presented in **Figure 7.2.96** to **Figure 7.2.105** and described as follows.

- Mean concentration conservative tracer at location DP 1 discharging STP from Phase 1a and Phase 1b reclamation is less than 0.5%. While the maximum is less than 2 %. The results indicated that the flushing at DP1 location is good, where the concentration tracer has dispersed and mixed well with neighbourhood environment. The changes is similar for all different seasonal conditions.
- Mean concentration conservative tracer at location DP 2 discharging STP from maritime industrial park during Phase 1c is less than 1% with maximum below 2%. The location of DP2 also considered as good flushing location. The changes is similar for all different seasonal conditions.
- Mean concentration conservative tracer at location DP3 discharging STP from Phase 1c reclamation is less than 1% localised at the project area. The maximum concentration is about 2% with an extent of 0.4km to the south during NE and Inter monsoon conditions. Mean concentration conservative tracer at location DP2a which was shifted from DP2 location due to reclamation during Phase 2 is less than 0.5% which is good since it is located at deeper area.
- Mean concentration conservative tracer at location DP4 discharging STP from Phase 2 is less than 0.5% with maximum less than 1% which is good flushing. The maximum concentration at the nearshore area (around DP3) is around 2% with an extent of 0.7km to the south during NE and Inter monsoon conditions.
- Mean concentration conservative tracer at location DP 4 discharging STP from both Phase 2 and Phase 3 reclamation is less than 1% with maximum about 2% just beside the reclaimed

Phase 3. The maximum concentration at the nearshore area is around 2% with an extent 1.2km to the south during inter monsoon.

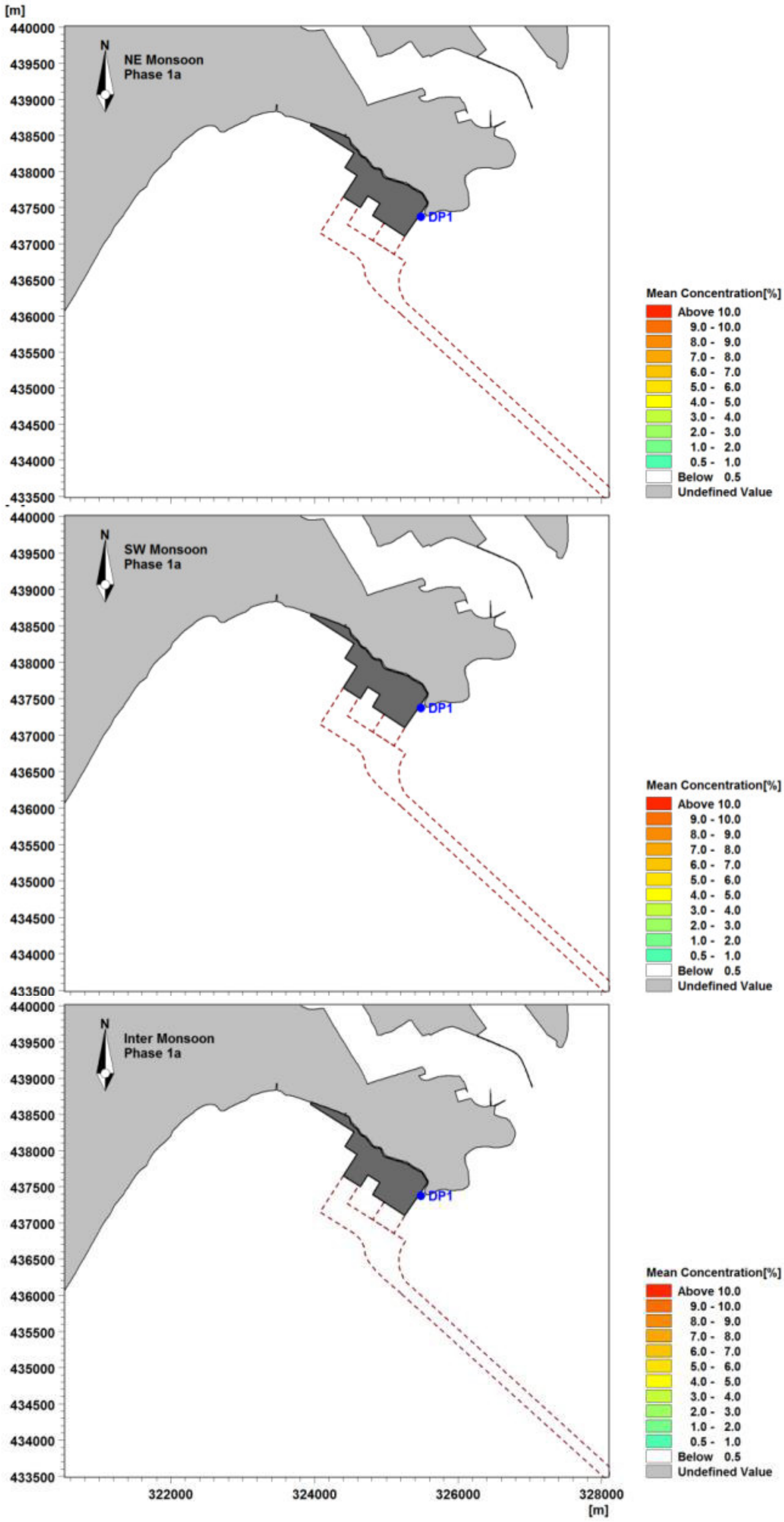


Figure 7.2.96: Phase 1a. Mean concentration during NE (top), SW (middle) and Inter (bottom) monsoon condition.

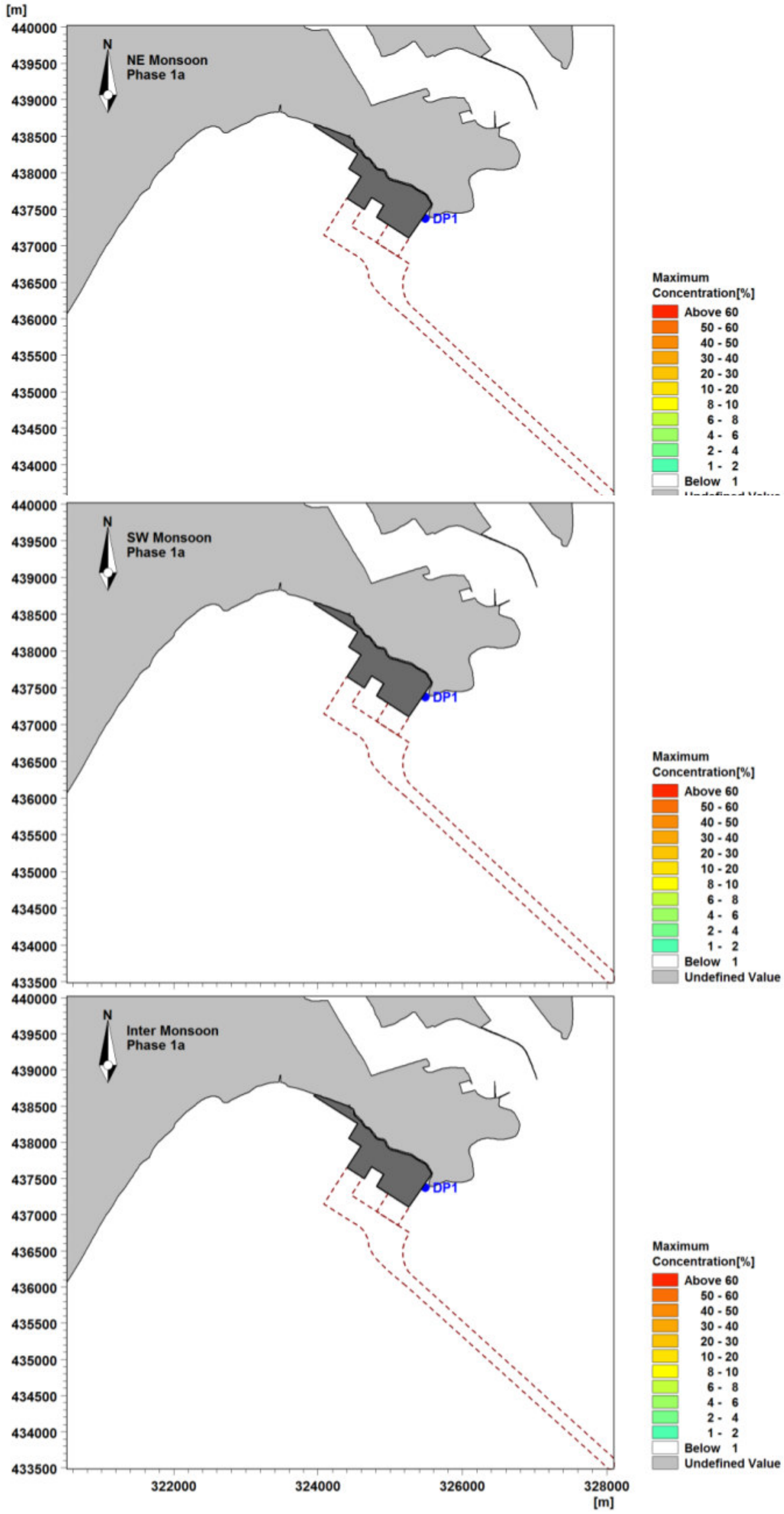


Figure 7.2.97: Phase 1a. Maximum concentration during NE (top), SW (middle) and Inter (bottom) monsoon condition.

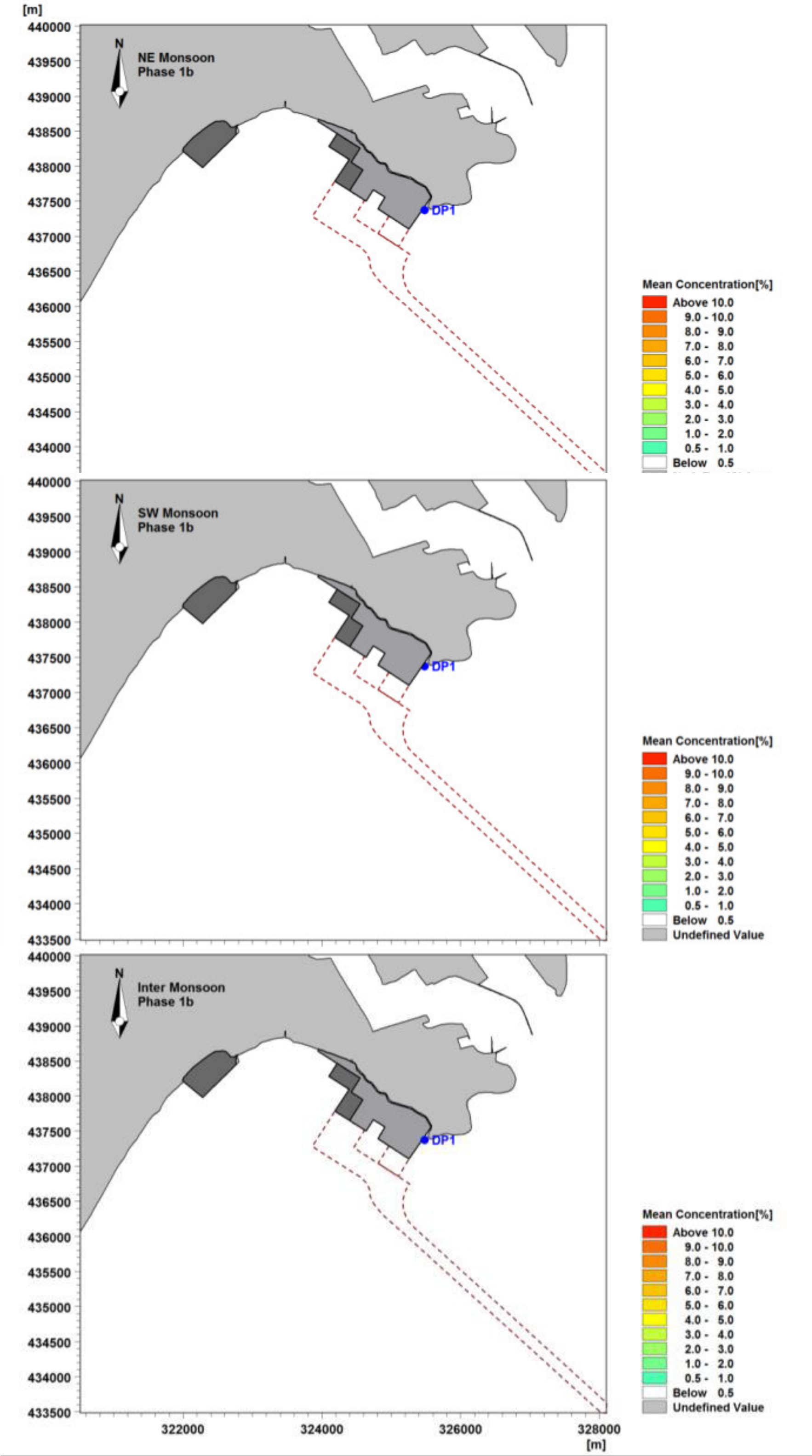


Figure 7.2.98: Phase 1b. Mean concentration during NE (top), SW (middle) and Inter (bottom) monsoon condition.

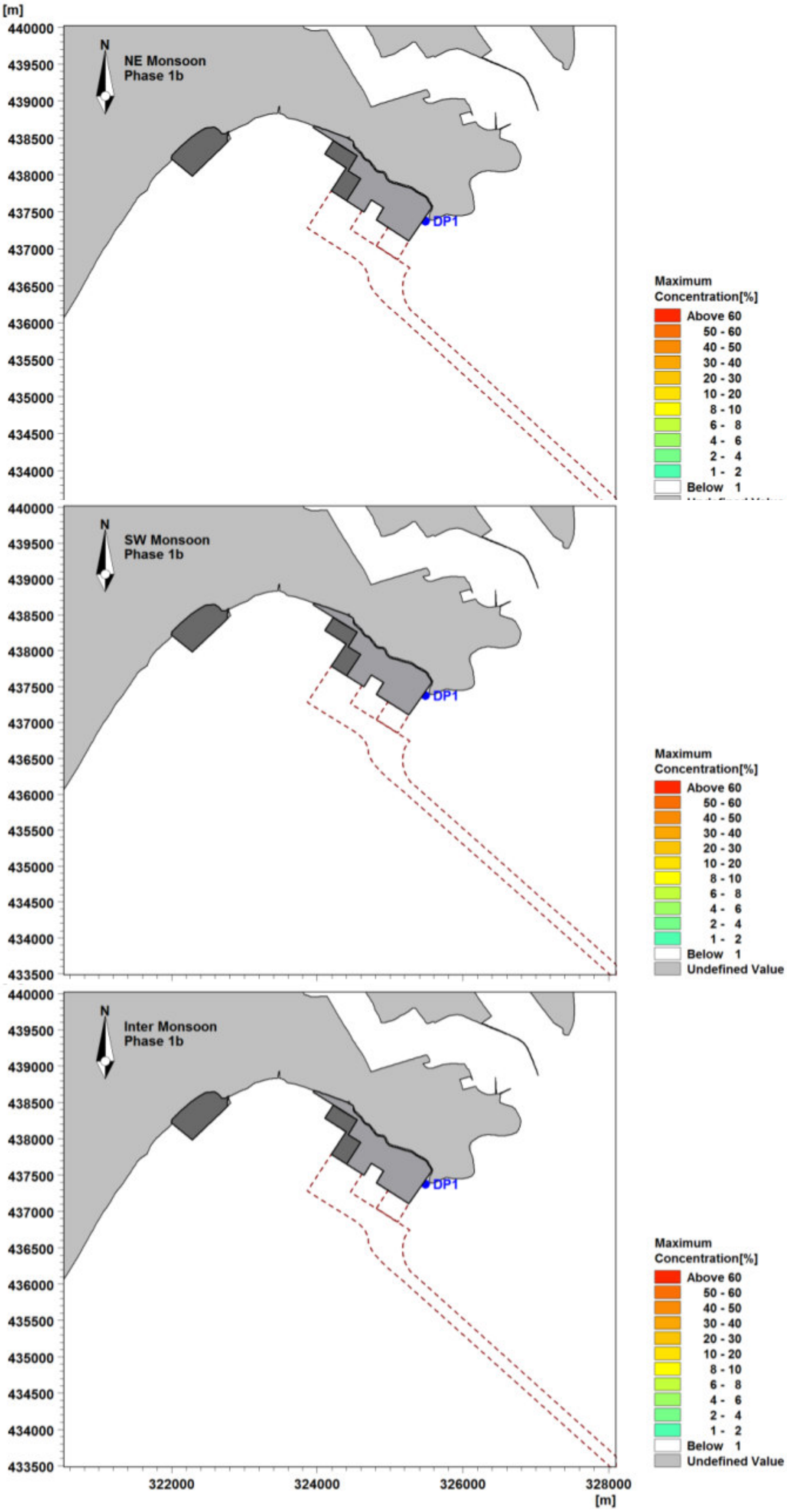


Figure 7.2.99: Phase 1b. Maximum concentration during NE (top), SW (middle) and Inter (bottom) monsoon condition.

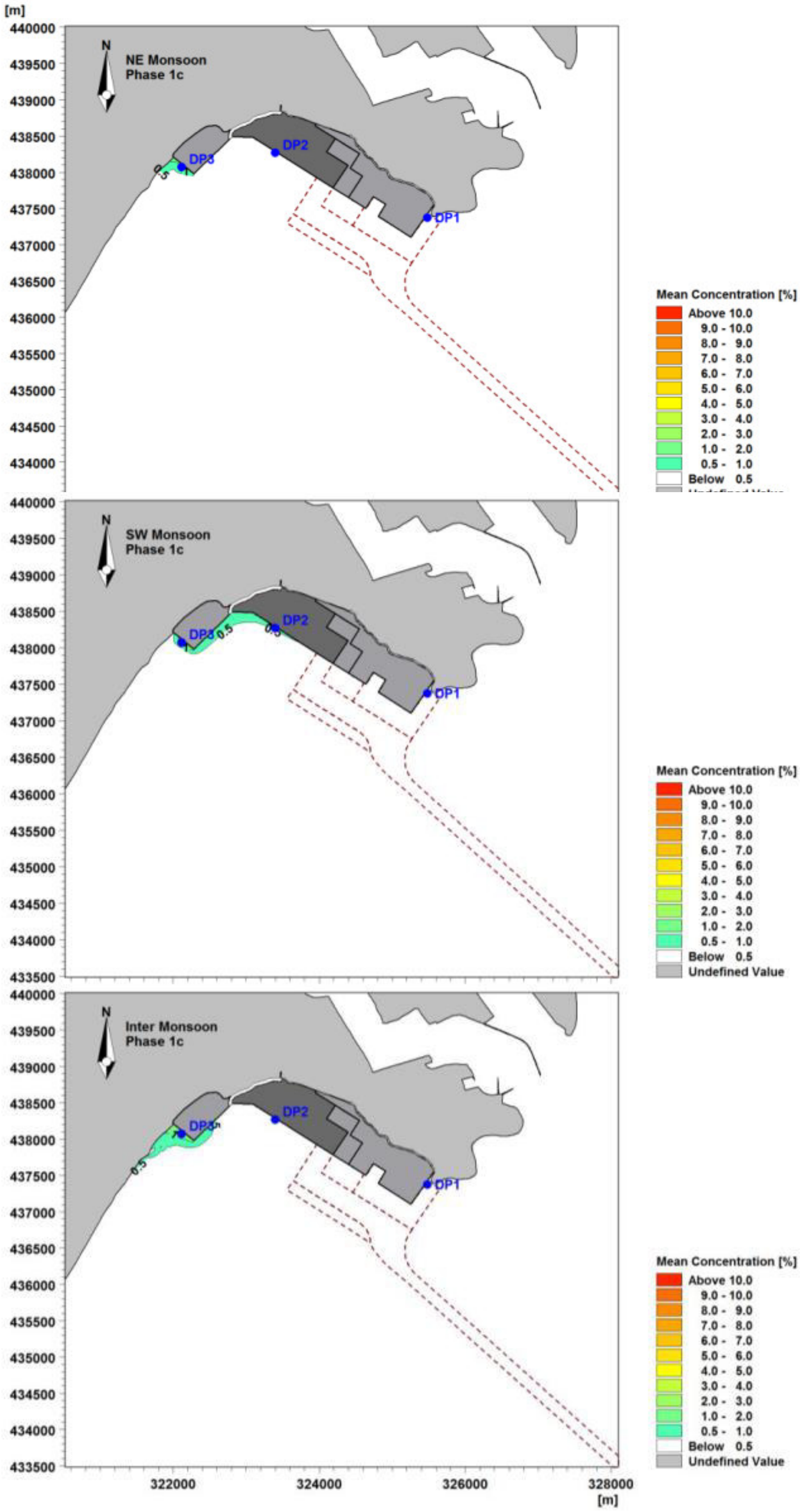


Figure 7.2.100: Phase 1c. Mean concentration during NE (top), SW (middle) and Inter (bottom) monsoon condition.

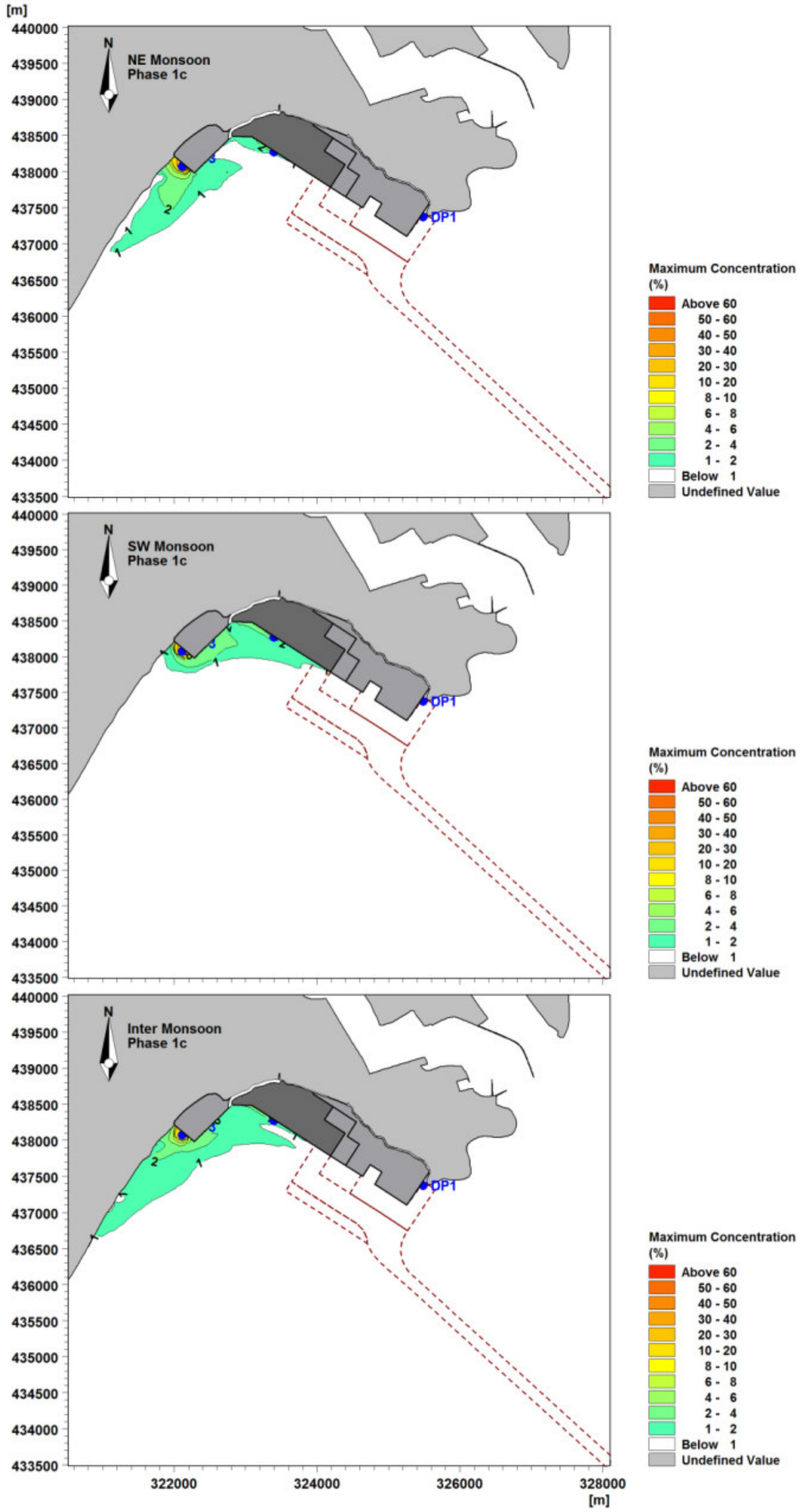


Figure 7.2.101: Phase 1c. Maximum concentration during NE (top), SW (middle) and Inter (bottom) monsoon condition.

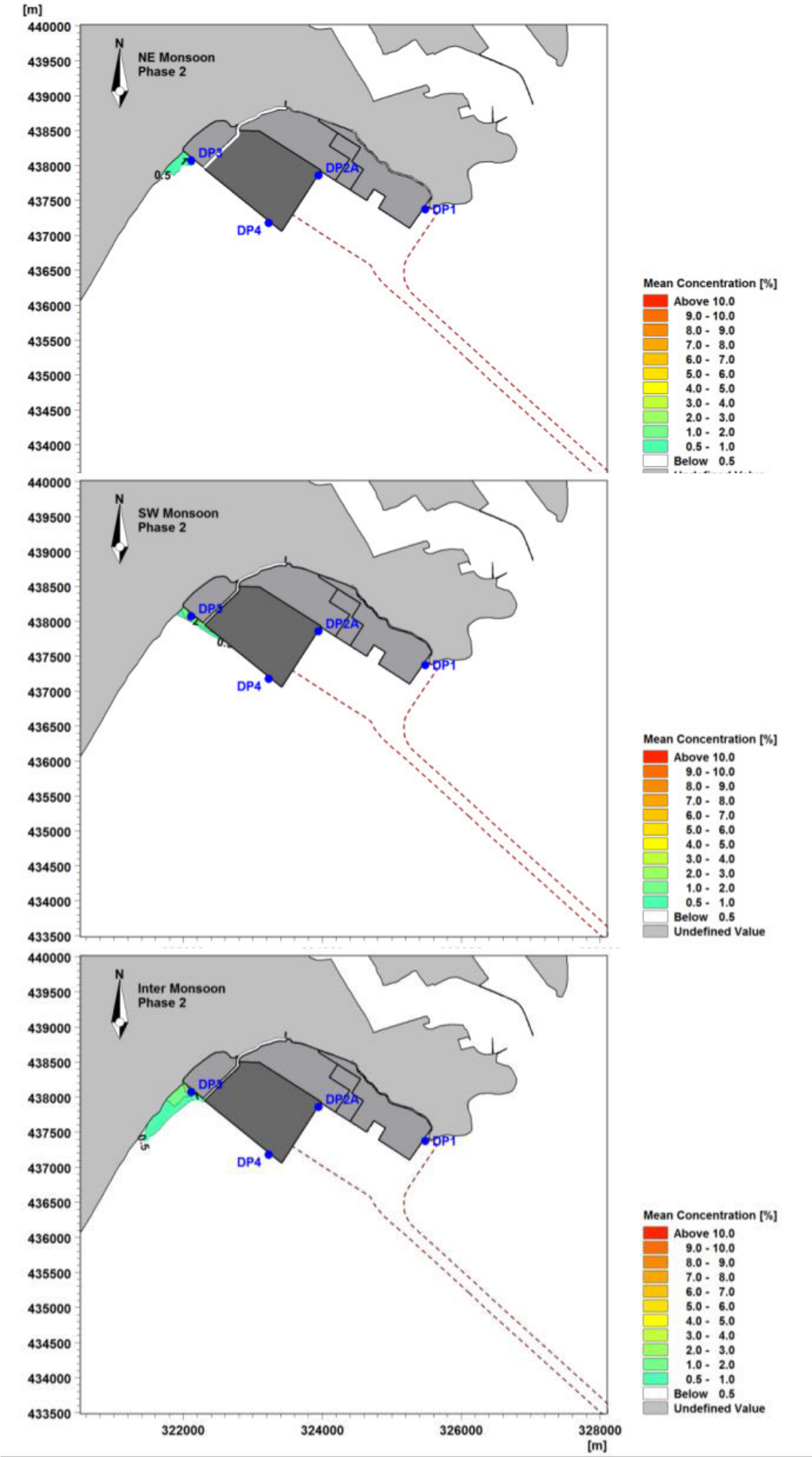


Figure 7.2.102: Phase 2. Mean concentration during NE (top), SW (middle) and Inter (bottom) monsoon condition.

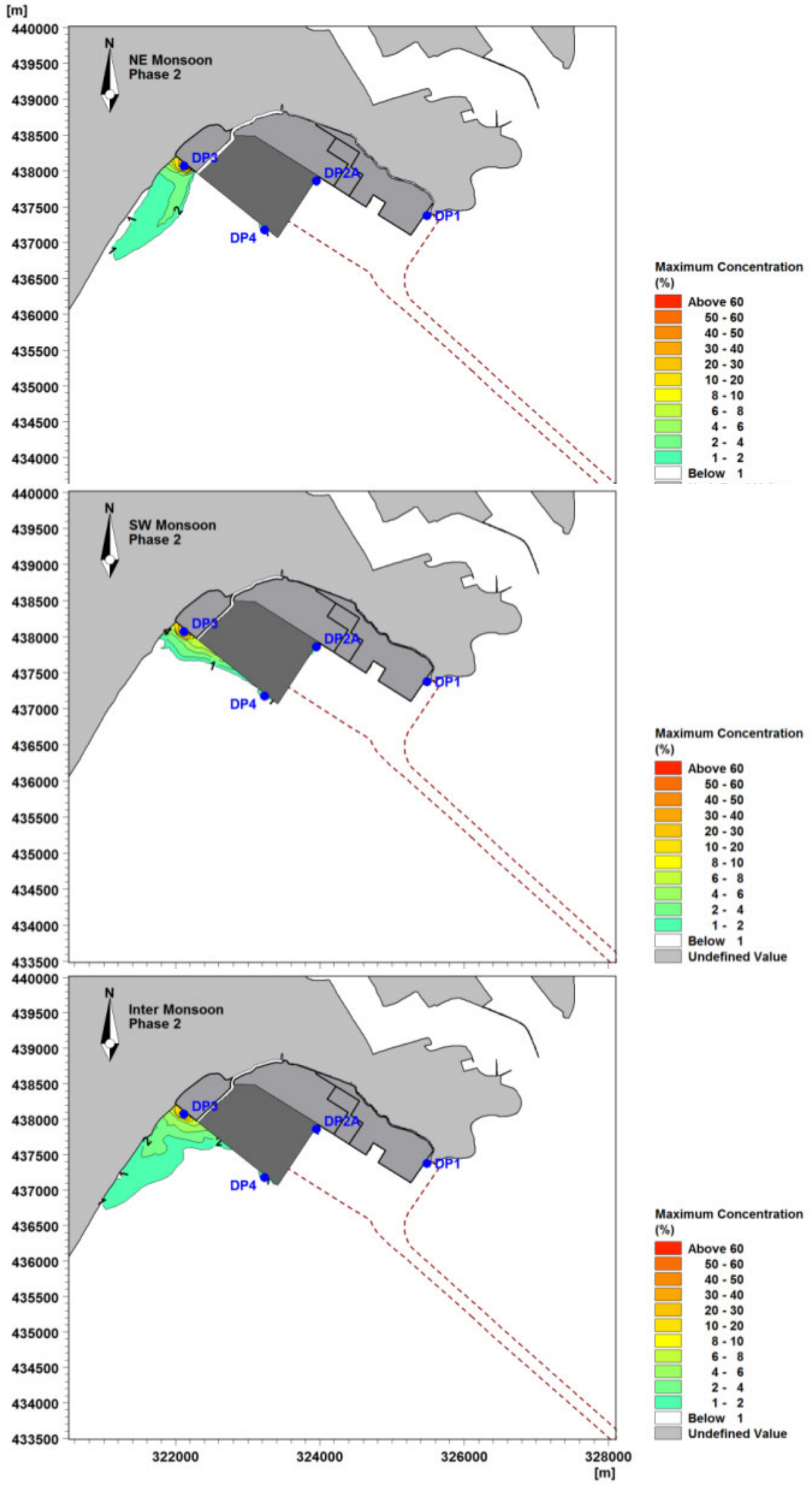


Figure 7.2.103: Phase 2. Maximum concentration during NE (top), SW (middle) and Inter (bottom) monsoon condition.

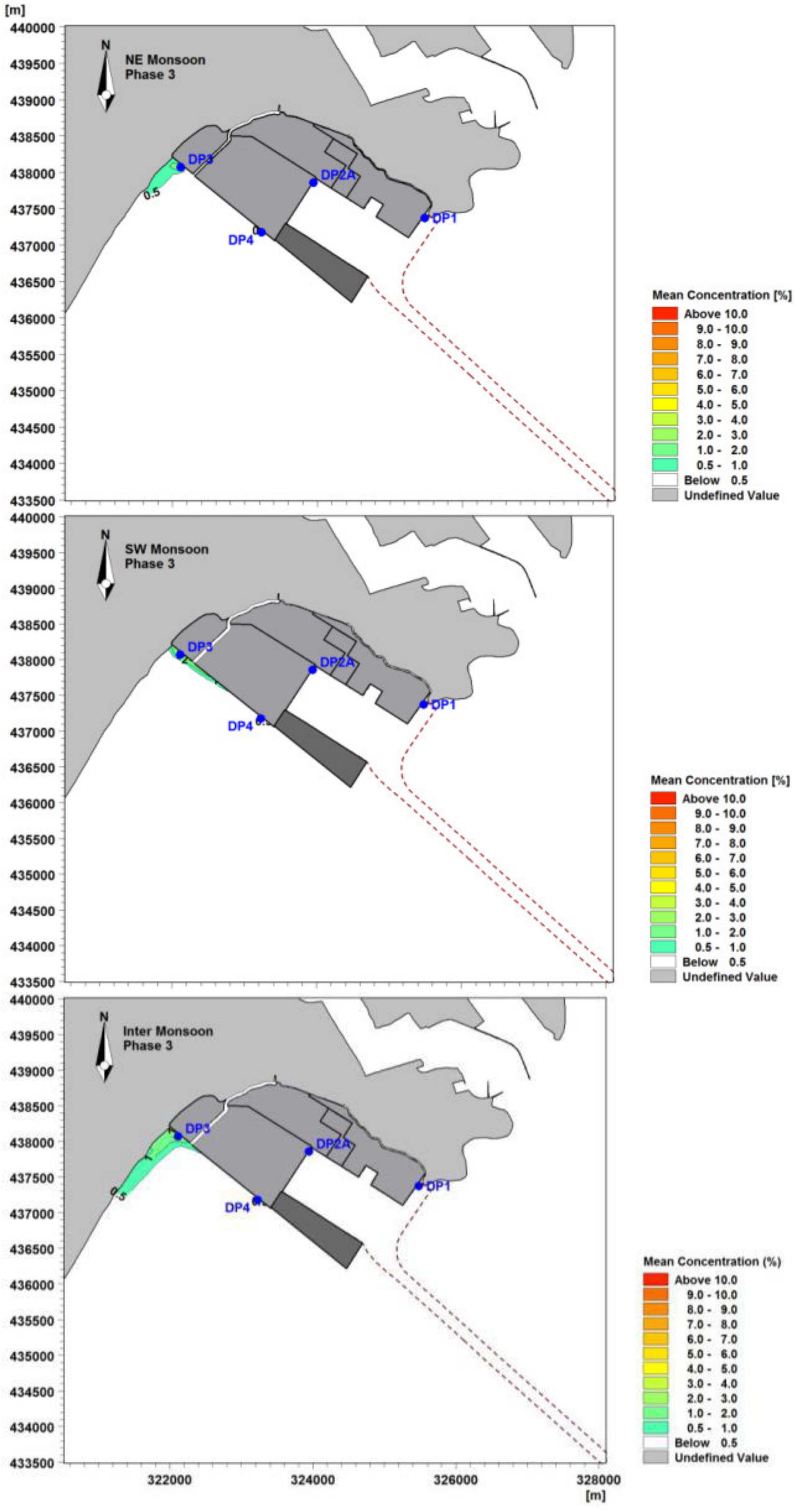


Figure 7.2.104: Phase 3. Mean concentration during NE (top), SW (middle) and Inter (bottom) monsoon condition.

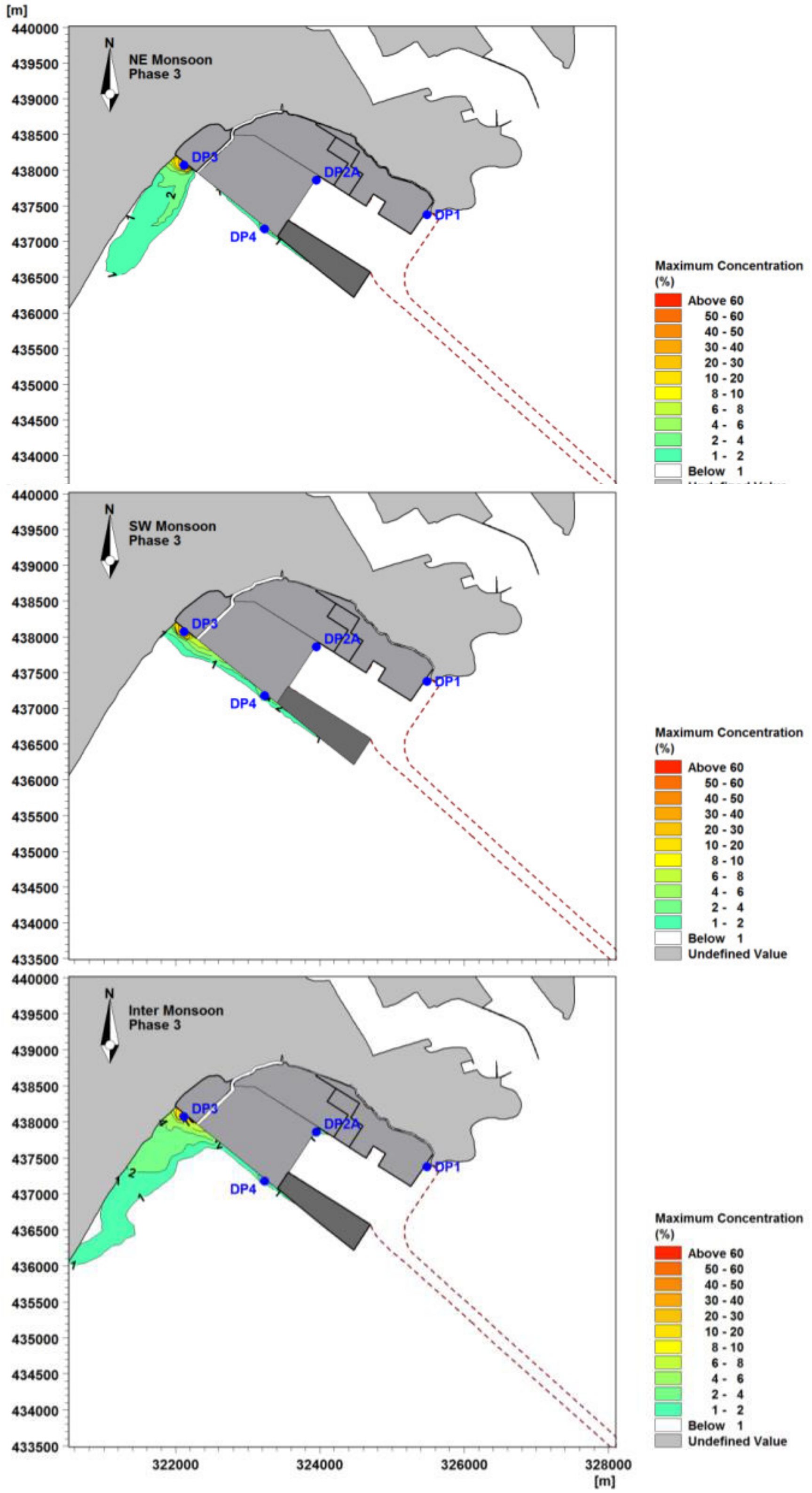


Figure 7.2.105: Phase 3. Maximum concentration during NE (top), SW (middle) and Inter (bottom) monsoon condition.

7.2.2.2.7.1 Construction Stage

Water pollution may potentially occur from untreated sewage and domestic wastewater discharges from site office, work areas and workers quarters. During peak of construction period, approximately 2,800 workers are anticipated at site. Wastewater generated from these workers is estimated about 616 m^3 per day. It is proposed that multiple temporary holding tanks or toilet with septic tank that can comply with Standard B effluent requirement, are to be used during the construction stage.

Table 7.2.30 shows the predicted BOD loading during the construction stage for both treated and untreated sewage scenarios. With treatment to Standard B requirement, the predicted incremental mean of BOD level at the receiving point of discharge is about 0.5 mg/L, as compared to 2.2 mg/L in the case of untreated sewage.

Therefore, it is concluded that the potential impact due to sewage generation during construction stage is small with proper containment and treatment toilet facility.

Table 7.2.30: BOD Loading for Treated and Untreated Sewage during Construction Stage Based on Predicted Mean and Max Concentration at Receiving Point of Discharge

Estimated Population	Effluent Characteristics	Predicted Incremental BOD Concentration at Receiving Point of Discharge			
		Mean, %	Mean Concentration mg/l	Max, (%)	Max Concentration mg/l
2800	Untreated Sewage, BOD level = 220 mg/l	1	2.2	2	4.4
2800	Treated to Standard B Effluent, BOD level = 50 mg/l	1	0.5	2	1.0

7.2.2.2.7.2 Operation Stage

The Project will be developed in phases with 4 units of Sewage Treatment Plants (STP) planned for Phase 1 (refer Section 5.3.2.4 of this EIA report). The planned STP with estimated PE for Phase 1 development and the calculated incremental mean and maximum BOD levels based on the flushing capacity simulated earlier are summarised in **Table 7.2.31**. Prediction for worst case scenario (total STP failure) and normal scenario (with proper performance of STP) are considered. STP for Phases 2 and 3 are not included as details for future development are presently not available.

With treatment to Standard B effluent requirement, the predicted instantaneous mean increase of BOD at the receiving point of discharge is estimated to be less than 0.5 mg/L for each phases. However, without sewage treatment and under worst case scenario, the maximum incremental BOD level could be at 4.4 mg/L.

It is concluded that the potential impact due to sewage generation during operation stage is insignificant if STP operates properly and complies with at least Standard B effluent quality.

Table 7.2.31: BOD Loading for Treated and Untreated Sewage during Operational Stage Based on Mean and Max Percentage Concentration Tracer at the Discharge

STP-Phase	Estimated PE	Effluent Characteristics	Predicted Incremental BOD Concentration at Receiving Point of Discharge			
			Mean, %	Mean Concentration mg/l	Max, (%)	Max Concentration mg/l
STP 1-Phase 1a (Shipyard)	1012	Untreated Sewage, BOD level = 220 mg/l	0.5	1.1	2.0	4.4
	1012	Treated to Standard B Effluent, BOD level = 50 mg/l	0.5	0.25	2.0	1.0
STP 2-Phase 1b (Fabrication Yard)	1720	Untreated Sewage, BOD level = 220 mg/l	0.5	1.1	2.0	4.4
	1720	Treated to Standard B Effluent, BOD level = 50 mg/l	0.5	0.25	2.0	1.0
STP 3-Phase 1c (Institution, Business, Residential)	8061	Untreated Sewage, BOD level = 220 mg/l	1	2.2	2.0	4.4
	8061	Treated to Standard B Effluent, BOD level = 50 mg/l	1	0.5	2.0	1.0
STP 4-Phase 1c (Maritime Industrial Park)	2467	Untreated Sewage, BOD level = 220 mg/l	1	2.2	2.0	4.4
	2467	Treated to Standard B Effluent, BOD level = 50 mg/l	1	0.5	2.0	1.0

7.2.3 Assessment of the Impacts

7.2.3.1 Temporary Impacts – Sediment Spill

Based on the presented analysis, there is a potential small sedimentation impact to the Kuantan Port channel during the reclamation and dredging works for Phase 1a, 1b, 1c, and Phase 2. However it should be noted that this temporary sedimentation impact will not exist after the project completion. It is also noted that the impacts are characterized as insignificant as the excess suspended sediment being less than the tolerance limit per DOE Guidelines of Class III. It is finally stressed that model results are conservative; the sediment spill associated with the proposed reclamation and dredging works have been quantified for each of the phases without the use of silt curtains.

The impacts during Phase 3 development is predicted to be localised as only reclamation works to be carried out and there will be no capital dredging during this phase.

Upon appraising the model simulations, it is recommended that silt curtains be used in the shallow areas before the sand bund construction. Here the current flows are weak and silt curtains would thus be suitable (good practice) for controlling the spillage of sediment during construction works. Besides, it is suggested to conduct water monitoring during the construction stages in order to monitor the levels of suspended sediment at the sensitive areas. The details of the water monitoring will be described in Section 8.4 of the EIA report.

7.2.3.2 Water Levels on Open Water

Numerical simulations of water levels were carried out to assess potential changes in water levels due to the construction of the project. The modelling of seasonal water levels due to tide, wind and waves and normal river/drain discharges show that only minor changes in water levels will be encountered; i.e. water levels will change less than 1 cm and only in the absolute vicinity of the study area. The results show that changes in water level are not significant at any of the sensitive receptors.

7.2.3.3 Current Flow

The changes in current flow conditions in the vicinity of the development have been assessed. The predicted changes show similar pattern across different monsoons. The current flow changes are summarised as below:

- The reduction in mean and maximum current speed of 0.1 m/s and 0.2 m/s localised around the project development area are predicted.
- An increase of current speed around east of dredged basin area can be observed. This is due to the deepening of the basin which have allow good water exchange.
- The most noticeable changes are found in the dredging basin area and reserved river channel with magnitude below 0.2 m/s.
- Overall, the current flow impacts are localized around the project area and no regional current impacts are predicted.

7.2.3.4 Waves

The changes in wave conditions in the vicinity of the development area have been assessed for mean and maximum significant wave heights. The wave changes are summarised as below:

- For all different seasonal conditions, changes in mean significant wave height are predicted to be less than 0.15 m and localised around the project area;
- For NE monsoon, the impacts are bigger in extent compared with other monsoons;
- As expected, the future reclamation will induce a wave-sheltering effect to the south of the project area. This sheltering effect may benefit the local fishermen as slightly lower waves are expected at the area;

- It may also benefit the coastline at the south of project site as the rate of erosion caused by NE waves will be reduced. However, this effect is not a permanent benefit from the structure, as erosion will likely be shifted further away from the proposed development along the coast;
- The predicted changes are localised around the proposed development. No significant changes to the area beyond the immediate vicinity of the project site are predicted.

7.2.3.5 Water Levels in Waterways

The water levels upstream of the existing outlets of Sg. Pengorak, culvert of Rumah Pangsa LPK and storm culvert drain of the Kuantan Port area were assessed. The models have been simulated for the 100-year return period flows on a tide involving a MHWS. To quantify impacts from the KMH development on the water levels, and thus on upstream flooding, simulations have been done for the existing waterways as well as the existing waterways extended by, respectively, the proposed 40 m wide river channel (for Sg. Pengorak), the smaller concrete drain for the culvert of Rumah Pangsa LPK and the smaller concrete drain for the storm culvert drain of the Kuantan Port area.

The simulations indicate that the impacts on the upstream water levels are small except in the outlets of the waterways. The upstream impacts and, in particular, the elevated waters at the outlets can be mitigated by widening and streamlining the channel. The impacts have been reduced to acceptable levels mainly by streamlining which has been achieved partly by smoothing the reclamation frontage and by increasing the curvature of certain channel bends. Recommendations are further provided in Section 7.2.2.2.4.4 above.

The proposed Phase 1 and Phase 2 outfalls of the extended Sg. Pengorak channel is located on the south-western side of the reclamation. In both phases, the outfalls are located on shallow waters and near the existing shoreline. The sheltered seabed in front of the outfalls will be susceptible to periodic sedimentation (from e.g. littoral transport) and thus to sediment obstructing or even blocking the outfall. Such blocking of the outlet may hinder the discharge of the Sg. Pengorak water to flow to sea freely. The susceptibility of sedimentation in front of the new outfalls are however expected to be similar to that of the existing Sg. Pengorak river mouth. This is because:

- The proposed outfalls will be discharging into the sea at an angle similar to the angle of the existing river, and more importantly
- The shoreline orientation and the inset of the outfall from the headland tip (which in combination implies that the degree of wave and current sheltering is similar) is comparable.

The proposed outfall for the Kuantan Port storm water drain located at Tg. Gelang is not at risk of being blocked by sedimentation due to the degree of wave exposure and naturally large water depths.

7.2.3.6 Retention Time in Water Channel

Simulations to assess the flushing capacity have been carried out to determine the natural water exchange capacity for pre-development (existing) conditions and final post development. The simulations have been carried out by applying the 2D advection-dispersion model to describe the dispersal of conservative tracer that represents any type of pollution. Tracers have been released as 100% at the first time step after the warm-up period. They are being released in three (3) areas, namely Sg Pengorak extension channel, Rumah Pangsa LPK extension drain and Kuantan Port extension drain.

The concentration does not change significantly in post-development phase from the existing conditions, so the flushing capacity in the extension channels is as good as existing condition and the impacts to the flushing capacity due to the proposed development is unlikely.

7.2.3.7 Adjacent Coastline and Sediment Transport

Littoral sediments transported towards Kuantan Port from the north are either trapped north of the breakwater or transported along the breakwater, in which case the sediments:

- are flushed and deposited offshore (outside the coastal zone) and thus lost from the coastal sediment budget, or
- transported to the port entrance and the access channel by the combined waves and tidal currents where they will be trapped and later eliminated from the coastal system as part of maintenance dredging.

As a consequence, the bypass of sediment around Tg. Gelang is brought close to zero with only the temporary sediment reserves present in the existing seabed just south of Kuantan Port being available for the bypass. The limited bypass has manifested itself in coastal erosion south of the Kuantan Port. The stretches of moderate erosion, which has been observed in the bay immediately south of Tg. Gelang, is likely the result of the Kuantan Port developments.

Based on observations and coastal modelling, the following coastal impacts are expected:

- The proposed KMH will have no impacts on the littoral transport and coastal morphology north of Tg. Gelang and thus north of Kuantan Port.
- For the presented study, the proposed KMH development is located immediately south of Tg. Gelang and Kuantan Port, and as the bypass around Tg. Gelang is already brought close to zero, the KMH will not aggravate the bypass and thus the sediment budget south of Tg. Gelang. Consequently, planned/projected developments south of the KMH site known at the time of this study (i.e. development around Sg. Kuantan) will not be impacted by the KMH development.
- Although the sediment budget is not altered by the KMH development, the KMH development will cause a change in the existing coastal erosion/deposition pattern observed along the

coastline south of Tg. Gelang. It is expected that the current erosion/deposition pattern is shifted southwards. The alongshore shift in the erosion/deposition patterns will correspond to the width of the completed project development.

- The proposed navigation channel which is aligned with the anchorage zone and Kuantan Port navigation channel will trap all north-going sediment transport. The trapped sediment would otherwise have been transported further north and trapped in the Kuantan Port access channel and basins. The proposed navigation channel for the KMH development will thus indirectly benefit the Kuantan Port navigation channel through reduced sedimentation and maintenance dredging volumes.

The moderate erosion/deposition patterns currently observed along the coastline south of Tg. Gelang is found to be shifted further south. The shift will correspond to the width of the project development, which can be explained by the fact that the KMH development will shelter the coastline to the south from NE monsoon waves approximately in the manner similar to that of the existing headland; only further south. It should be noted that the actual coastal erosion/deposition rates are highly dependent on the monsoonal wave climate and wind conditions. Therefore there is always some uncertainty involved in the estimation of erosion rates and its alongshore patterns. Consequently, it is proposed that shoreline monitoring is undertaken to determine the critical areas susceptible to changes in the coastline. The coastal monitoring of the coastline should be done along the critical stretch. The coastal monitoring campaign is further described in Section 8.4.2 of this EIA report.

7.2.3.8 Water Quality Change by STP Discharge

The water quality impacts caused by the reclamation and effluent discharging from the proposed STP have been quantified by carrying out simulations for baseline and post-development conditions for three (3) different monsoons.

The modelled results show that the water quality changes are localised as the STP discharge rate is relatively small. The impacts for three different monsoons are very similar.

7.3 Air Quality

7.3.1 Marine Works

During the reclamation, dredging and other marine works, the primary potential air quality impacts from the activities are the combustion gases from the machineries, equipment and working barges and marine vessels. As the marine works will be done from the sea, the potential receptors are limited and any emissions generated will be dispersed quickly by the sea breeze. Therefore, the potential impacts from marine works are expected to be insignificant and limited to the duration of marine works.

7.3.2 Land Works

The primary potential air pollutant sources from construction activities are windblown dust and dust and combustion gases from machineries and equipment. Fugitive dust may be generated from entrainment of windblown dust over exposed surfaced (fine particles including fine sand) and due to vehicular movement at the work areas. This fugitive dust may be more prominent during dry and windy days. Land construction works will commence once the reclaimed areas are stabilised, as such the potential impact from this dust generation is expected to be localised and short term, during active construction stage only.

7.3.3 Operational Stage

Air emission from the operation stage may be from the activities at the proposed shipyard and fabrication yard. Associated activities are likely to be emission of particulate during sand blasting works, gases from welding works, vapours from painting works and combustion gases from fuel burning equipment such as vehicles, generator sets and other machinery and equipment.

Sand blasting and spray-painting works are largely to be carried out at designated buildings and with specialised machines for smaller components. Potential air pollutants are generally fugitive in nature and to ensure a safer work environment, these facilities will be equipped with bag filters and scrubbers to trapped air pollutants prior to emission to the ambient air.

Meanwhile welding works may be carried out at open yards and other combustion machinery and equipment are largely mobile in nature. Active work areas at shipyard and fabrication yard are planned nearer to the seaward boundaries of the proposed site. The stronger sea breeze at these locations will also help to provide better dispersion for air pollutants generated by these operational activities.

Emissions associated with increase of land vehicles is also expected to be limited with effective dispersion of traffic with the planned three junctions from the proposed Project site and good internal road circulation network.

As such, it is anticipated that any potential impact to the ambient air quality as a result of the proposed Project activities is limited to the respective work areas and potential concern to other external receptors is insignificant.

7.4 Noise

This noise assessment will cover both the construction and operation stages. Primary sources of noise will be identified and the expected levels of noise will be sourced in order to determine the potential impact from such noise generation.

The impacts of noise are also highly dependent on the topography, land use, ground cover of the surrounding area and climatic conditions. The beat, rhythm, pitch of noise and distance from the noise source will affect the impact of the noise on the receiver differently. Foremost, the impact of noise is highly dependent on the acceptability of new type of noise and noise levels. In order to better understand the impact of noise, actual noise levels could be measured for existing facilities or predicted for newly planned projects.

7.4.1 Acceptable Noise Limits

In the consideration of new noise sources, the acceptability of these new noises is dependent on:

- The existing noise level
- Intensity of new type of noise
- Type of noise (impact, high frequency, continuous, intermittent etc.)
- Duration of exposure
- Distance between the source of noise and the recipient
- Attenuating measures

Baseline noise data was obtained to characterise and describe the existing background noise levels at the identified receptor sites. The measured noise levels over the period of monitoring events are re-tabulated as **Table 7.4.1**.

Table 7.4.1: Baseline for Noise Levels

Monitoring Locations	Measured Noise Levels, dB(A)							
	Day time				Night time			
	L_{eq}	L_{10}	L_{90}	L_{max}	L_{eq}	L_{10}	L_{90}	L_{max}
N1 (Represent LPK Apartment, about 100 m from Project boundary)	**63.9**	66.2	59.3	83.6	**55.4**	58.1	51.3	80.1
N2 (Represent Kg. Selamat, about 100 m from Project boundary)	56.8	66.5	49.8	97.2	**52.9**	55.6	48.8	74.3
N3 (Represent Project site at northwest, near proposed mixed development area)	56.7	57.4	35.4	88.3	**50.5**	52.3	43.8	82.5
Guideline Limit (L_{eq})	**60**	-	-	-	**50**	-	-	-

In addition to the above, the Department of Environment Malaysia has published a planning guideline for environmental noise limits and control which recommends acceptable noise levels at Project boundary as well as at sensitive receptor (**Table 7.4.2**). The measured noise level at N1, N2 and N3 are evaluated against the recommended guideline levels for Urban Land Use Category of Schedule 1 of the Planning Guidelines for Environmental Noise Limits and Control.

Measured night time noise levels at all monitoring locations were above the recommended guideline limit of 50 dB(A) and noise level at N1 during day time was above the requirement of 60 dB(A). As these sensitive receptors are located within the industrial zone of Kuantan Port and Bukit Pengorak and near main access roads to these industrial areas, the contributing noise sources observed during monitoring exercises were vehicles movement and human activities around these areas.

Table 7.4.2: Maximum Permissible Sound Level (LA_{eq}) by Receiving Land Use for Planning and New Development

Receiving Land Use Category	Day Time 7.00 am – 10.00 pm	Night Time 10.00 pm – 7.00 am
Noise Sensitive Areas, Low Density Residential, Institutional (School, Hospital), Worship Areas.	50 dB (A)	40 dB(A)
Suburban Residential (Medium Density) Areas, Public Spaces, Parks, Recreational Areas.	55 dB(A)	45 dB(A)
Urban Residential (High Density) Areas, Designated Mixed Development Areas (Residential – Commercial)	60 dB(A)	50 dB(A)
Commercial Business Zones	65 dB (A)	55 dB(A)
Designated Industrial Zones	70 dB(A)	60 dB(A)

Meanwhile the occupational requirement for noise exposure limits are guided by the Factories and Machinery (Noise Exposure) Regulations, 1989 as presented in **Table 7.4.3**.

Table 7.4.3: Permissible Noise Exposure Limit

Noise Level	Duration of Exposure Permitted per day	Noise Level	Duration of Exposure Permitted per day
dB(A) – slow	**(hours - minute)**	**dB(A) - slow**	**(hours - minute)**
85	16 - 0	101	1 – 44
86	13 - 56	102	1 – 31
87	12 - 8	103	1 – 19
88	10 - 34	104	1 – 9
89	9 - 11	105	1 – 0
90	8 - 0	106	0 – 52
91	6 - 58	107	0 – 46
92	3 - 4	108	0 – 40

Noise Level	**Duration of Exposure Permitted per day**	**Noise Level**	**Duration of Exposure Permitted per day**
dB(A) – slow	**(hours - minute)**	**dB(A) - slow**	**(hours - minute)**
93	5 - 17	109	0 – 34
94	4 - 36	110	0 – 30
95	4 - 0	111	0 – 26
96	3 - 29	112	0 – 23
97	3 - 2	113	0 – 20
98	2 - 50	114	0 – 17
99	2 - 15	115	0 – 15
100	2 - 0		

Source: Factories and Machinery (Noise Exposure) Regulations, 1989

7.4.2 Prediction Tools

Noise levels at a distance from source can be predicted based the approach that noise emanating from a point source will attenuate naturally as it propagates over free air. This is due to wave divergence, which results in dissipation of sound energy. The attenuation of noise can be estimated based on information about the sound power level of the source and the distance over which the sound travels. Therefore, the propagation of a noise source measured at a distance of 1m away can be shown to behave to the following formula:

$L = L_0 - 20\ log_d$ (point source)

$L = L_0 - 10 log_d$ (line source)

Where,

L = Noise Level at d metres away from the source

L_0 = Noise Level measured at 1 meter away from the source

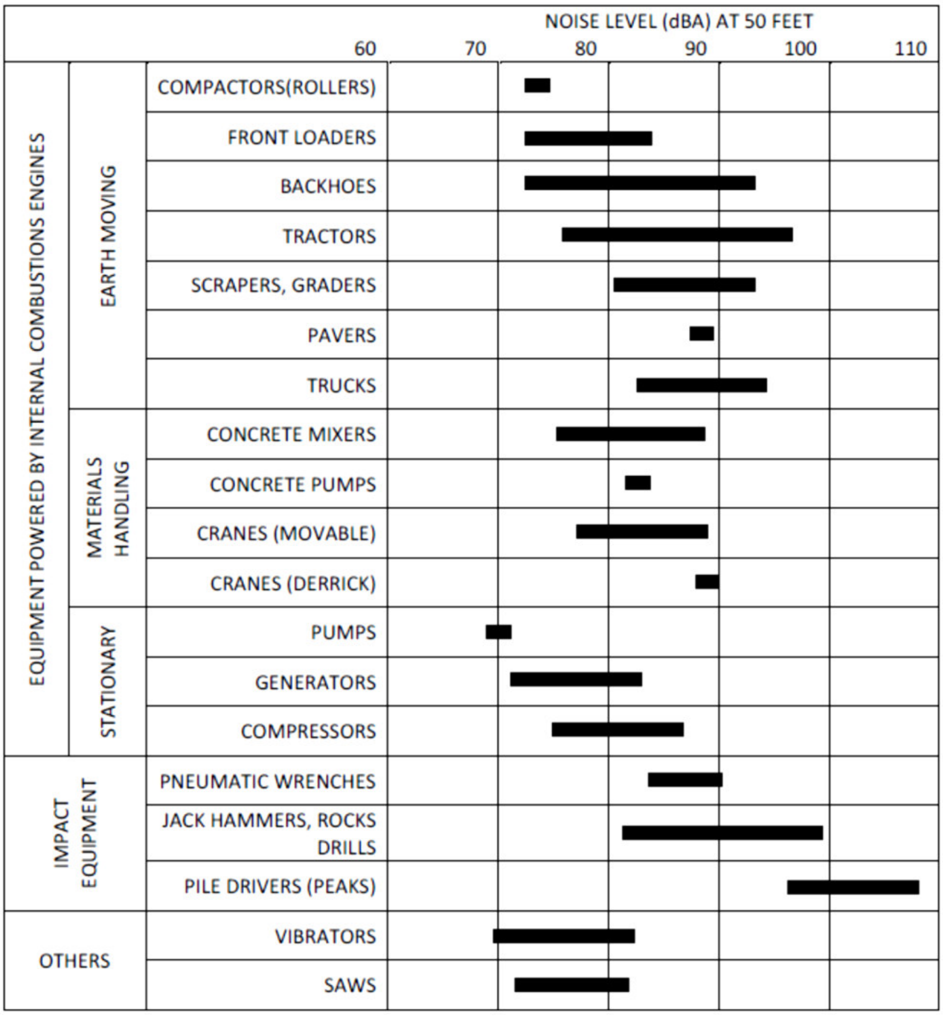
d = Distance from the point source in meters

For a point source, the noise level decreases by a 6 dB per doubling of distance but as for line source, the noise level only decreases by 3 dB per doubling of distance.

7.4.3 Construction Noise

Construction of the proposed Project will require the use of various construction equipment and machineries, and these can mainly be grouped to earth moving equipment, materials handling and stationary equipment, all of which are powered by internal combustion engines. Meanwhile some equipment creates noises from the activities associated with the use of the equipment, such as the impact equipment. Typical noise levels for the types of construction equipment that would be considered in this assessment are listed in **Table 7.4.4**. Noise level as generated by selected equipment shall be used and recalculated to the distance of 1 m (at source) (**Table 7.4.5**) for further determination of noise levels being experienced by the nearest sensitive receptor.

Table 7.4.4: Typical Construction Equipment and Noise Levels at 50 feet



Source: United States Environmental Protection Agency, 1971, "Noise from Construction Equipment and Operation, Building Equipment and Home Application", NTID 300-1.

Table 7.4.5: Typical Construction Equipment's Noise Levels Recalculated to 1 m (at source)

Types of Equipment	Noise Level dB(A) at 1m
Earth moving	84-107
Materials handling	87-100
Stationary	81-99
Impact Equipment	81-118

The instantaneous noise as generated by impact equipment, has the potential in generating the highest noise level up to 118 dB(A). The maximum noise level from each group of noise sources is used to propagate and determine the zone of noise impact as presented in **Figure 7.4.1**.

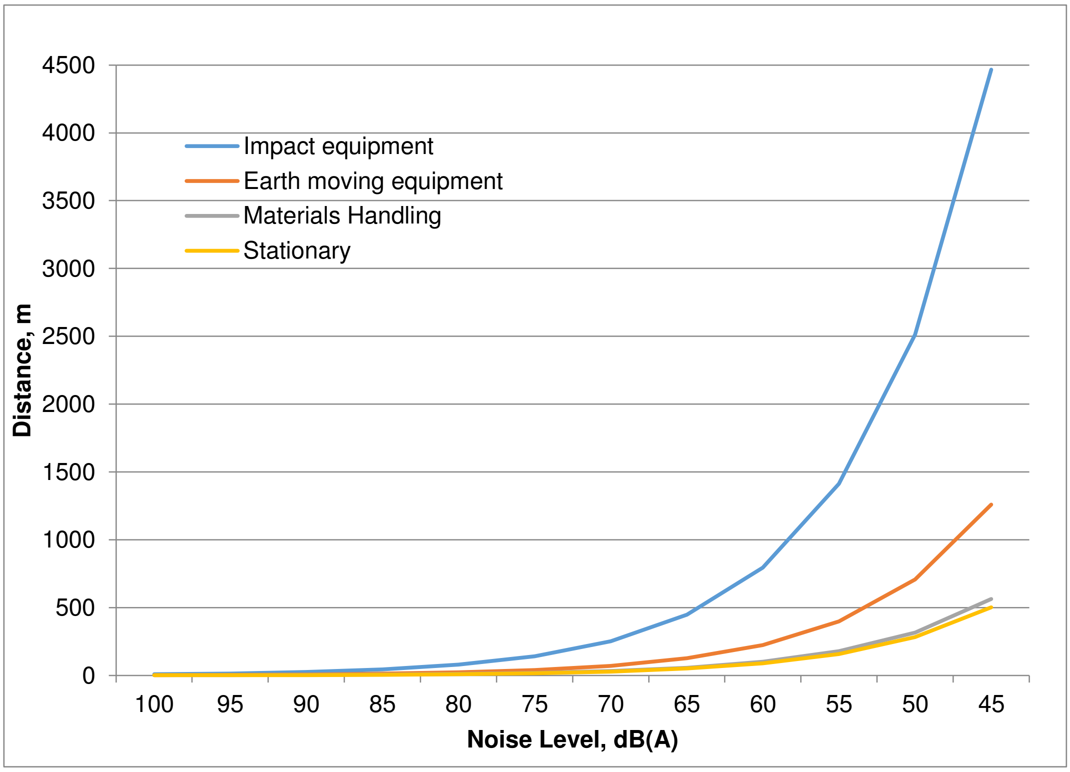


Figure 7.4.1: Zone of Noise Impact by Construction Equipment

Based on the above assessment, it was observed that noise generated through impact equipment (piling work during daytime only) will attenuate and reaches a noise level of 60 dB(A) (a day time noise requirement for urban residential) at a distance of about 800 m (worst case).

However it is also important to note that the above computation did not account for the structures and vegetation surrounding the site which may serve as natural barrier. At the same time, the piling work is expected to be short-term in nature at the beginning of the construction stage.

7.4.4 Operation Stage

During the operational stage, activities within fabrication yard and shipyard may generate and contribute to high noise levels. Typical and major sources of noise during the operational stage and the anticipated corresponding noise levels at 1m are tabulated in **Table 7.4.6**.

Table 7.4.6: Typical Noise Level for Sources of Noise during Operational Stage

Source of Noise	Noise Level at 1 m, dB(A)
Grinding work	98
Welding work	98
Drilling work	96
Gauging work	107
Blasting work	107
Paint shop	87
Compressor	87
Hull workshop	97
Piping workshop	96
Engine room	86
Mechanical/Electrical/Carpentry workshop	95

Sources:

Initial Noise Exposure Monitoring Report at Fabrication Yard for Muhibbah Steel Industries Sdn Bhd, June 2014

Initial Noise Exposure Monitoring Report at Shipyard for Muhibbah Marine Engineering Sdn Bhd, May 2013

It is noted that the some of the proposed activities may operate on shifts over 24 hours a day. Thus the noise emitted during day time and night time operations are deemed to be the same. This assessment also considers secondary buffer where the noisy activities are planned about 150 m from the Project's land boundary (refer **Figure 5.2.1**) and the overall effective buffer is at least 250 m from the nearest external receptors (N1 and N2).

Considering the sources of noise listed in **Table 7.4.6**, the highest noise levels are deemed to be from the blasting / gauging works and this noise level was selected for this noise assessment to represent the worst case scenario for a point source. In addition, no effective noise barrier (e.g. building structure) is considered and the zone of noise impact based on natural air attenuation for this selected activity is presented in **Figure 7.4.2**.

Based on **Figure 7.4.2**, it was observed that noise generated through blasting / gauging activity will attenuate and reaches a noise level of 60 dB(A) (a day time requirement for urban land use) at a distance of 224 m from the source and noise level of 50 dB(A), a night time requirement for urban land use, at 708m. Meanwhile noise level at 70 dB(A), a boundary noise requirement for industrial setup, is predicted at about 71m from noise source.

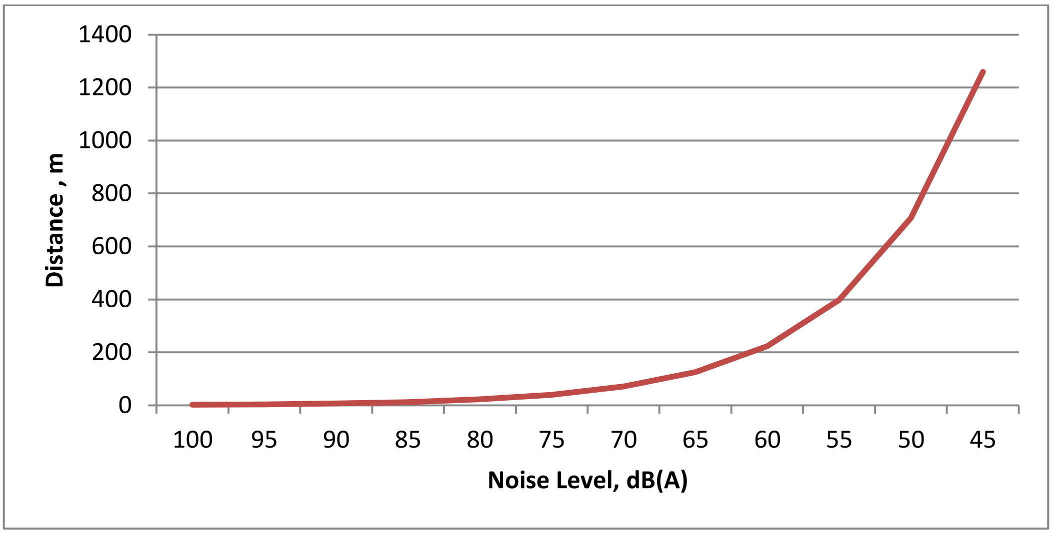


Figure 7.4.2: Zone of Noise Impact by Operation Activity

Based on the predicted noise levels, it is anticipated that the boundary noise levels will comply with the DOE guideline requirement of 70 dB(A) during day time but will not comply with the boundary limit of 60 dB(A) during night time without any mitigation measures. Similarly the predicted noise levels at nearest receptor area (about 250 m away from source of noise) will comply with day time requirement of 60 dB(A) but without mitigation measures, the predicted noise level will not comply with land use requirement of 50 dB(A) at night. The actual noise levels at these receptor areas are expected to be much lower, if noise attenuation from barrier effect of building structures within the Project site as well as from the surrounding terrain (e.g. Tanjung Gelang forest hill) are considered.

In conclusion, no noise impact is anticipated during day time operation and it is recommended no noisy activities during night time. Meanwhile the recommended boundary noise limits for shipyard and fabrication yard are as follows.

Table 7.4.7: Recommended Noise Limits at Proposed Shipyard and Fabrication Yard

Period	Recommended Boundary Noise Limits, dB(A)
Day Time	70
Night Time	60

At the same time, noise exposure to workers manning the machinery and workers in the general vicinity may be significantly higher. Without protection, workers subjected to high noise level are at risk of hearing impairments. The risk of noise-induced permanent hearing loss becomes greater if either noise levels and/or duration of exposure increases. **Table 7.4.3** indicates the permissible noise exposure limit with the corresponding duration.

7.5 Waste Management

Waste generated during development and operation stages of the Project will potential deteriorates the condition of the surrounding environment if they are not properly managed. Waste generators are responsible to establish effective waste management programme prior to waste generation.

7.5.1 Sources of Wastes

It is understood that waste generated by ship maintenance works at the shipyard shall be managed by the ship owner or contractors hired by the ship owner. The proposed shipyard will not provide waste collection and disposal services to incoming vessels for repair and maintenance works as well as other support vessels owned by the Project Proponent. Disposal of wastes generated on marine vessels will be managed at designated port facility authorised to receive such wastes.

Anyhow, the proposed Project is expected to generate some wastes during both the construction and operation stages. The anticipated type of waste, sources of waste and proposed management approach is presented in **Table 7.5.1**.

Table 7.5.1: Anticipated Type of Wastes from the Project Activities

Stage	Type of Waste	Category	Possible Sources	Waste Management
Construction	Scheduled Waste	Ballast water-oil mixture (SW309)	Working barge, dredger	To be managed by the ship owner according to MARPOL requirement
		Diesel and Oil spills (SW307)	Working barge, dredger	Dispose to licensed facility, e.g. Kualiti Alam
		Equipment with mineral oil (SW409)	Working barge, dredger, workers	Recycle / Recover by licensed contractor
		Rags or filters contaminated with scheduled waste (SW410)	Workshops/stockpile on site	Dispose to licensed facility, e.g. Kualiti Alam
	Solid Waste	Metal Scrap	Fabrication works	Recycle or reuse
		Domestic	Offices, work areas, workers' facilities	Disposal at approved landfill
Operation	Scheduled Waste	Spent garnet sand (SW104)	Blasting works	Recycle / Recover by licensed contractor
		Spent lubricating oil (SW305)	Barges, docks, workshops	Recycle / Recover by licensed contractor
		Spent hydraulic oil (SW306)	Barges, docks, workshops	Recycle / Recover by licensed contractor
		Diesel and oil spills/ Spent coolant (SW307)	Barges, docks, workshops	Dispose to licensed facility, e.g. Kualiti Alam
		Ballast water-oil mixture (SW309)	Barges, docks	To be managed by the ship owner according to MARPOL requirement

Stage	Type of Waste	Category	Possible Sources	Waste Management
		Clinical Waste (SW404)	Office	Dispose to licensed facility
		Empty paint container (SW409)	Docks, workshops	Recycle / Recover by licensed contractor
		Rags and gloves contaminated with scheduled waste (SW410)	Workshops	Dispose to licensed facility, e.g. Kualiti Alam
		Waste of inks and paints (SW417)	Painting room, workshops	Dispose to licensed facility, e.g. Kualiti Alam
	Solid Waste	Metal Scrap	Fabrication works	Recycle or reuse
		Domestic	Offices, work areas, workers' facilities	Disposal at approved landfill

Sources: Muhibbah Steel Industries Sdn Bhd and Muhibbah Marine Engineering Sdn Bhd

As the generation of wastes are subjected to the type of projects / contracted activities, an estimation of wastes generation is not possible. Review of historical data from other existing shipyard and fabrication yards indicated that the amount of wastes generated will be manageable with the existing recycle / recover and disposal facilities currently available in the market. The proposed Project will not create any significant concern to the capability of these existing recycle / recover and disposal facilities, and thus misappropriate handling of such wastes is not anticipated.