Chapter 7

Evaluation of Impacts

7.1 Introduction

Some environmental impacts are anticipated to arise from the implementation of the proposed Project. Pre-construction activities are expected to present insignificant impacts and the following sections will discuss key environmental impacts anticipated from the development and operational stages of the proposed Project. Abandonment of the Project will also be discussed.

The assessment of environmental impacts in the context of this proposed Project will be considered in light of the following aspects:

- Nature and source of the impact;
- The sensitivity of the impact on various specific environmental components and its anticipated magnitude, duration, frequency, risk and importance; and
- The applicability of mitigation measures.

Pollution prevention and mitigating measures for potential impacts with significant concern are recommended and discussed in the following Chapter 8 of this EIA report.

7.2 Marine Water Quality

Impacts on marine water quality are generally caused by the disturbance of soil and/or discharging of higher levels of physical, chemical or biological pollutants than that can be accommodated by the water body. Detrimental effect to the marine water quality can be because of sediment transport during reclamation, soil disturbance during dredging, lack of awareness, inappropriate site management, and the absence of adequate control measures, all of which can be prevented. Changes in water quality will not only impact the sensitive aquatic ecosystem, but also has the potential to have secondary impacts such as health due to contact with polluted water and loss of livelihood.

7.2.1 Identification of Sources of Impacts

7.2.1.1 Reclamation and Dredging Stage

One of the major sources of impact to marine water quality during reclamation and dredging stage is potential sediment plume**.** During reclamation of the Project site, the major activity that has risk of causing sediment plume is sand filling. Other activities such as construction of sand bund and armour rocks will not generate significant level of sediment plume. Moreover, the movement of vessels and barges will potentially cause a trail of plumes if come into contact of the plumes. However, the trail of plumes will not spread over a large area and the impact will not be significant.

As for dredging activity, Trailing Suction Hopper Dredger (TSHD) will be used for deep sea dredging and Grab Dredger will be used at shallow area. Spillage of the dredge material during dredging at the sand source or transporting from the source will potentially cause significant plumes to form.

In addition to sediment plume, barges and vessels deployed for work is another potential source of marine water pollution. On the vessels there will be storage of fuel, diesel, and oil for operation and maintenance purposes. Spillage of the mentioned substances will bring significant impacts to the surrounding water body, even if it is accidental spill. Ballast water generated from the barges are also a potential source of pollution to marine water as the ballast water potentially contain significant levels of pollutants, such as oil. Furthermore, the domestic waste generated by the kitchen and toilet of the barges such as greywater and solid waste are detrimental to the marine water quality if they are directly discharged into the sea in large quantity.

Furthermore, the biodiversity of the surrounding is a good indication of the water quality. Impacts onto the marine ecology will be helpful determining the quality of the surrounding marine water. The biodiversity of phytoplankton and zooplankton would be impacted from reclamation and dredging activities due to the increase of water turbidity and sedimentation at the sea bottom. The ecological effects of dredging could result in the changes of water clarity, reduce the light penetration of water column and reduce the photosynthetic zone which caused decrease of the number and biomass of phytoplankton. Phytoplankton is a food source of zooplankton and fish larval. The decrease of phytoplankton could lead to high mortality in zooplankton and fish larval due to the limitation of food resource.

The release of substantial amount of nutrient elements such as nitrogen and phosphorus from sediments during dredging which control the growth rate of phytoplankton poses a risk of triggering alga bloom. Apart from this, the ballast water discharge may release exotic species which can have result in red tide bloom and introduction of non-indigenous species to the water column which may out-compete native species.

Reclamation and dredging activities involved the direct removal of macro benthos and results in physically smothering the coastal and marine habitat. The physical and chemical alteration such as degradation of water quality may reduce biodiversity, richness, abundance and biomass of macro benthos. The changes of sediment characteristic including grain size and mineral composition could lead to a reduction in benthic communities as the macro benthos may not able to adapt it.

The reclamation and dredging activities will be conducted along the coastal from Gebeng Industrial Estate to the southeast of Kampung Selamat has a high risk of sediment plume. This potentially affect the fish fauna to have gills clogging by releasing of large amount of suspended solid from the construction site. Fish mortality is normally related to anoxia associated with gill impairment, impaired osmoregulation, reduced metabolic capacity and reduced capability in clearing of sediment from gills.

The artificial reef, Tukun Darat and Tukun Pisang (**Figure 6.2.1**) which is about 1 km from the proposed navigation channel would has a potential risk of being affected and decrease the fish breeding rate and fish stock in Kuantan.

7.2.1.2 Land work Construction

As explained in Chapter 5, the land work construction will be commenced after the completion of reclamation work of each phase (Phase 1a, 1b and 1c). Construction will include the shipyard and fabrication yard's components, commercial area, residential area, infrastructures and relevant utilities. Details on the land work construction of Phase 2 and 3 are not included in this EIA as the mentioned phases are planned for future development.

Temporary storm water drainage system will be included in the construction plan to control and channel the runoff water from the Project areas directly into the sea. However, as the site will be reclaimed using sand, the high water permeability of sand will allow rain water to infiltrate through the ground better than normal ground on land. Therefore storm water runoff volume is expected to be much less significant than normal construction site.

Nevertheless, there will still be some amount of surface runoff and during rainy season, more runoff will occur as the infiltration rate will not be able to cater to the volume of storm water during heavy rains. Well planned drainage system during construction shall be installed to prevent significant runoff from the site into the sea. Furthermore, untreated sewage will potentially impact the water quality of the surrounding area around the Project site.

The increase of heavy machinery and motor vehicles entering the Project site during the construction may pose a risk of potential contamination of nearby water body due to accidental spillage, leakage and discharge of oil and grease. However major spillage or leakage of oil and grease or chemicals is considered to be remote and unlikely to happen if proper housekeeping is practised and stringent handling and containment facility are implemented on site.

Moreover, with the completion of the reclamation of the site, dredging of the navigation channel and the construction of the Project components, the originally sea body will be permanently converted into reclaimed land. This will permanently change the hydrology of the site and surrounding. Expected permanent impacts from the implementation of the Project are changes in water levels, current flows, wave patterns, adjacent coastline and sediment transport, flushing capability, retention time and water levels in artificial river channel.

The primary potential impacts to the biological components are mostly due to the pollutants discharged to the sea through runoff such as sewage and domestic wastewater runoff. There is also a possibility of contaminated storm water runoff from land surface and drainage system into marine environment and affecting the biological communities. The discharge of raw or poorly treated domestic sewage could have a result in high level of bacteria *Escherichia coli*.

During construction of shipyard and fabrication yard, there is a possibility of oil and grease spillage from the heavy machinery and maintenance work on the reclaimed land. The oil and grease spills may adverse effects on marine organisms by reducing the concentration of dissolved oxygen (DO). Biodegradation of oil generates polymerized oil particles and toxic aromatic fractions using up DO in the water column which will cause further deterioration of marine ecosystem. However, the planktonic community has a low influence from oil and grease spills in terms of density, diversity and biomass as there is no sufficient evidence to show hydrocarbon is one of the stress factor.

7.2.1.3 Operational Stage

Operation of the shipyard and fabrication yard mainly involve activities that are potential sources of pollutants to unit-in-dock wash water and storm water include abrasive blasting; hydro blasting; pressure washing; sanding; painting; electrical work; mechanical work; metal work; short-term material storage (paints, lubricants, solvents, zinc anodes, etc.); heavy equipment operations; and other industrial activities

Abrasive blasting involves removing sea growth and paints from ship surfaces to prepare them for resurfacing. By-products of this process include spent abrasive, rust, scale, and paint particles. During these processes, a variety of pollutants (including copper, lead, zinc, and tributyltin) may be released into the environment and be discharged to waters through direct deposition and/or surface runoff.

Hydro blasting and pressure washing uses water to remove sea growth and surface materials from ship surfaces. This process results in the production of wash water, which may contain rust, scale, paint particles, and associated pollutants. These pollutants have the potential to contaminate surface runoff or contaminate the receiving water through direct deposition.

Coating operations involve painting ship surfaces with paints and other materials. Products typically used include anti-corrosives to prevent rust and anti-foulants to prevent sea growth. These materials contain a variety of pollutants including copper, lead, zinc, and tributyltin. Like abrasive blasting and pressure washing, these pollutants enter waters via direct deposition and/or surface runoff.

Electrical work, sanding, mechanical work, metal work, heavy equipment operations, and short-term material storage are also potential pollutant sources for petroleum products, metals, debris, and other pollutants through surface runoff and direct deposition.

Moreover, navigation channel to and from the shipyard requires periodical maintenance. Dredger will be used to maintain the desired depth of the channel. The dredging work will potentially cause potential plume to occur.

The construction, maintenance and repair activities of ships involved the generation and daily handling of a substantial amount of toxic materials, fumes and fluids such as heavy metal and particulate matter which may lead to discharge of toxic compound into water. Bilge and ballast water are additional waste streams are that contain oil, solvents and other hazardous substances. The highly use of metals in the construction of large vessels could contribute a large amount of metal contents such as steels, aluminium, zinc, copper and iron in the marine environment and may lead to heavy metal pollution. The increase of metal contents in water column will lead to adverse effects by bio-accumulating and bio-magnifying of metal contents through the food chain. Macro benthos community would be expected to have a higher bio-accumulation of metal contents due to their behaviour which frequently associated with sediments. Marine organisms have a wide tolerance range to certain metals, however, the metals will be bio-accumulated in human body through consumption and affecting the health as fish is one of the important protein source.

Anti-fouling paint consists of organotin compounds such as tributyltin (TBT) poses an adverse effect to the marine organism by poisoning the bottom organisms of the food chain such as alga and barnacles. TBT will cause imposex in gastropod where female convert to male by growing male reproduction system, thus in turn lead to declaration of population and disruption of ecosystem. The toxic compound could also reach to human through bio-accumulation and bio-magnification.

There is also a high risk of oil and grease spillage during the operational stage that will severely deteriorate the marine water quality if fail to control.

7.2.2 Quantification of Impacts

7.2.2.1 Hydraulic Study – Temporary Effect

Sediment plume simulations have been carried out for each transitional stage of every phase. The reclamation works will be carried out using sand carriers, whereas the dredging works will be carried out by two different methods, by grab dredgers and by trailer suction hopper dredging (TSHD). The grab dredgers will be used to dredge the seabed to about -5 m CD and TSHDs will be used to dredge from -5 m CD to the design depths. It is assumed that all dredgers are working simultaneously as a conservative approach. The basis of the simulation is illustrated in the full hydraulic report in **Appendix 7.1**. Following is the findings of the hydraulic report on potential impact of sediment plume during reclamation and dredging phases.

Sediment Plume Assessment

Potential impacts associated with the increase in suspended sediment concentrations due to the reclamation and dredging works during each scenario are presented in the following sections. The prediction of sediment plume from the reclamation and dredging works are important as they can give visual impacts on the field, plus could give negative impacts onto the marine ecology in some sensitive areas.

In addition to the 2D maps, seven (7) locations of sensitive receptors have been selected as “extraction point” to further detail the impacts of sediment plume. **Figure 7.2.1** and **Table 7.2.1** presents an overview of the key extraction points and the approximate coordinates for each location. It should be noted that the impacts presented are the project-related spilled sediments, and should be interpreted as excess sediment concentrations (i.e. concentrations in excess of the ambient concentrations).

The increased in suspended sediment concentration is evaluated for all three climatic conditions through a set of spatial statistical plots of mean, maximum as well as 5, 10 and 25 mg/l percentage of exceedances.

Table 7.2.1: Extraction locations and its sensitive receptors

Points	Receptors
1	Sg. Balok
2	Sg. Pengorak
3	Drain Culvert
4	Storm Water Drain Culvert
5	Kuantan Port Navigation Channel
6	Tukun Darat (artificial reefs)
7	Tukun Pisang (artificial reefs)

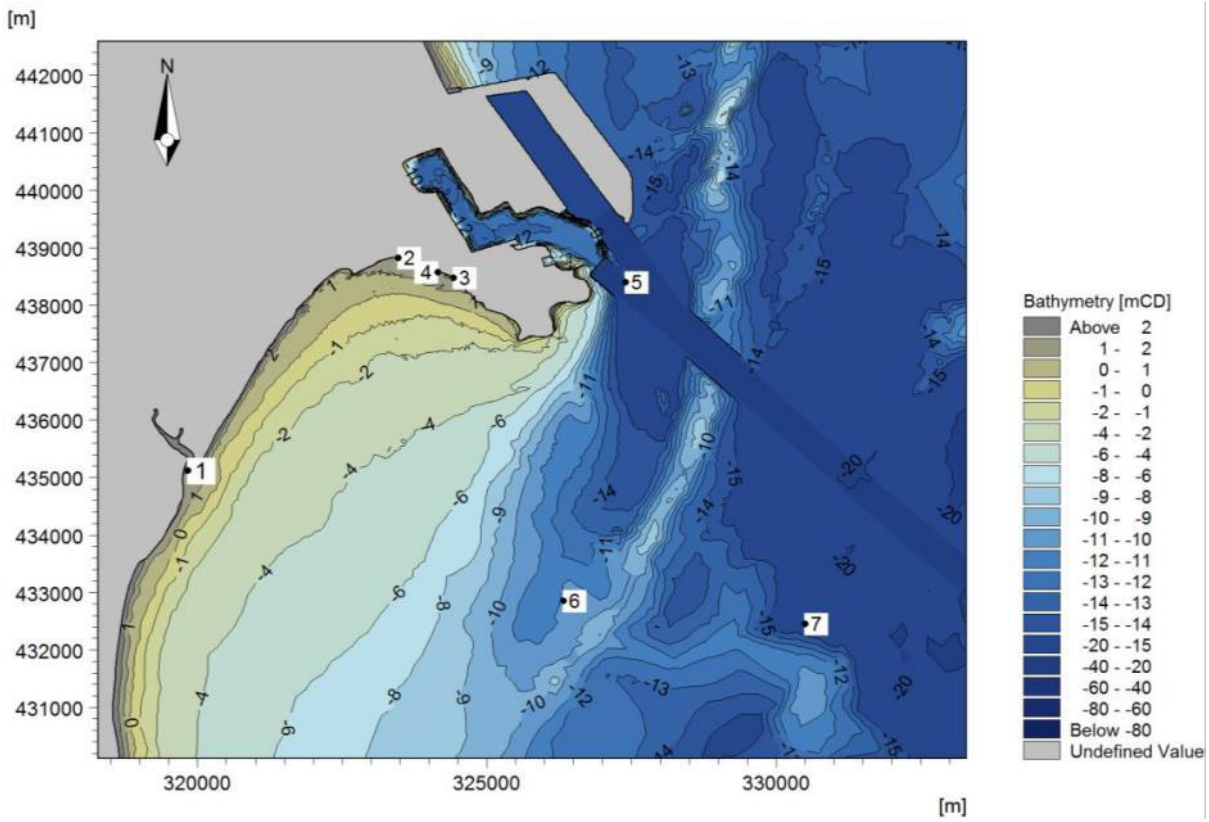


Figure 7.2.1: Extraction points representing sensitive receptors at the study area.

7.2.2.1.1 Phase 1a (Case A)

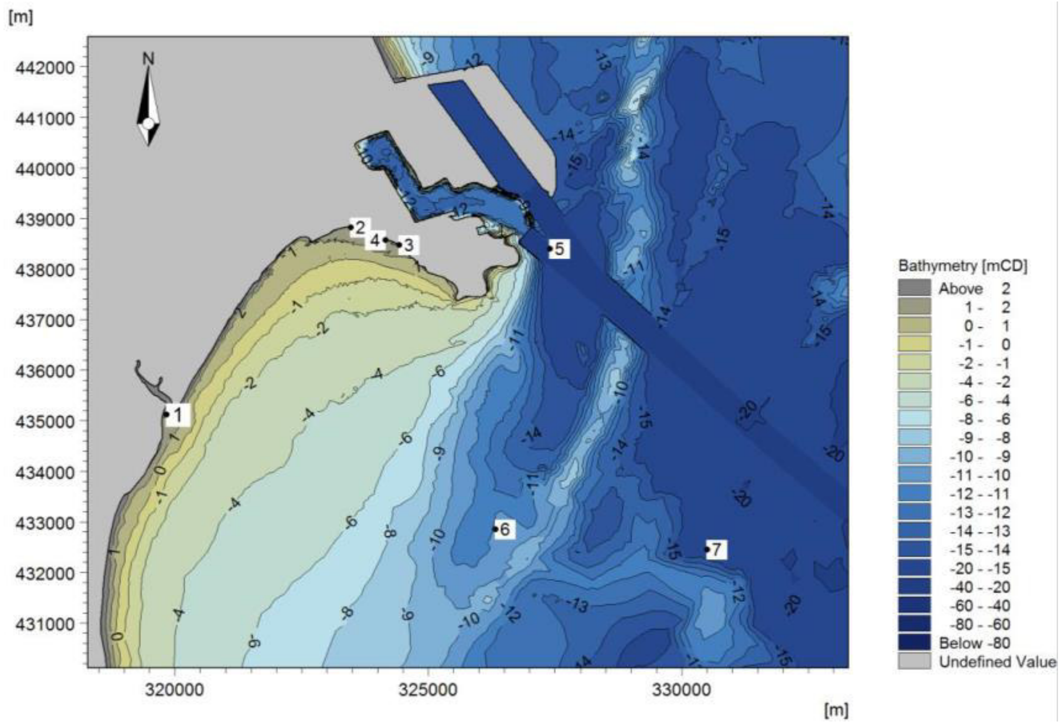
The predicted sediment plume results for Phase 1a (Case A where all the dredging works happen in the nearshore area) are presented as follows:

Figure	Descriptions
Figure 7.2.2	Phase 1a (Case A): Simulated **mean** excess TSS levels during NE (top), SW (middle) and inter (bottom) monsoons.
Figure 7.2.3	Phase 1a (Case A): Simulated **maximum** excess TSS levels
Figure 7.2.4	Phase 1a (Case A): **Exceedance of 5 mg/L** excess TSS in % of time for NE (top), SW (middle) and Inter (bottom) monsoons.
Figure 7.2.5	Phase 1a (Case A): **Exceedance of 10 mg/L** excess TSS in % of time for NE (top), SW (middle) and Inter (bottom) monsoons.
Figure 7.2.6	Phase 1a (Case A): **Exceedance of 25 mg/L** excess TSS in % of time for NE (top), SW (middle) and Inter (bottom) monsoons.
Figure 7.2.7	Phase 1a (Case A): **Exceedance of 50 mg/L** excess TSS in % of time for NE (top), SW (middle) and Inter (bottom) monsoons.
Figure 7.2.8	Phase 1a (Case A): Total bed thickness change within 28days for NE (top), SW (middle) and Inter (bottom) monsoons. Phase 1a (Case A): Exceedance of 50 mg/L excess TSS in % of time for NE (top), SW (middle) and Inter (bottom) monsoons.

The modelling results show:

- The geometry of the sediment plume aligns with the current direction (i.e. north-east and south-west). The pattern of sediment plume does not change significantly across the difference monsoon periods.
- Localised plume of 5 mg/L mean excess suspended sediment concentrations are predicted around the study area.
- The maximum excess suspended sediment concentration of 10 mg/L are predicted about 4 km north-east and 4 km south-west from the source.
- 5 mg/L excess concentration is exceeded 5% of the time at about 3.5 km north-east and 3.5 km south-west from the source.
- 10 mg/L excess concentration is exceeded 5% of the time at about 3 km north-east and 3 km south-west from the source.
- Localised 25 mg/L excess concentration is exceeded 5% of the time at about 1 km northeast and 1 km south-west from the source.
- Localised 50 mg/L excess concentration is exceeded 5% of the time at around the source.
- The excess TSS levels have been extracted at 7 defined spots and summarised in **Table 7.2.2**.
- The predicted sedimentation rate and impacted areas in Kuantan Port channel induced by construction works of proposed development Phase 1a (Case A) is shown in **Figure 7.2.8**. However, it should be highlighted that this temporary sedimentation impact will not exist after the project completion.

Table 7.2.2: Phase 1a (Case A): Summary of predicted excess TSS levels at specific spots.



Phase 1a (Case A) Points	Excess Mean TSS (mg/L)			Excess Maximum TSS (mg/L)			Exceedance of 5 mg/L in % of time		
	NE	SW	Inter	NE	SW	Inter	NE	SW	Inter
P1	<2	<2	<2	<5	<5	<5	<5	<5	<5
P2	<2	<2	<2	<5	<5	<5	<5	<5	<5
P3	<2	<2	<2	<5	<5	<5	<5	<5	<5
P4	<2	<2	<2	<5	<5	<5	<5	<5	<5
P5	2	4	3	28	33	34	8	18	13
P6	<2	<2	<2	<5	<5	<5	<5	<5	<5
P7	<2	<2	<2	<5	<5	<5	<5	<5	<5

Phase 1a (Case A) Points	Exceedance of 10 mg/L in % of time			Exceedance of 25 mg/L in % of time)			Exceedance of 50 mg/L in % of time		
	NE	SW	Inter	NE	SW	Inter	NE	SW	Inter
P1	<5	<5	<5	<5	<5	<5	<5	<5	<5
P2	<5	<5	<5	<5	<5	<5	<5	<5	<5
P3	<5	<5	<5	<5	<5	<5	<5	<5	<5
P4	<5	<5	<5	<5	<5	<5	<5	<5	<5
P5	<5	10	6	<5	<5	<5	<5	<5	<5
P6	<5	<5	<5	<5	<5	<5	<5	<5	<5
P7	<5	<5	<5	<5	<5	<5	<5	<5	<5

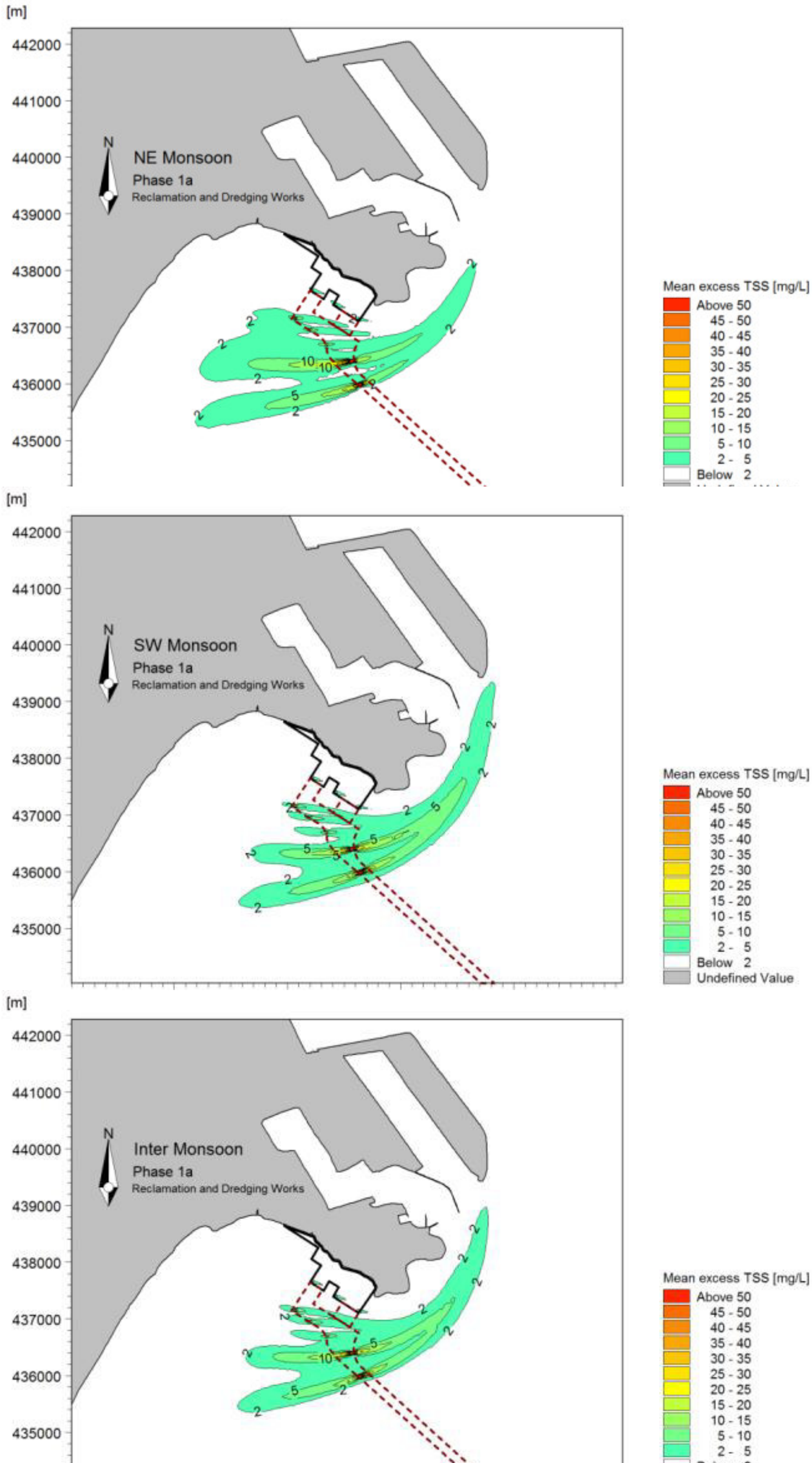


Figure 7.2.2: Phase 1a (Case A): Simulated mean excess TSS levels during NE (top), SW (middle) and inter (bottom) monsoons.

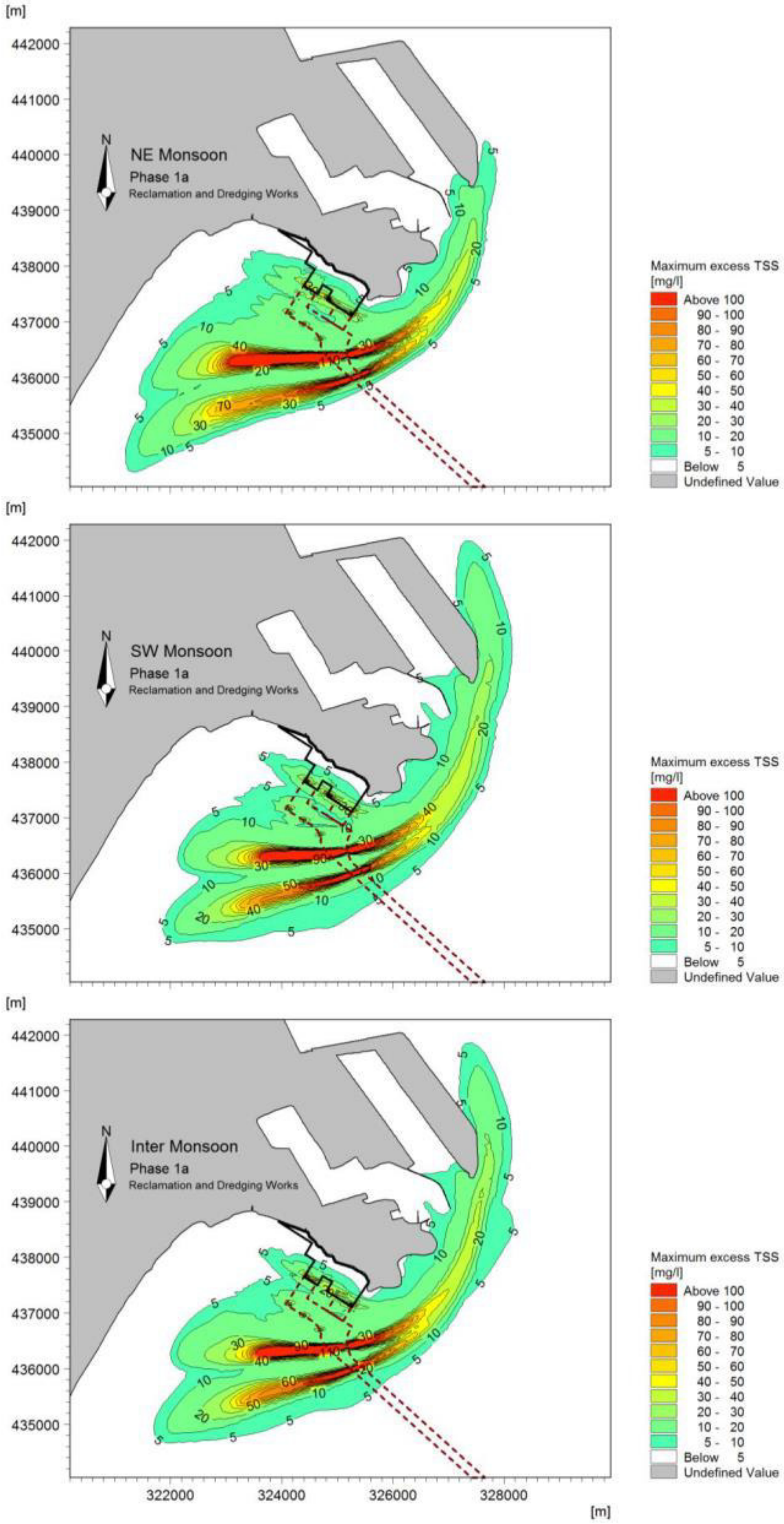


Figure 7.2.3: Phase 1a (Case A): Simulated maximum excess TSS levels during NE (top), SW (middle) and inter (bottom) monsoons.

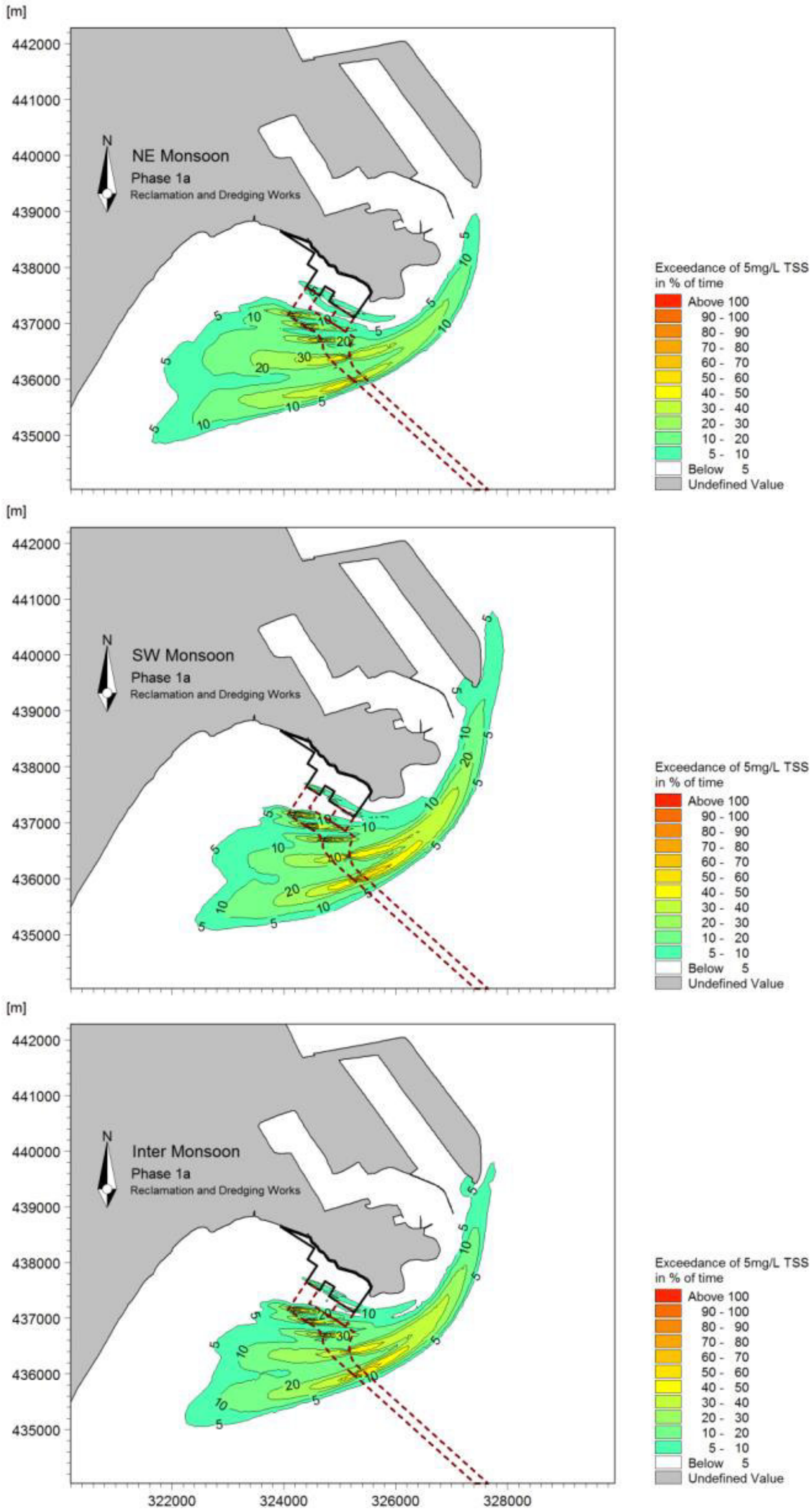


Figure 7.2.4: Phase 1a (Case A): Exceedance of 5 mg/L excess TSS in % of time for NE (top), SW (middle) and Inter (bottom) monsoons.

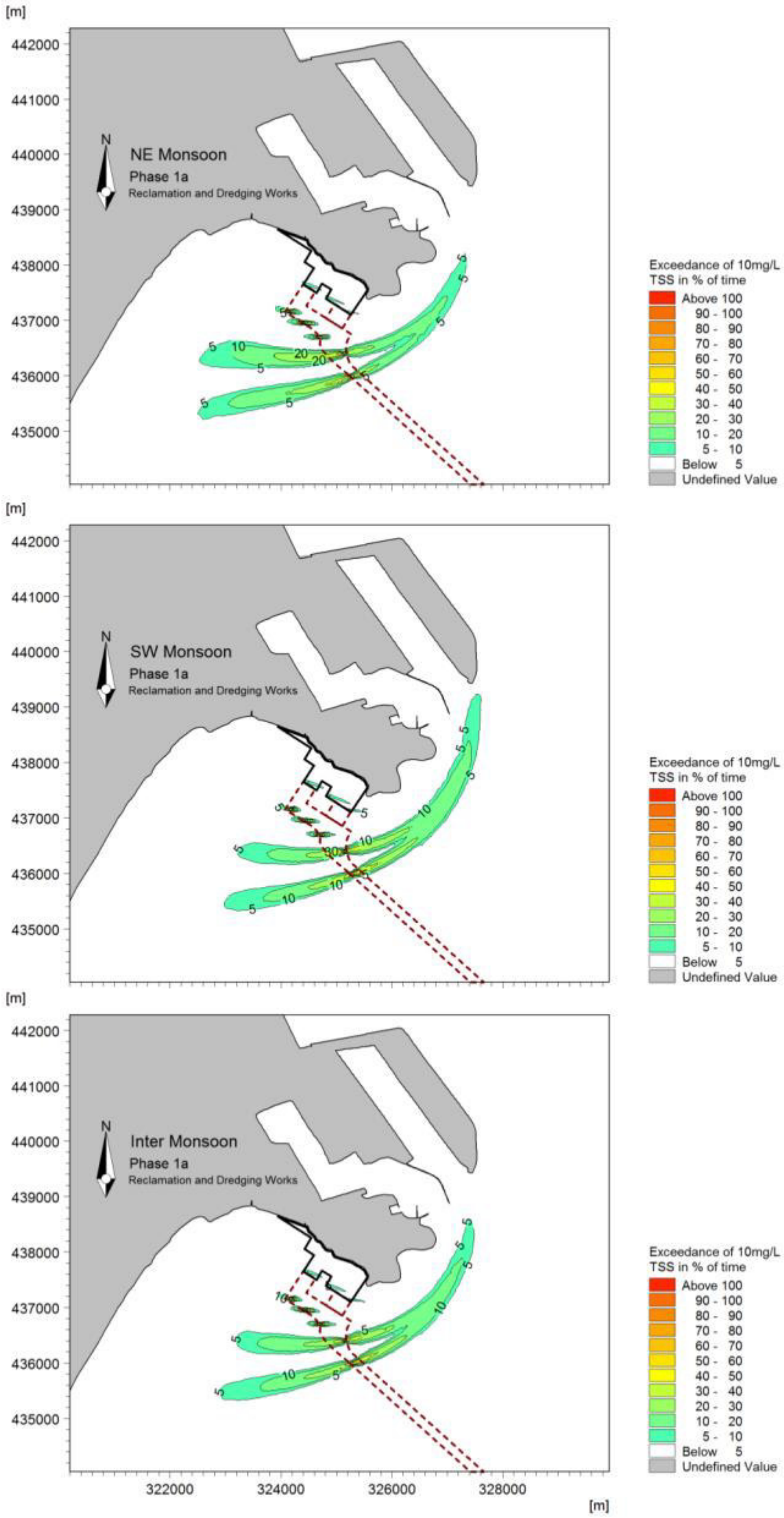


Figure 7.2.5: Phase 1a (Case A): Exceedance of 10 mg/L excess TSS in % of time for NE (top), SW (middle) and Inter (bottom) monsoons.

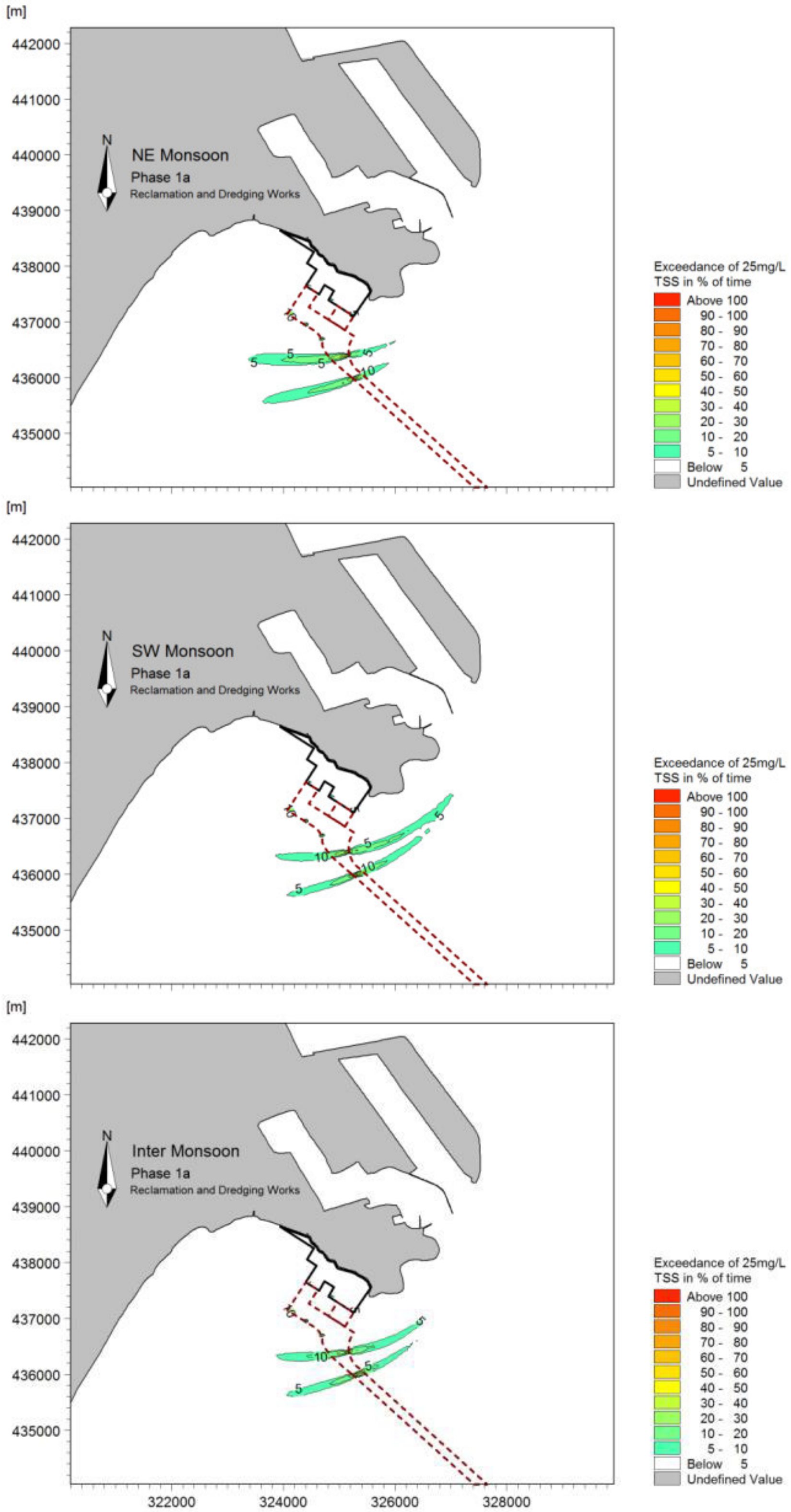


Figure 7.2.6: Phase 1a (Case A): Exceedance of 25 mg/L excess TSS in % of time for NE (top), SW (middle) and Inter (bottom) monsoons.

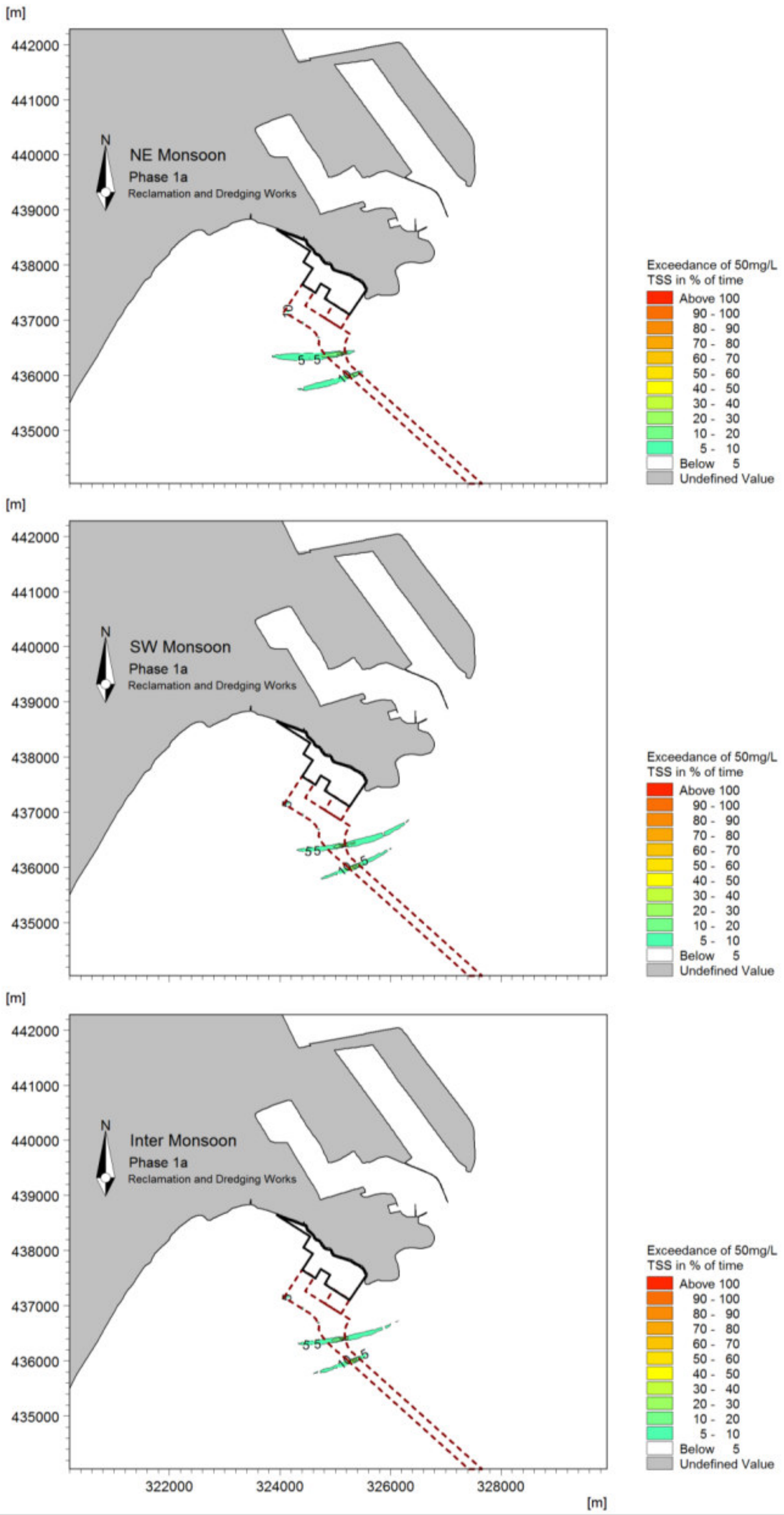


Figure 7.2.7: Phase 1a (Case A): Exceedance of 50 mg/L excess TSS in % of time for NE (top), SW (middle) and Inter (bottom) monsoons.

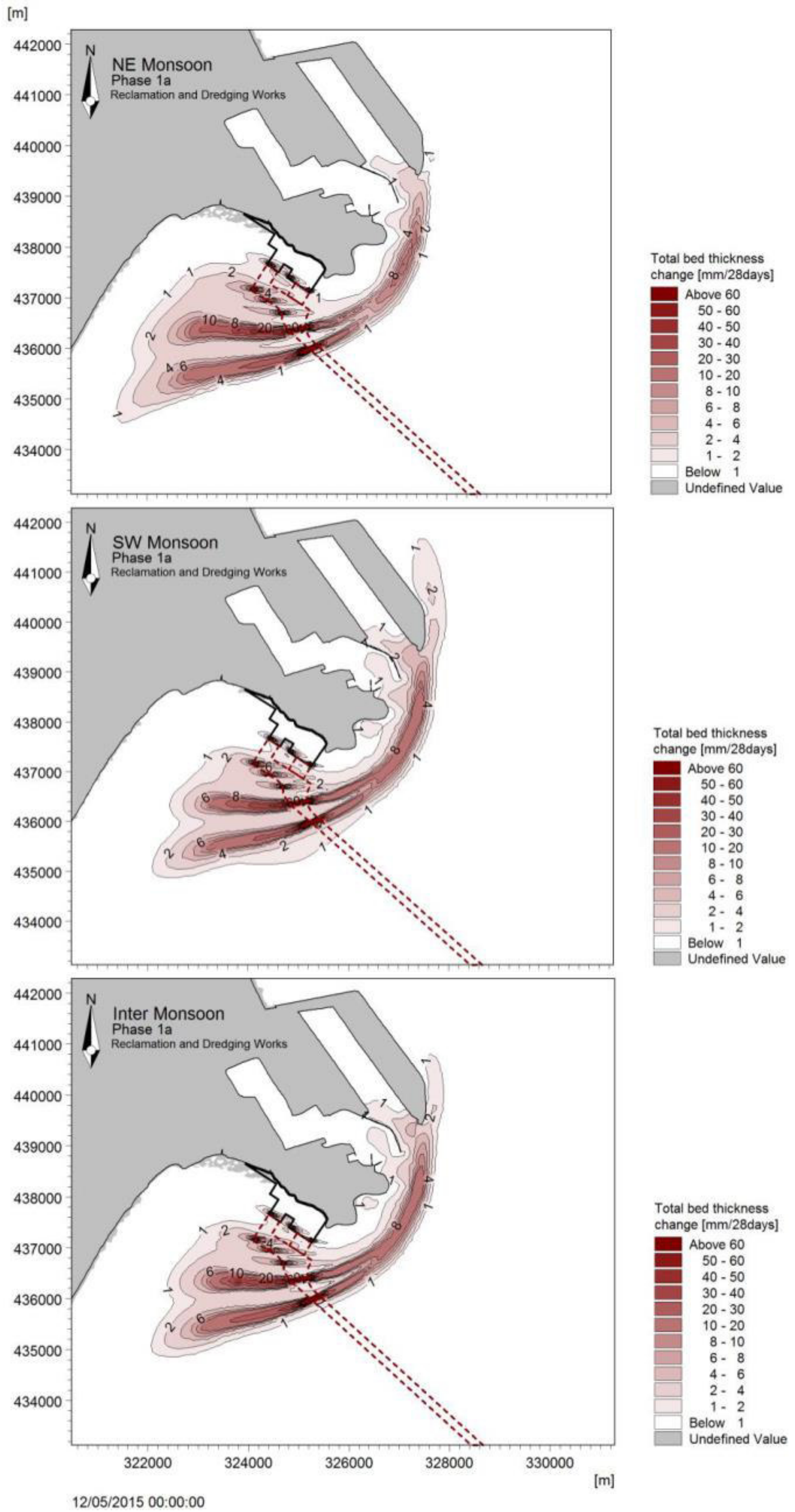


Figure 7.2.8: Phase 1a (Case A): Total bed thickness change within 28days for NE (top), SW (middle) and Inter (bottom) monsoons.

7.2.2.1.2 Phase 1a (Case B)

In addition, the predicted sediment plume results for Phase 1a (Case B where the TSHDs work along the channel which closer to the defined receptors) are presented as follows:

Figure	Descriptions
Figure 7.2.9	Phase 1a (Case B): Simulated **mean** excess TSS levels during NE (top), SW (middle) and inter (bottom) monsoons.
Figure 7.2.10	Phase 1a (Case B): Simulated **maximum** excess TSS levels
Figure 7.2.11	Phase 1a (Case B): **Exceedance of 5 mg/L** excess TSS in % of time for NE (top), SW (middle) and Inter (bottom) monsoons.
Figure 7.2.12	Phase 1a (Case B): **Exceedance of 10 mg/L** excess TSS in % of time for NE (top), SW (middle) and Inter (bottom) monsoons.
Figure 7.2.13	Phase 1a (Case B): **Exceedance of 25 mg/L** excess TSS in % of time for NE (top), SW (middle) and Inter (bottom) monsoons.
Figure 7.2.14	Phase 1a (Case B): **Exceedance of 50 mg/L** excess TSS in % of time for NE (top), SW (middle) and Inter (bottom) monsoons.
Figure 7.2.15	Phase 1a (Case B): Total bed thickness change within 28days for NE (top), SW (middle) and Inter (bottom) monsoons. Phase 1a (Case A): Exceedance of 50 mg/L excess TSS in % of time for NE (top), SW (middle) and Inter (bottom) monsoons.

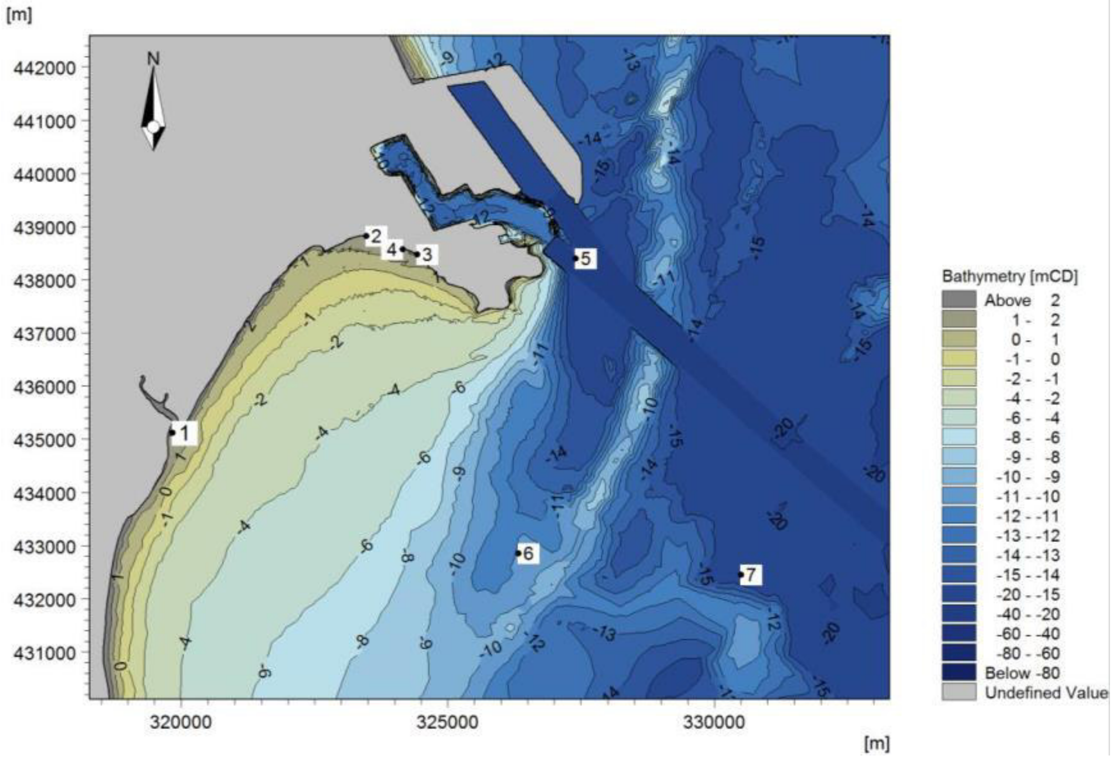
The modelling results show:

- The geometry of the sediment plume aligns with the current direction (i.e. north-east and south-west). The pattern of sediment plume does not change significantly across the difference monsoon periods.
- Smaller sediment plume impacts are predicted at the nearshore area (proposed basin area) as the TSHDs work along the offshore access channel. Localised plume of 5 mg/L mean excess suspended sediment concentrations are predicted around the proposed basin area and the channel closer to the sensitive receptors.
- Localised 5 mg/L, 10 mg/L, 25 mg/L and 50 mg/L excess TSS concentration is exceeded 5% of the time in the vicinity of the proposed nearshore study area.

The excess TSS levels have been extracted at 7 defined spots and summarised in **Table 7.2.3**.

- It should be noted that the dredging volume along the proposed offshore channel is relatively small, estimated 412,610 m^3 and it is estimated that the dredging works will be completed in approximately 13 days with the 2 units of TSHD with capacity of 3,500 m^3 and 4.6 trips per day. Therefore, the 28-day dredging works has been modelled as conservative approach.
- The predicted sedimentation rate and impacted areas in Kuantan Port channel induced by construction works of proposed development Phase 1a (Case B) is shown in **Figure 7.2.15**. However, it should be highlighted that this temporary sedimentation impact will not exist after the project completion.

Table 7.2.3: Phase 1a (Case B): Summary of predicted excess TSS levels at specific spots.



Phase 1a (Case B) Points	Excess Mean TSS (mg/L)			Excess Maximum TSS (mg/L)			Exceedance of 5 mg/L in % of time		
	NE	**SW**	**Inter**	**NE**	**SW**	**Inter**	**NE**	**SW**	**Inter**
P1	<2	<2	<2	<5	<5	<5	<5	<5	<5
P2	<2	<2	<2	<5	<5	<5	<5	<5	<5
P3	<2	<2	<2	<5	<5	<5	<5	<5	<5
P4	<2	<2	<2	<5	<5	<5	<5	<5	<5
P5	<2	<2	<2	3	<5	<5	<5	<5	<5
P6	<2	<2	<2	10	7	9	7	<5	5
P7	3	3	3	19	17	20	22	19	23

Phase 1a (Case B) Points	**Exceedance of 10 mg/L in % of time**			**Exceedance of 25 mg/L in % of time)**			**Exceedance of 50 mg/L in % of time**		
	NE	**SW**	**Inter**	**NE**	**SW**	**Inter**	**NE**	**SW**	**Inter**
P1	<5	<5	<5	<5	<5	<5	<5	<5	<5
P2	<5	<5	<5	<5	<5	<5	<5	<5	<5
P3	<5	<5	<5	<5	<5	<5	<5	<5	<5
P4	<5	<5	<5	<5	<5	<5	<5	<5	<5
P5	<5	<5	<5	<5	<5	<5	<5	<5	<5
P6	<5	<5	<5	<5	<5	<5	<5	<5	<5
P7	9	8	10	<5	<5	<5	<5	<5	<5

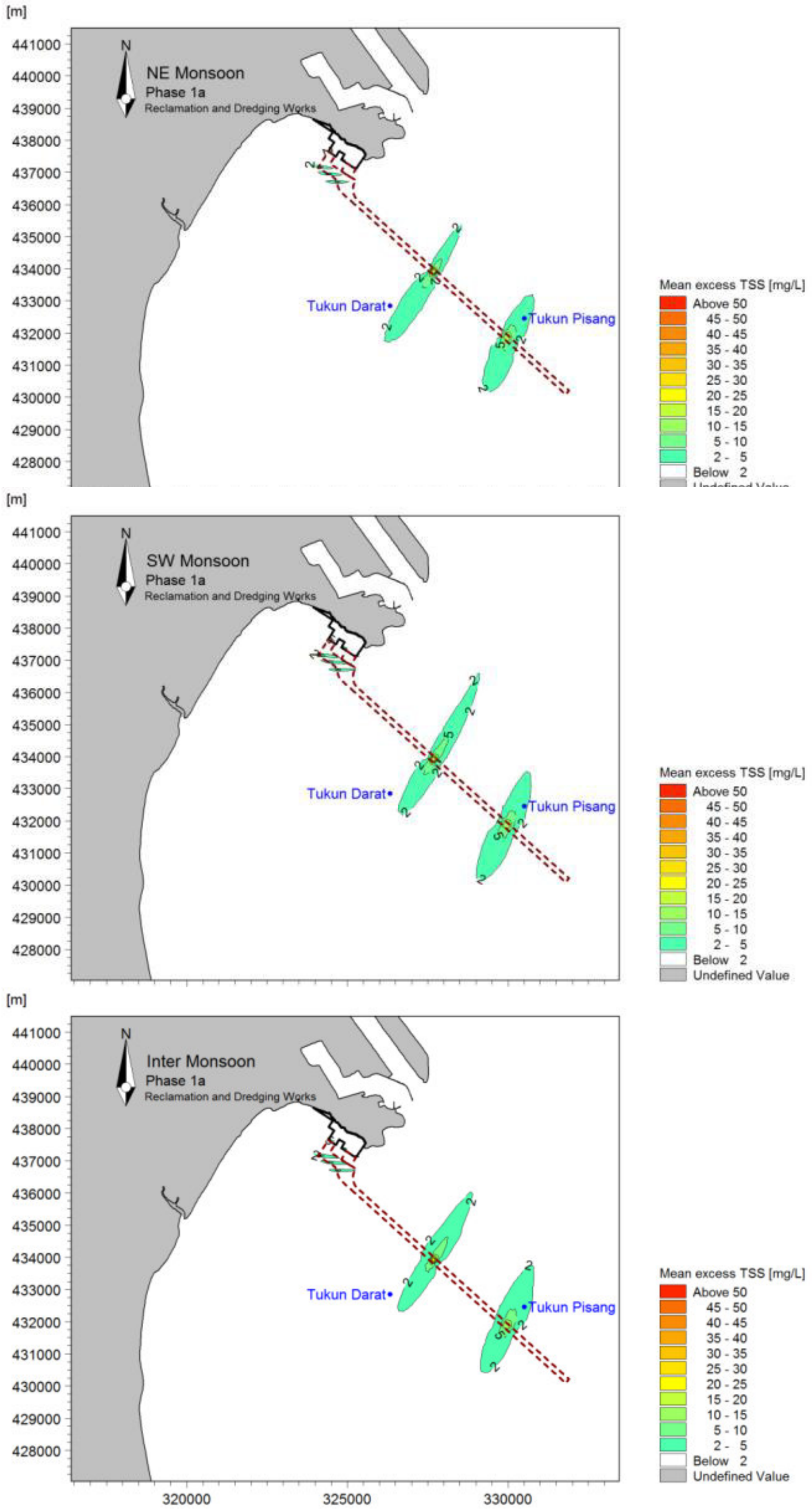


Figure 7.2.9: Phase 1a (Case B): Simulated mean excess TSS levels during NE (top), SW (middle) and inter (bottom) monsoons.

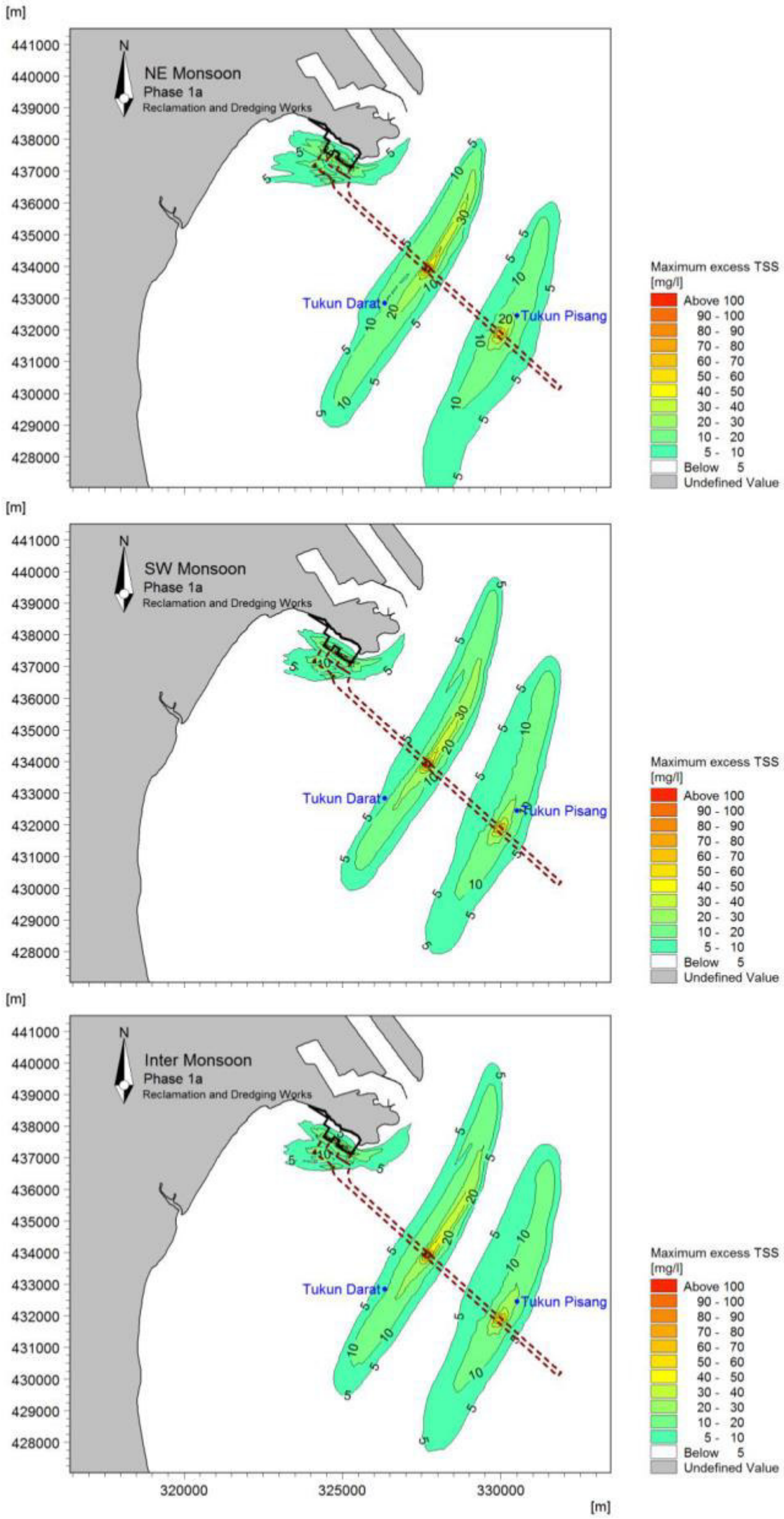


Figure 7.2.10: Phase 1a (Case B): Simulated maximum excess TSS levels during NE (top), SW (middle) and inter (bottom) monsoons.

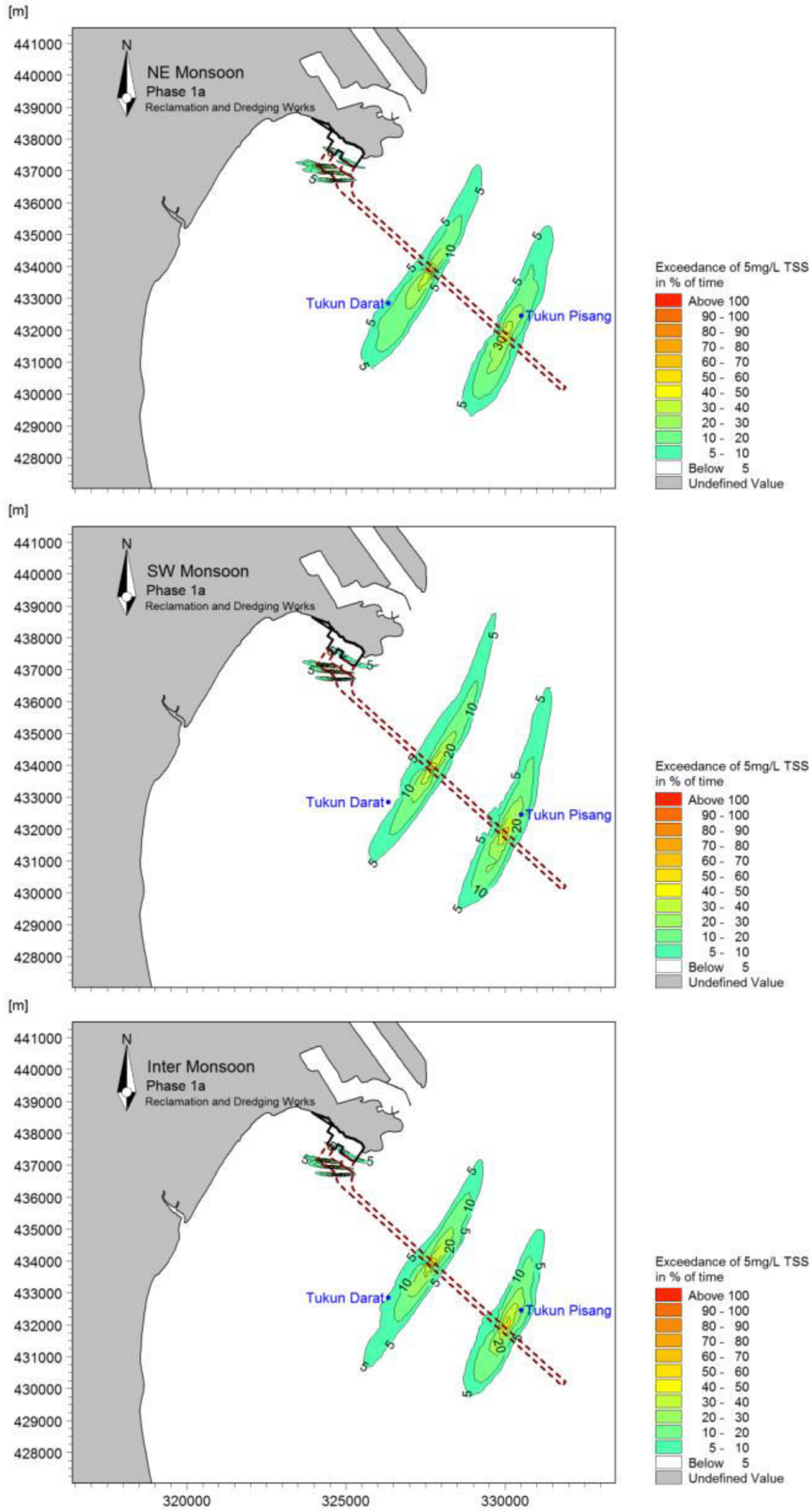


Figure 7.2.11: Phase 1a (Case B): Exceedance of 5 mg/L excess TSS in % of time for NE (top), SW (middle) and Inter (bottom) monsoons.

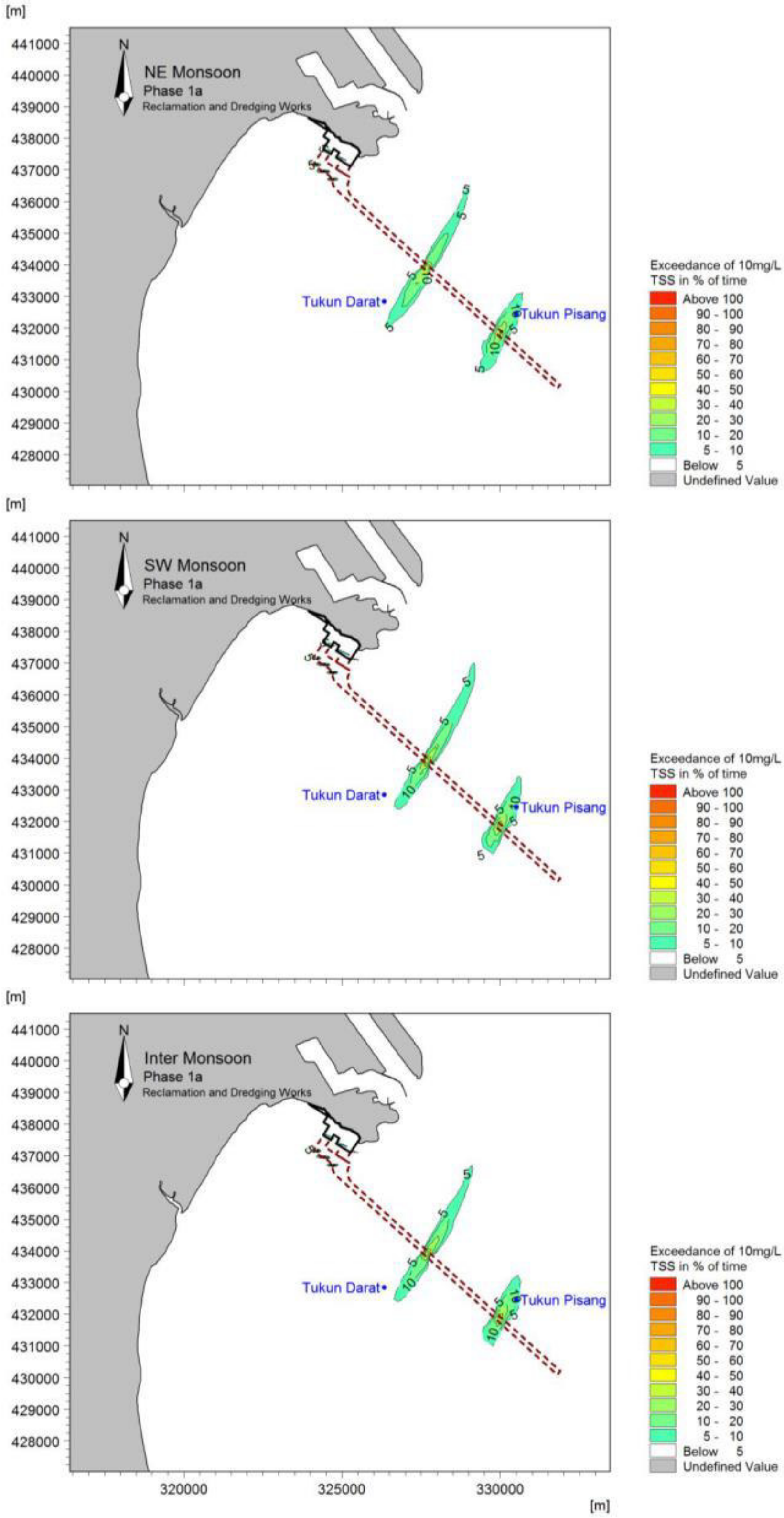


Figure 7.2.12: Phase 1a (Case B): Exceedance of 10 mg/L excess TSS in % of time for NE (top), SW (middle) and Inter (bottom) monsoons.

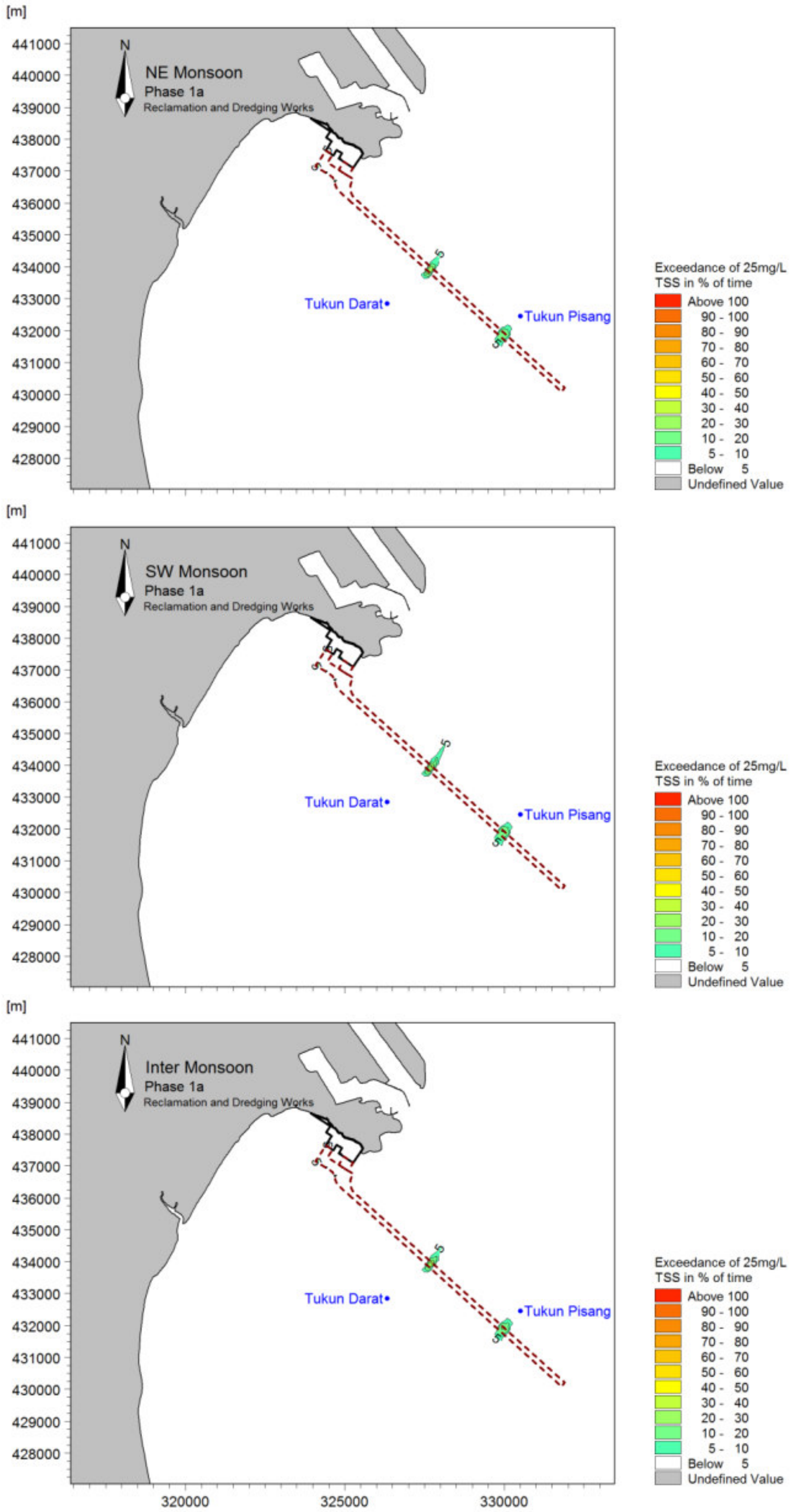


Figure 7.2.13: Phase 1a (Case B): Exceedance of 25 mg/L excess TSS in % of time for NE (top), SW (middle) and Inter (bottom) monsoons.

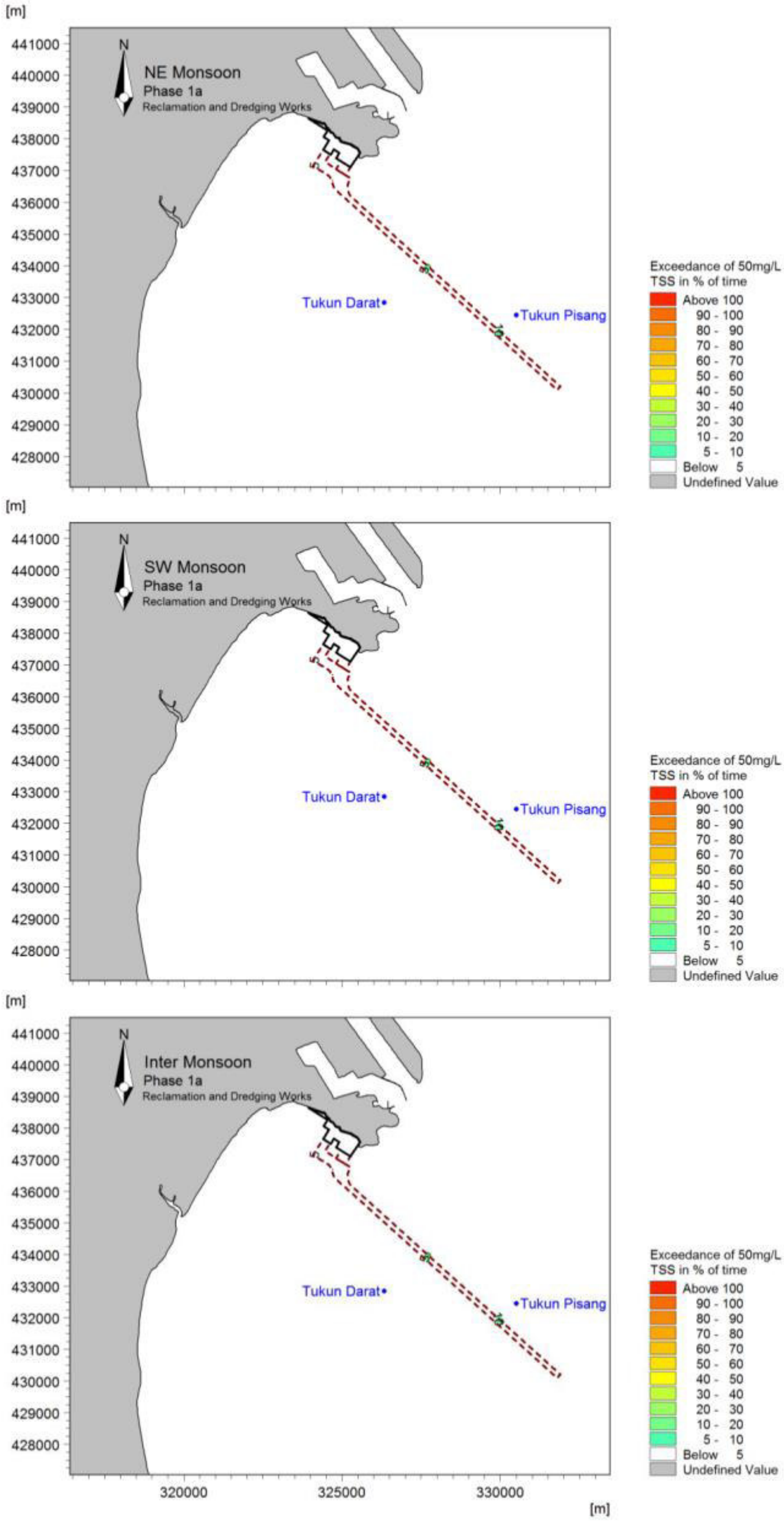


Figure 7.2.14: Phase 1a (Case B): Exceedance of 50 mg/L excess TSS in % of time for NE (top), SW (middle) and Inter (bottom) monsoons.

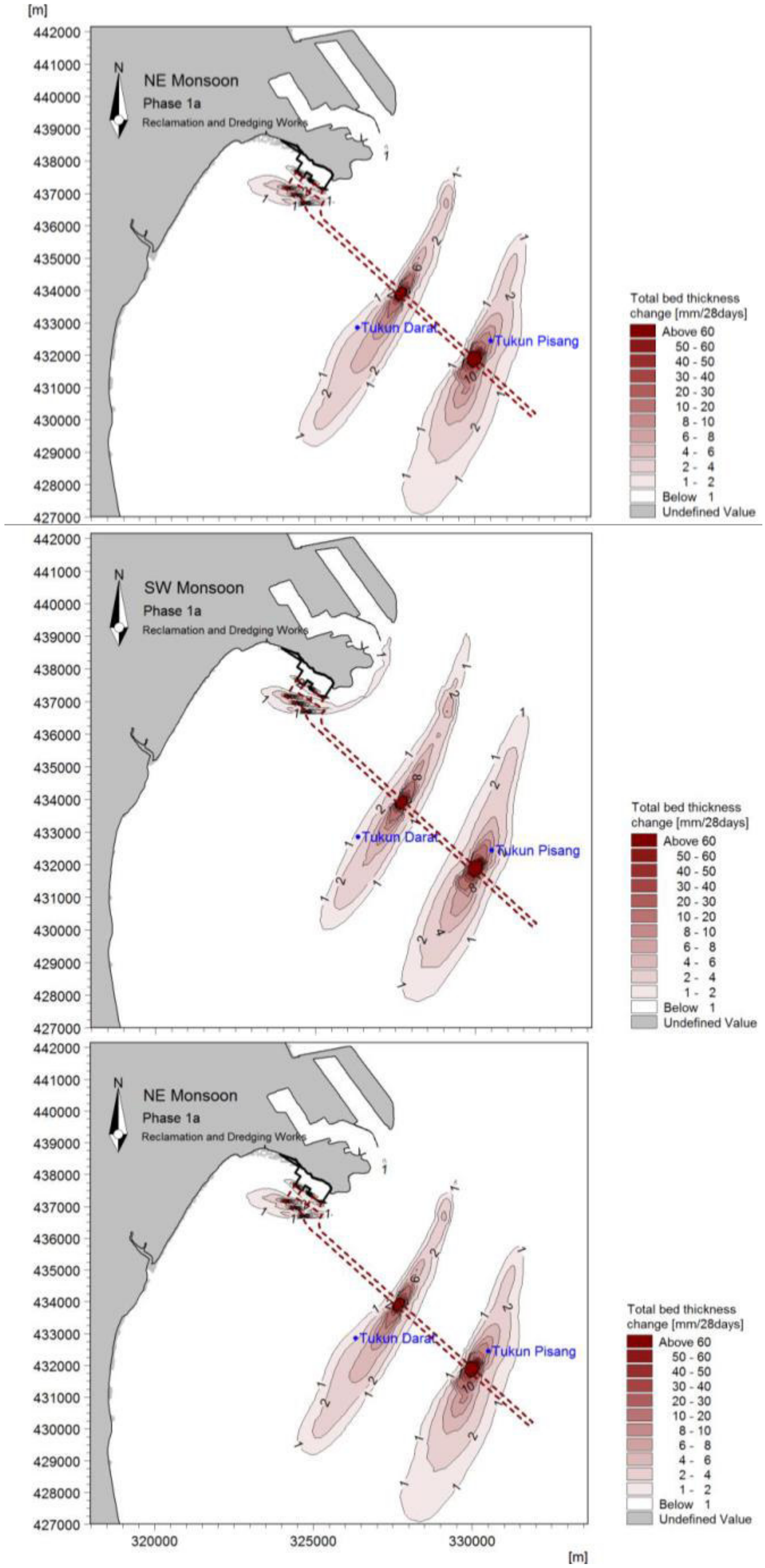


Figure 7.2.15: Phase 1a (Case B): Total bed thickness change within 28days for NE (top), SW (middle) and Inter (bottom) monsoons.

7.2.2.1.3 Phase 1b

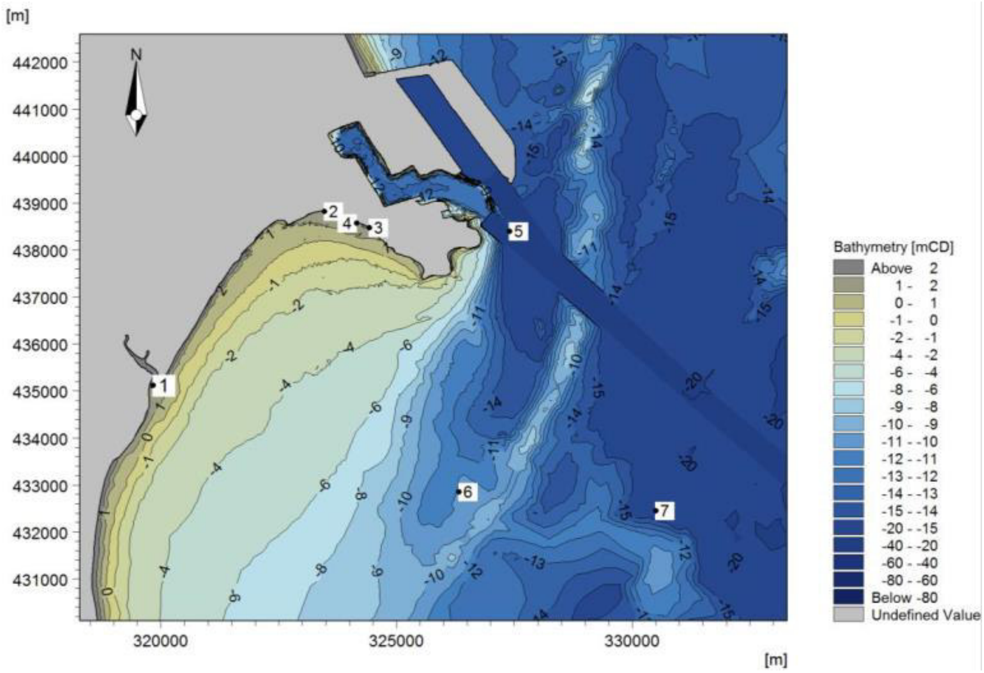
The predicted sediment plume results for Phase 1b are presented as follows:

Figure	Descriptions
Figure 7.2.16	Phase 1b: Simulated **mean** excess TSS levels during NE (top), SW (middle) and inter (bottom) monsoons.
Figure 7.2.17	Phase 1b: Simulated **maximum** excess TSS levels
Figure 7.2.18	Phase 1b: **Exceedance of 5 mg/L** excess TSS in % of time for NE (top), SW (middle) and Inter (bottom) monsoons.
Figure 7.2.19	Phase 1b: **Exceedance of 10 mg/L** excess TSS in % of time for NE (top), SW (middle) and Inter (bottom) monsoons.
Figure 7.2.20	Phase 1b: **Exceedance of 25 mg/L** excess TSS in % of time for NE (top), SW (middle) and Inter (bottom) monsoons.
Figure 7.2.21	Phase 1b: **Exceedance of 50 mg/L** excess TSS in % of time for NE (top), SW (middle) and Inter (bottom) monsoons.
Figure 7.2.22	Phase 1b: **Total bed thickness change** within 28days for NE (top), SW (middle) and Inter (bottom) monsoons. Phase 1a (Case A): Exceedance of 50 mg/L excess TSS in % of time for NE (top), SW (middle) and Inter (bottom) monsoons.

The modelling results show:

- The geometry of the sediment plume aligns with the current direction (i.e. east and west). The pattern of sediment plume does not change significantly across the difference monsoon periods.
- Localised plume of 5 mg/L mean excess suspended sediment concentrations are predicted around the sediment spill sources.
- The maximum excess suspended sediment concentration of 10 mg/L are predicted about 3 km east and 2 km west from the source.
- 5 mg/L excess concentration is exceeded 5% of the time at about 3 km east and 2 km west from the source.
- 10 mg/L excess concentration is exceeded 5% of the time at about 1 km east and 1 km west from the source.
- Localised 25 and 50 mg/L excess concentration is exceeded 5% of the time at around the sediment spill source.
- The excess TSS levels have been extracted at 7 defined spots and summarised in **Table 7.2.4**.
- The predicted sedimentation rate and impacted areas in Kuantan Port channel induced by construction works of proposed development Phase 1b is shown in **Figure 7.2.22**. However, it should be highlighted that this temporary sedimentation impact will not exist after the project completion.

Table 7.2.4: Phase 1b: Summary of predicted excess TSS levels at specific spots



Phase 1b Points	Excess Mean TSS (mg/L)			Excess Maximum TSS (mg/L)			Exceedance of 5 mg/L in % of time		
	NE	**SW**	**Inter**	**NE**	**SW**	**Inter**	**NE**	**SW**	**Inter**
P1	<2	<2	<2	<5	<5	<5	<5	<5	<5
P2	<2	<2	<2	<5	<5	<5	<5	<5	<5
P3	<2	<2	<2	<5	<5	<5	<5	<5	<5
P4	<2	<2	<2	<5	<5	<5	<5	<5	<5
P5	<2	<2	<2	<5	<5	<5	<5	<5	12
P6	<2	<2	<2	<5	<5	<5	<5	<5	<5
P7	<2	<2	<2	<5	<5	<5	<5	<5	<5

Phase 1b Points	Exceedance of 10 mg/L in % of time			Exceedance of 25 mg/L in % of time)			Exceedance of 50 mg/L in % of time		
	NE	**SW**	**Inter**	**NE**	**SW**	**Inter**	**NE**	**SW**	**Inter**
P1	<5	<5	<5	<5	<5	<5	<5	<5	<5
P2	<5	<5	<5	<5	<5	<5	<5	<5	<5
P3	<5	<5	<5	<5	<5	<5	<5	<5	<5
P4	<5	<5	<5	<5	<5	<5	<5	<5	<5
P5	<5	<5	<5	<5	<5	<5	<5	<5	<5
P6	<5	<5	<5	<5	<5	<5	<5	<5	<5
P7	<5	<5	<5	<5	<5	<5	<5	<5	<5

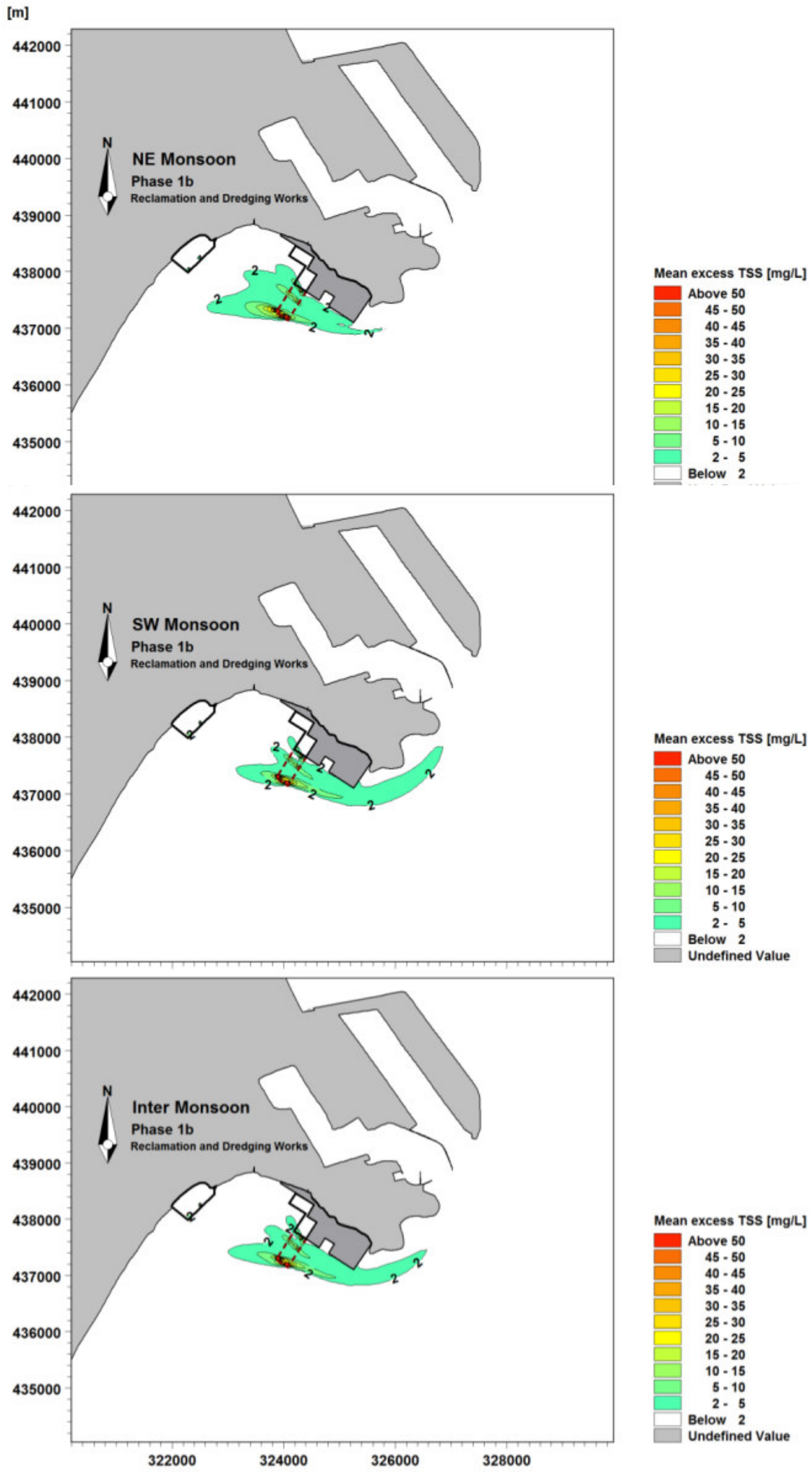


Figure 7.2.16: Phase 1b: Simulated mean excess TSS levels during NE (top), SW (middle) and inter (bottom) monsoons.

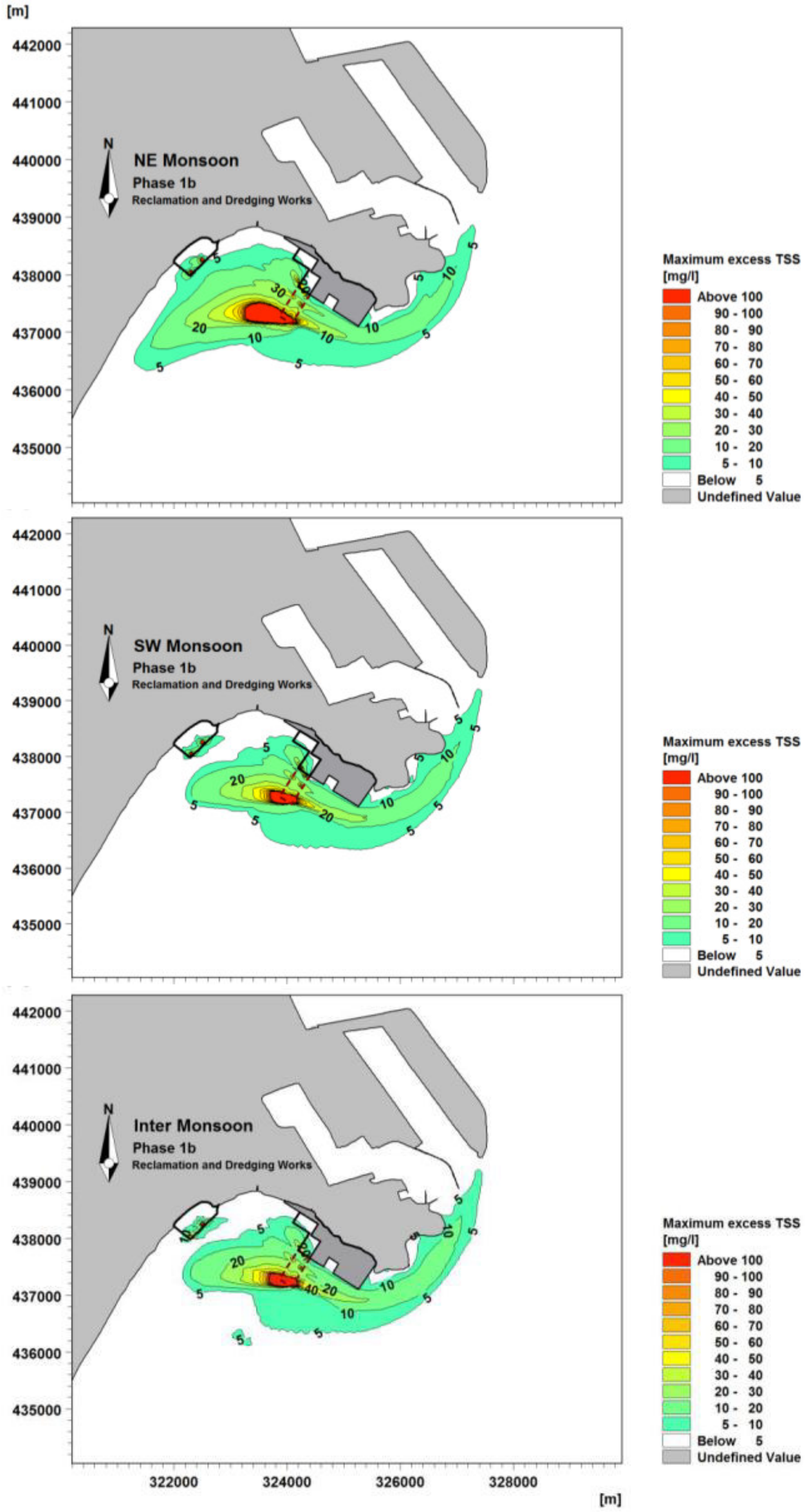


Figure 7.2.17: Phase 1b: Simulated maximum excess TSS levels during NE (top), SW (middle) and inter (bottom) monsoons.

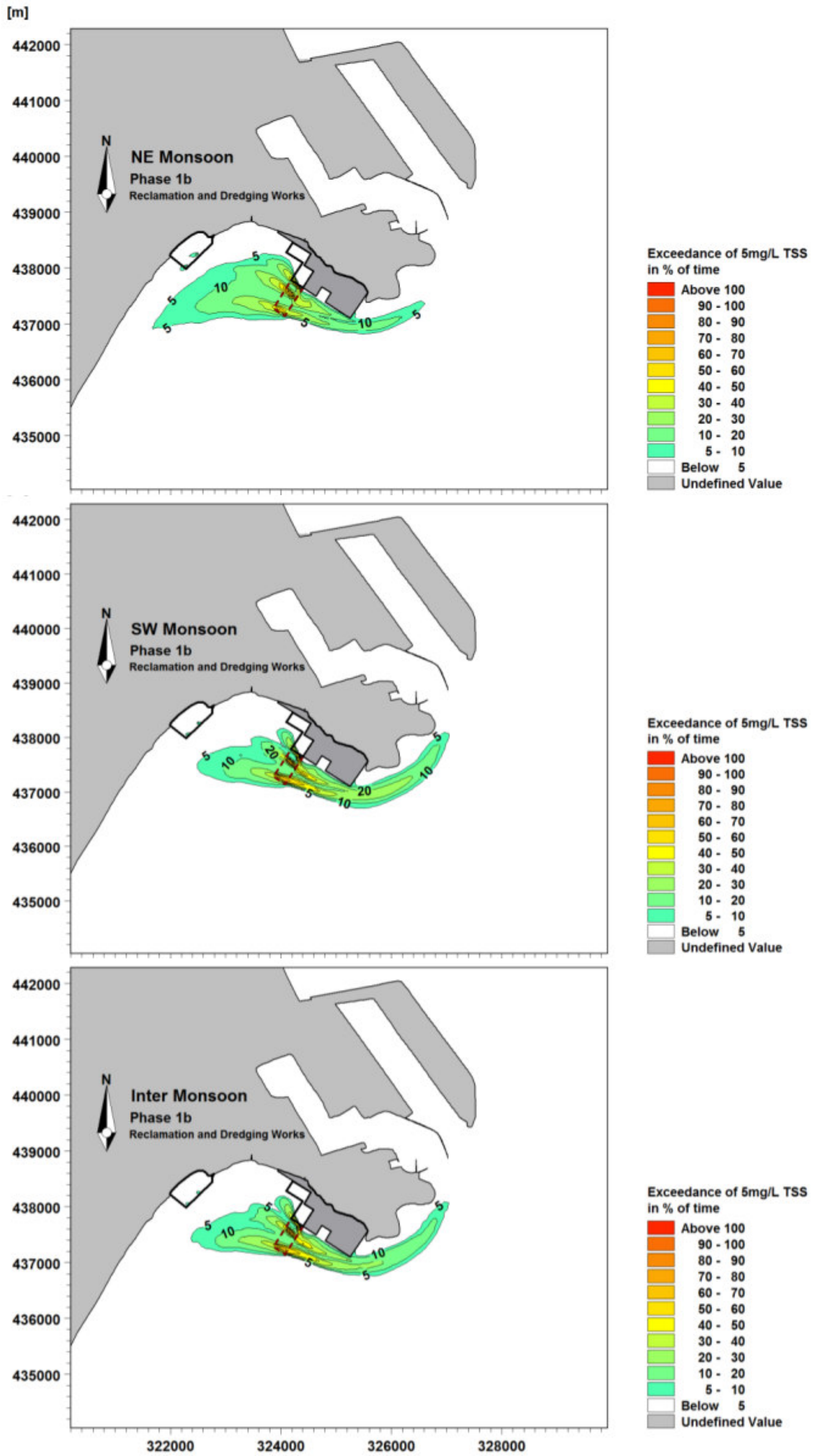


Figure 7.2.18: Phase 1b: Exceedance of 5 mg/L excess TSS in % of time for NE (top), SW (middle) and Inter (bottom) monsoons.

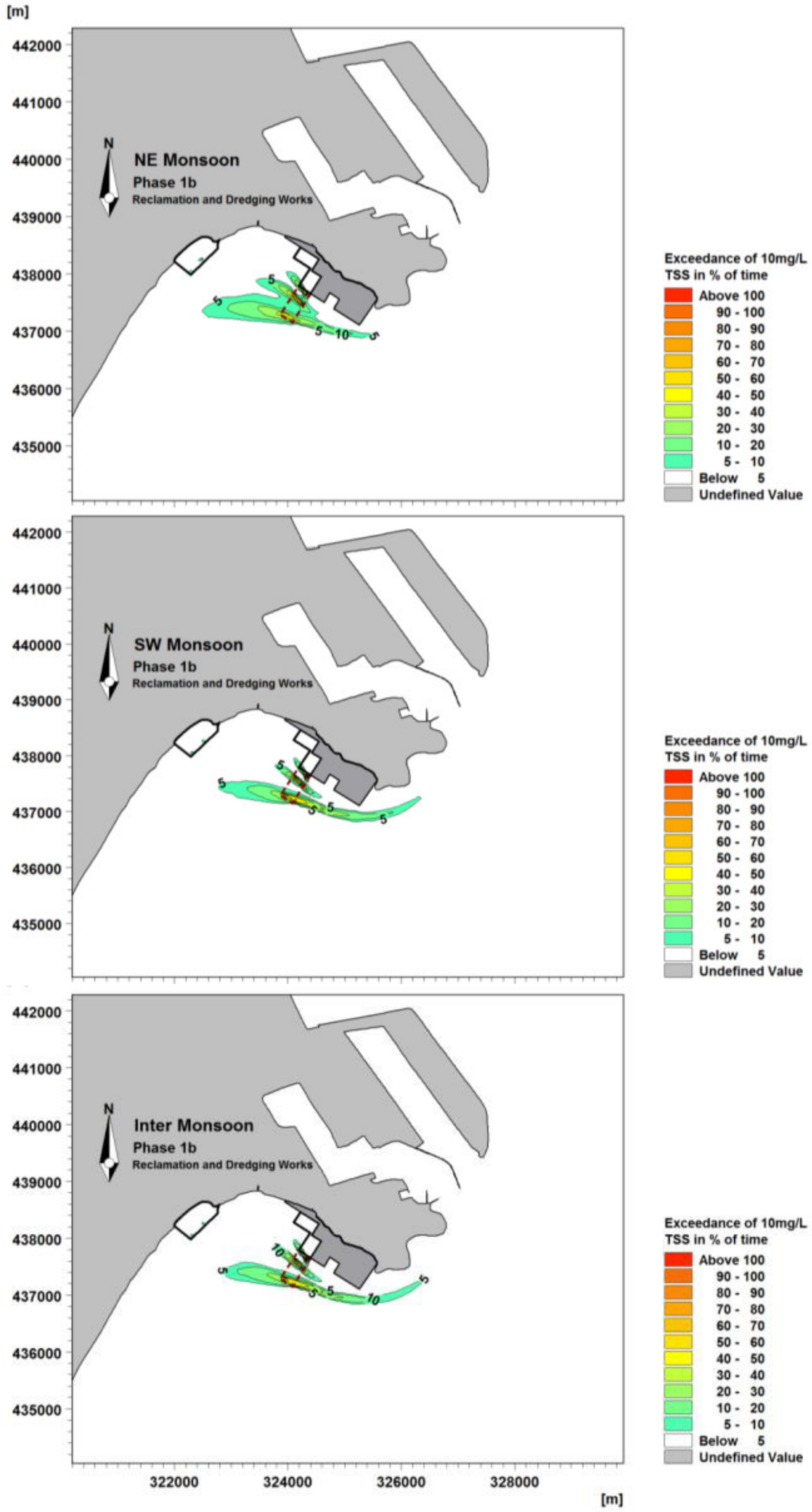


Figure 7.2.19: Phase 1b: Exceedance of 10 mg/L excess TSS in % of time for NE (top), SW (middle) and Inter (bottom) monsoons.

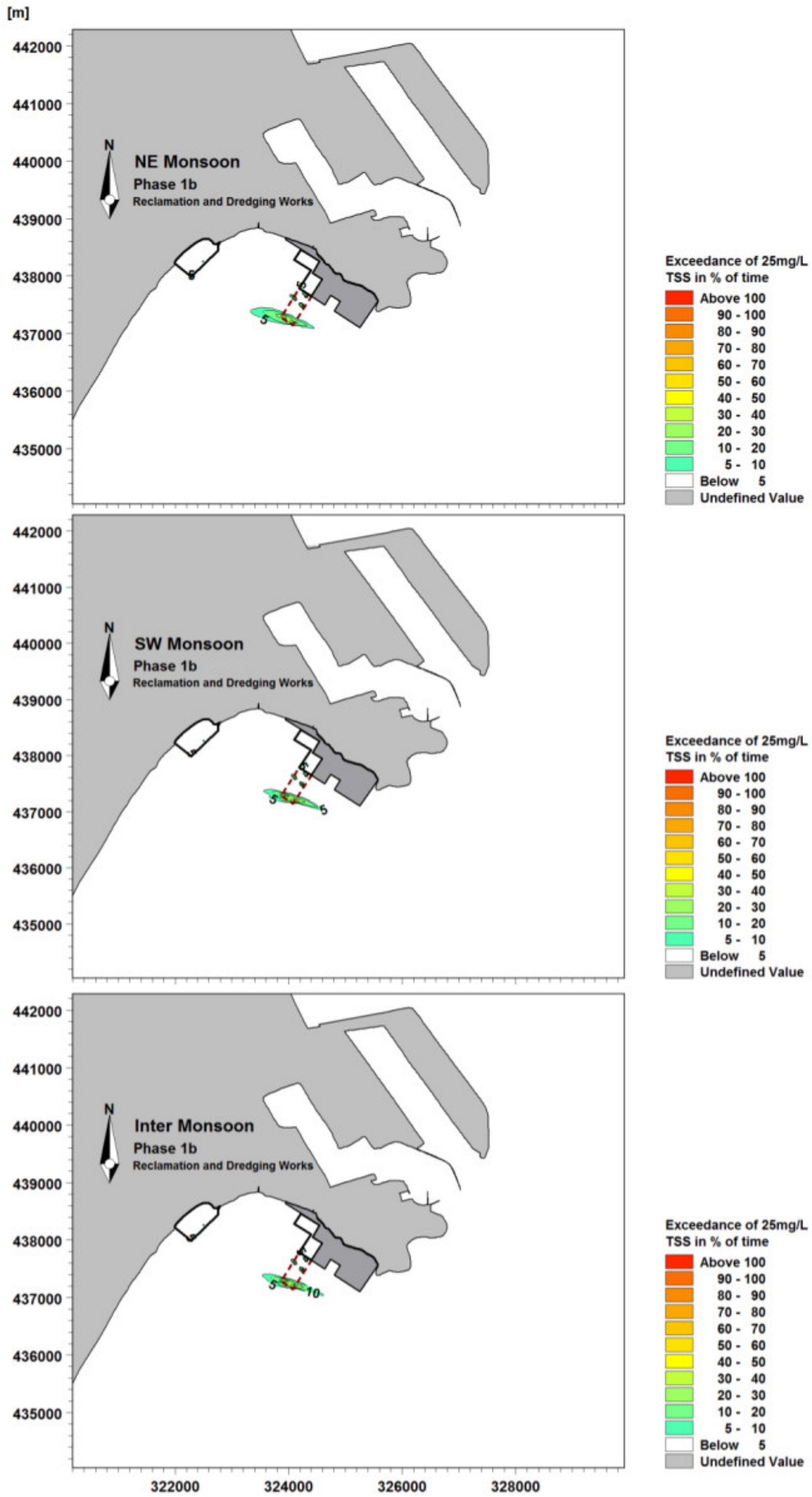


Figure 7.2.20: Phase 1b: Exceedance of 25 mg/L excess TSS in % of time for NE (top), SW (middle) and Inter (bottom) monsoons.

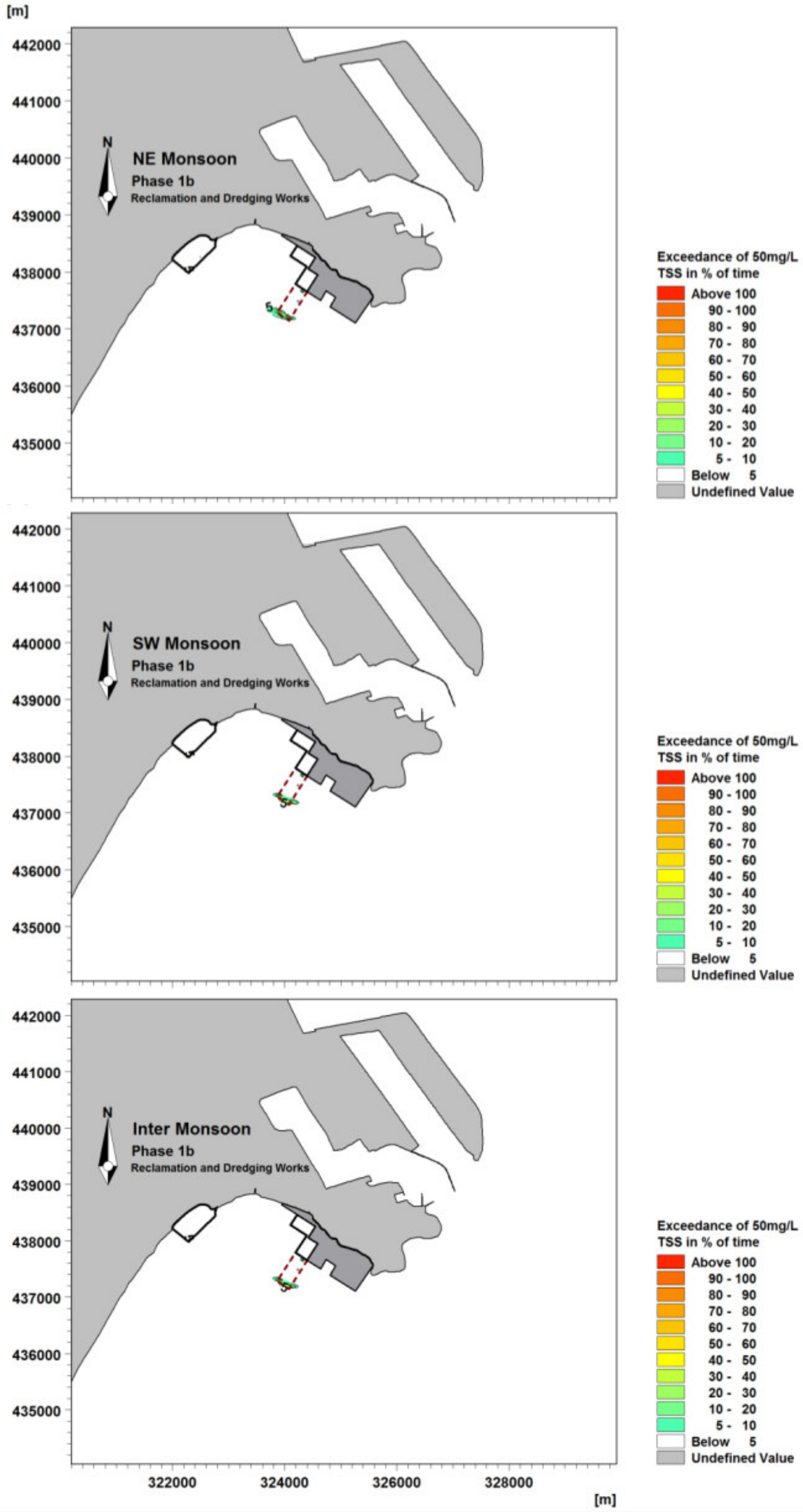


Figure 7.2.21: Phase 1b: Exceedance of 50 mg/L excess TSS in % of time for NE (top), SW (middle) and Inter (bottom) monsoons.

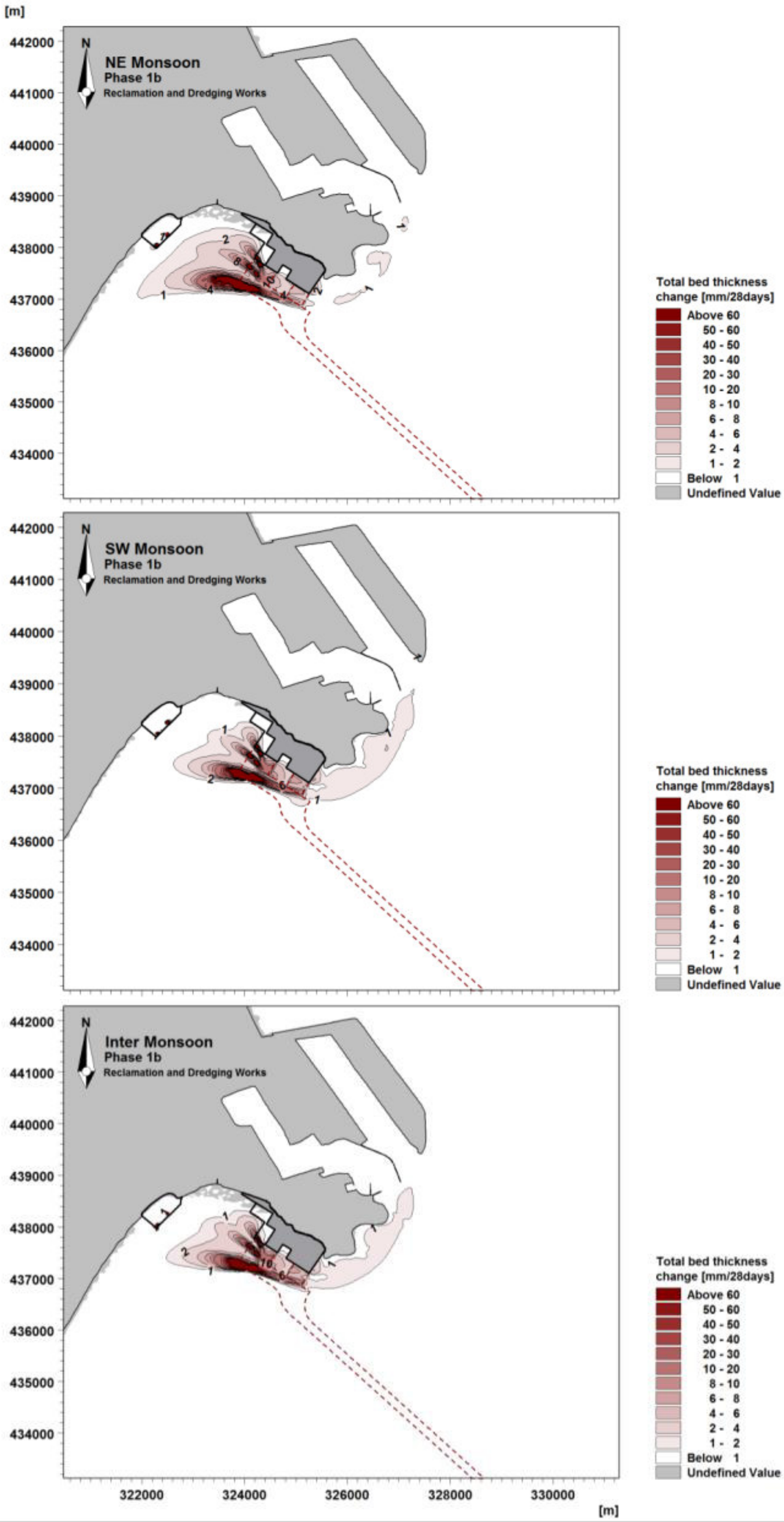


Figure 7.2.22: Phase 1b: Total bed thickness change within 28 days for NE (top), SW (middle) and Inter (bottom) monsoons.

7.2.2.1.4 Phase 1c

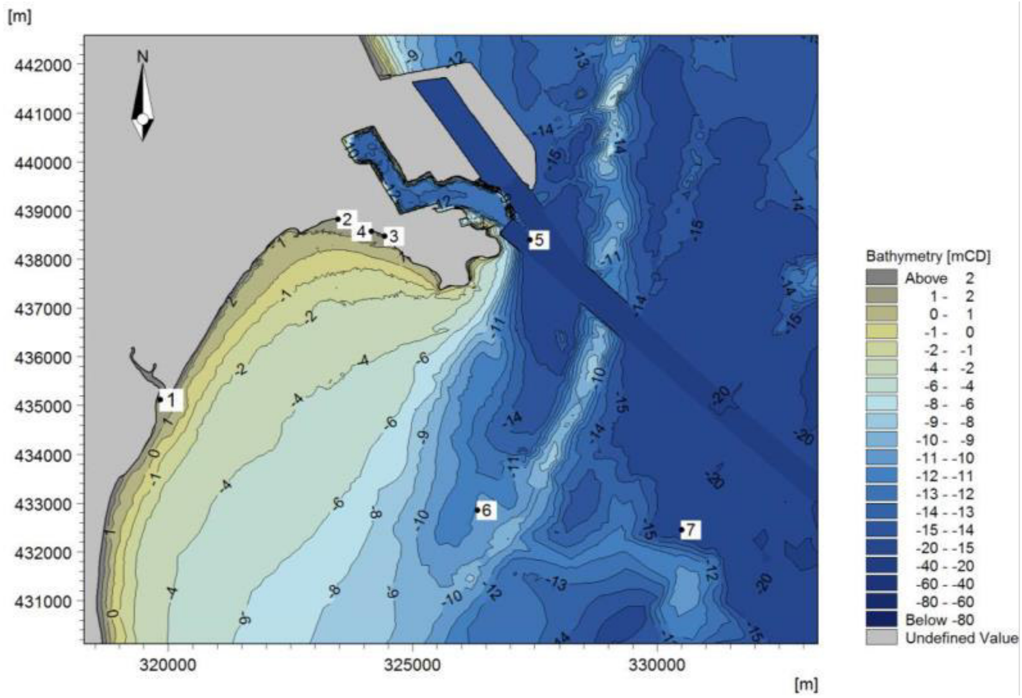
The predicted sediment plume results for Phase 1c are presented as follows:

Figure	Descriptions
Figure 7.2.23	Phase 1c: Simulated **mean** excess TSS levels during NE (top), SW (middle) and inter (bottom) monsoons.
Figure 7.2.24	Phase 1c: Simulated **maximum** excess TSS levels
Figure 7.2.25	Phase 1c: **Exceedance of 5 mg/L** excess TSS in % of time for NE (top), SW (middle) and Inter (bottom) monsoons.
Figure 7.2.26	Phase 1c: **Exceedance of 10 mg/L** excess TSS in % of time for NE (top), SW (middle) and Inter (bottom) monsoons.
Figure 7.2.27	Phase 1c: **Exceedance of 25 mg/L** excess TSS in % of time for NE (top), SW (middle) and Inter (bottom) monsoons.
Figure 7.2.28	Phase 1c: **Exceedance of 50 mg/L** excess TSS in % of time for NE (top), SW (middle) and Inter (bottom) monsoons.
Figure 7.2.29	Phase 1c: **Total bed thickness change** within 28days for NE (top), SW (middle) and Inter (bottom) monsoons. Phase 1a (Case A): Exceedance of 50 mg/L excess TSS in % of time for NE (top), SW (middle) and Inter (bottom) monsoons.

The modelling results show:

- The geometry of the sediment plume aligns with the current direction (i.e. north-east and south-west). The pattern of sediment plume does not change significantly across the difference monsoon periods.
- Localised plume of 5 mg/L mean excess suspended sediment concentrations are predicted around the study area.
- The maximum excess suspended sediment concentration of 10 mg/L are predicted about 4 km north-east and 4 km south-west from the source.
- 5 mg/L excess concentration is exceeded 5% of the time at about 3.5 km north-east and 3.5 km south-west from the source.
- 10 mg/L excess concentration is exceeded 5% of the time at about 2.5 km north-east and 2.5 km south-west from the source.
- Localised 25 and 50 mg/L excess concentration is exceeded 5% of the time at around the sediment spill source.
- The excess TSS levels have been extracted at 7 defined spots and summarised in **Table 7.2.5**.
- The predicted sedimentation rate and impacted areas in Kuantan Port channel induced by construction works of proposed development Phase 1c is shown in **Figure 7.2.29**. However, it should be highlighted that this temporary sedimentation impact will not exist after the project completion.

Table 7.2.5: Phase 1c: Summary of predicted excess TSS levels at specific spots.



Phase 1c Points	Excess Mean TSS (mg/L)			Excess Maximum TSS (mg/L)			Exceedance of 5 mg/L in % of time		
	NE	SW	Inter	NE	SW	Inter	NE	SW	Inter
P1	<2	<2	<2	<5	<5	<5	<5	<5	<5
P2	<2	<2	<2	<5	<5	<5	<5	<5	<5
P3	<2	<2	<2	<5	<5	<5	<5	<5	<5
P4	<2	<2	<2	<5	<5	<5	<5	<5	<5
P5	2	3	3	13	16	17	11	21	18
P6	<2	<2	<2	<5	<5	<5	<5	<5	<5
P7	<2	<2	<2	<5	<5	<5	<5	<5	<5

Phase 1c Points	Exceedance of 10 mg/L in % of time			Exceedance of 25 mg/L in % of time)			Exceedance of 50 mg/L in % of time		
	NE	SW	Inter	NE	SW	Inter	NE	SW	Inter
P1	<5	<5	<5	<5	<5	<5	<5	<5	<5
P2	<5	<5	<5	<5	<5	<5	<5	<5	<5
P3	<5	<5	<5	<5	<5	<5	<5	<5	<5
P4	<5	<5	<5	<5	<5	<5	<5	<5	<5
P5	<5	9	7	<5	<5	<5	<5	<5	<5
P6	<5	<5	<5	<5	<5	<5	<5	<5	<5
P7	<5	<5	<5	<5	<5	<5	<5	<5	<5

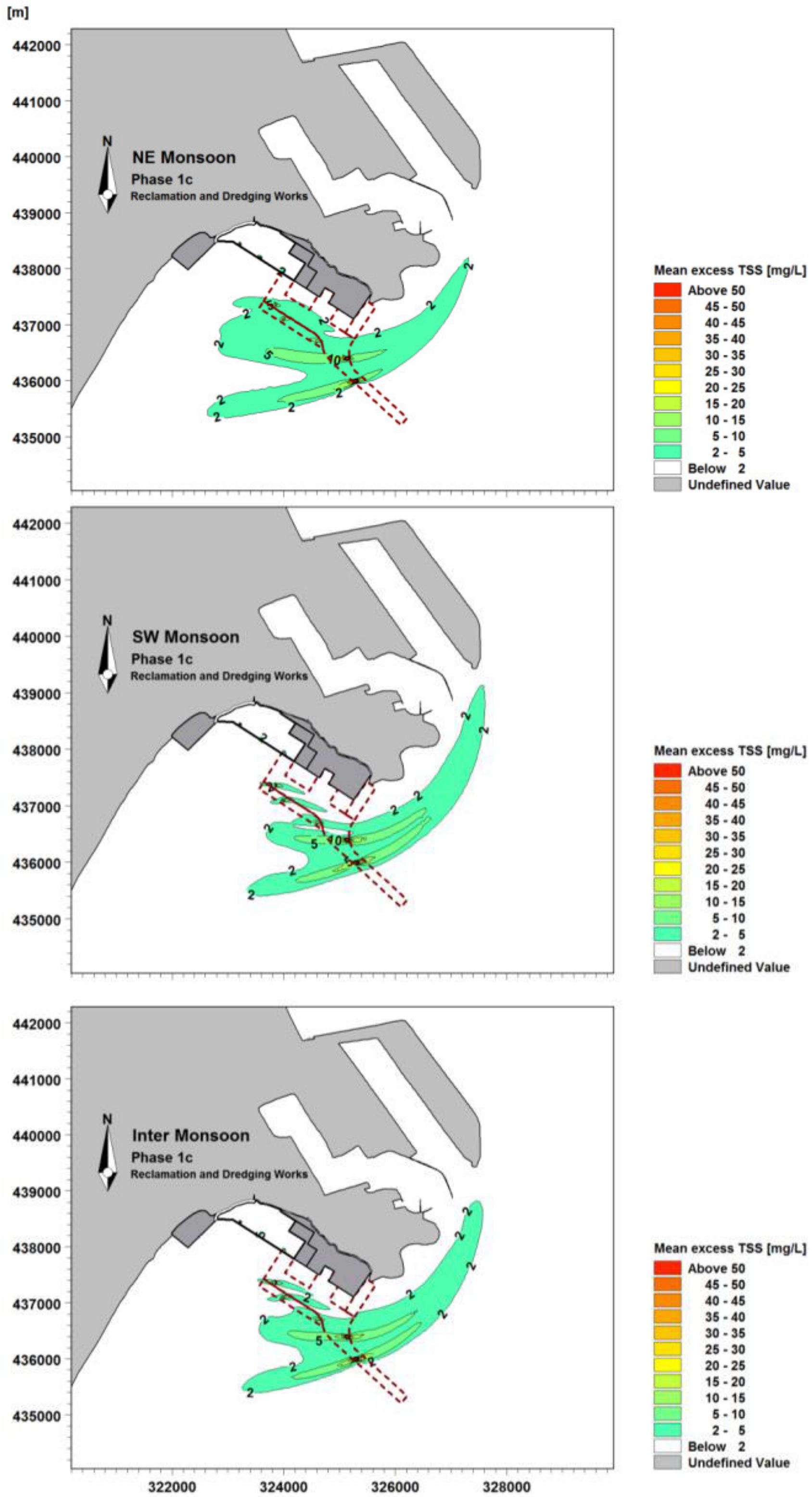


Figure 7.2.23: Phase 1c: Simulated mean excess TSS levels during NE (top), SW (middle) and inter (bottom) monsoons.

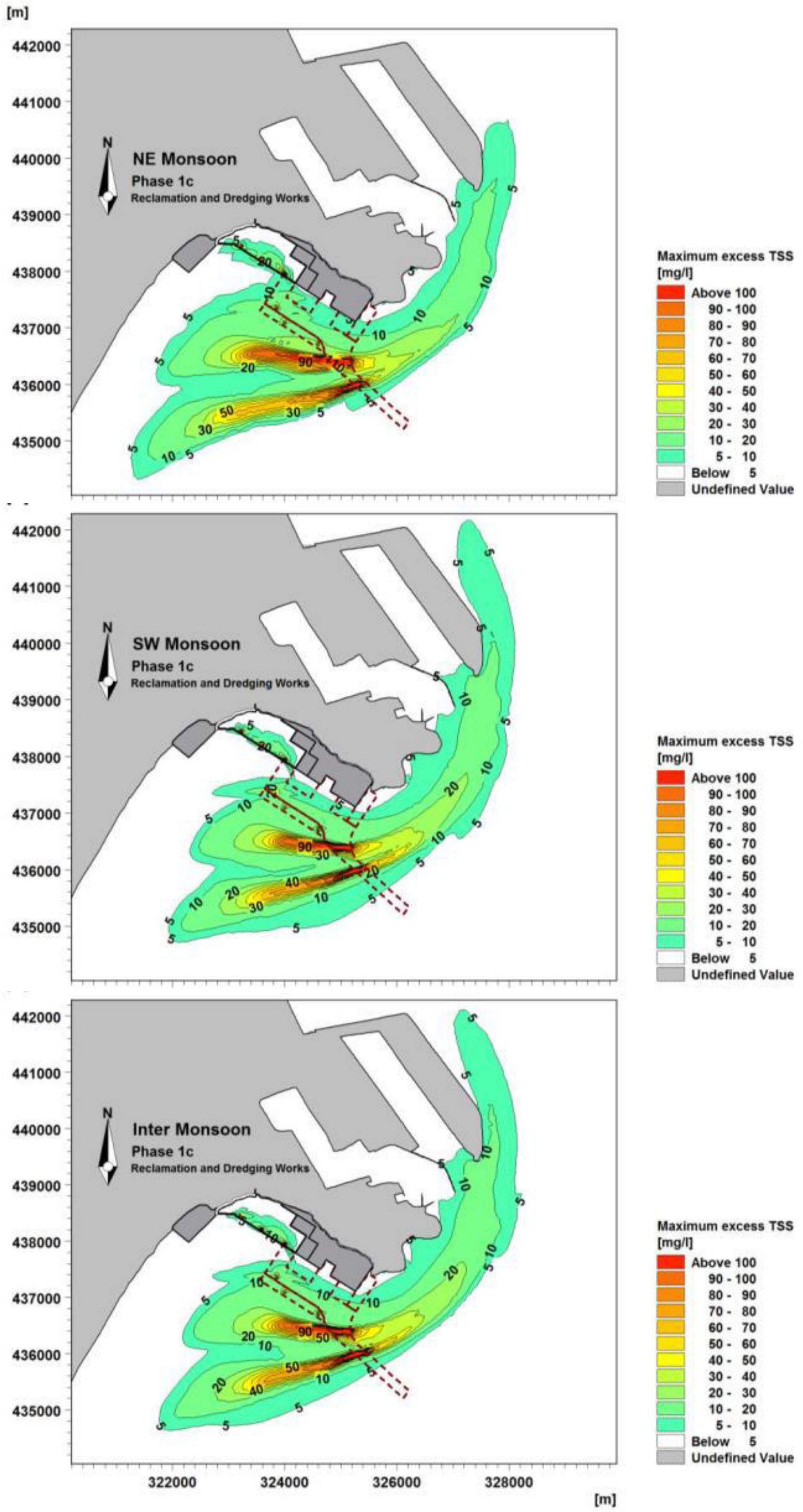


Figure 7.2.24: Phase 1c: Simulated maximum excess TSS levels during NE (top), SW (middle) and inter (bottom) monsoons.

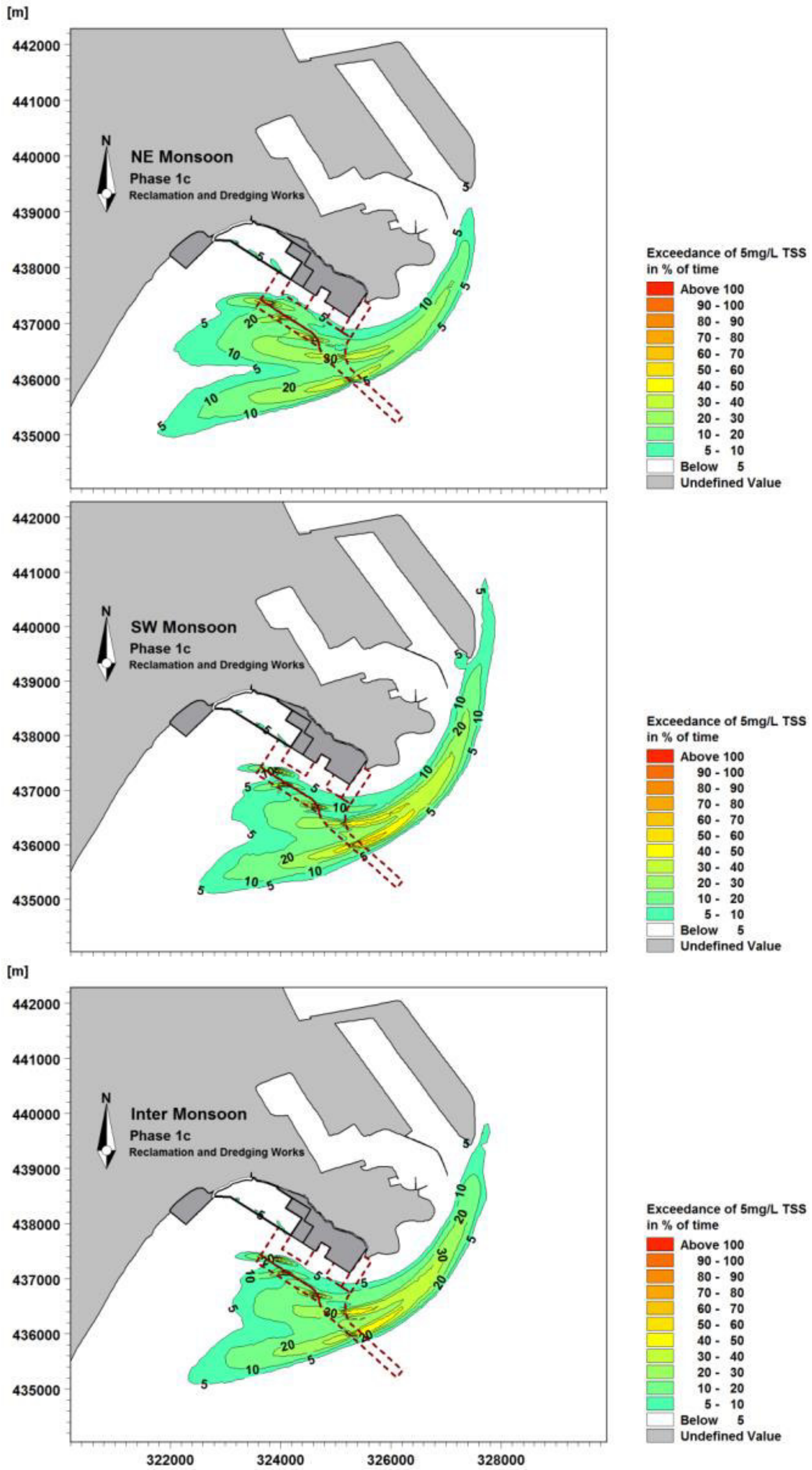


Figure 7.2.25: Phase 1c: Exceedance of 5 mg/L excess TSS in % of time for NE (top), SW (middle) and Inter (bottom) monsoons.

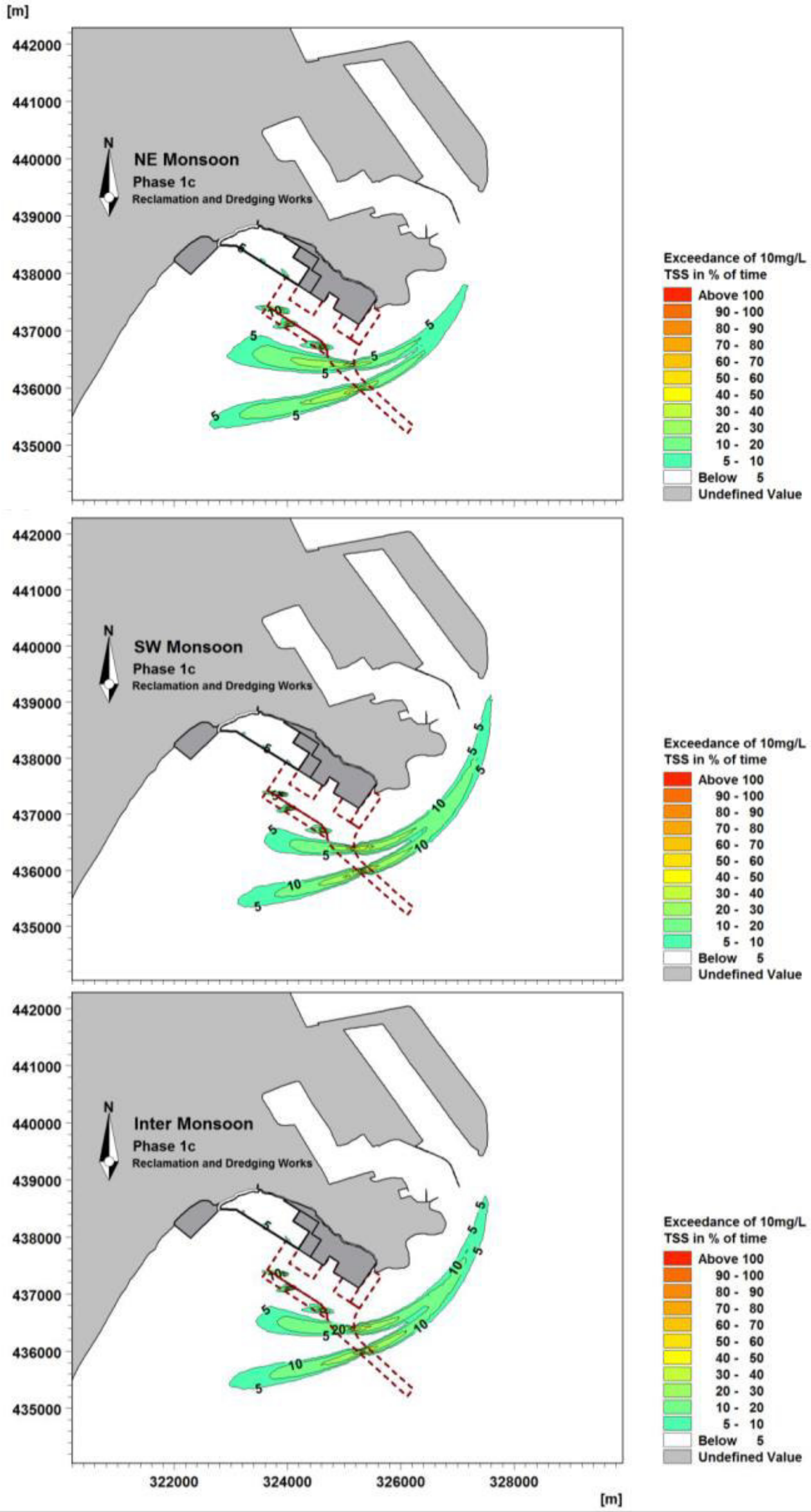


Figure 7.2.26: Phase 1c: Exceedance of 10 mg/L excess TSS in % of time for NE (top), SW (middle) and Inter (bottom) monsoons.

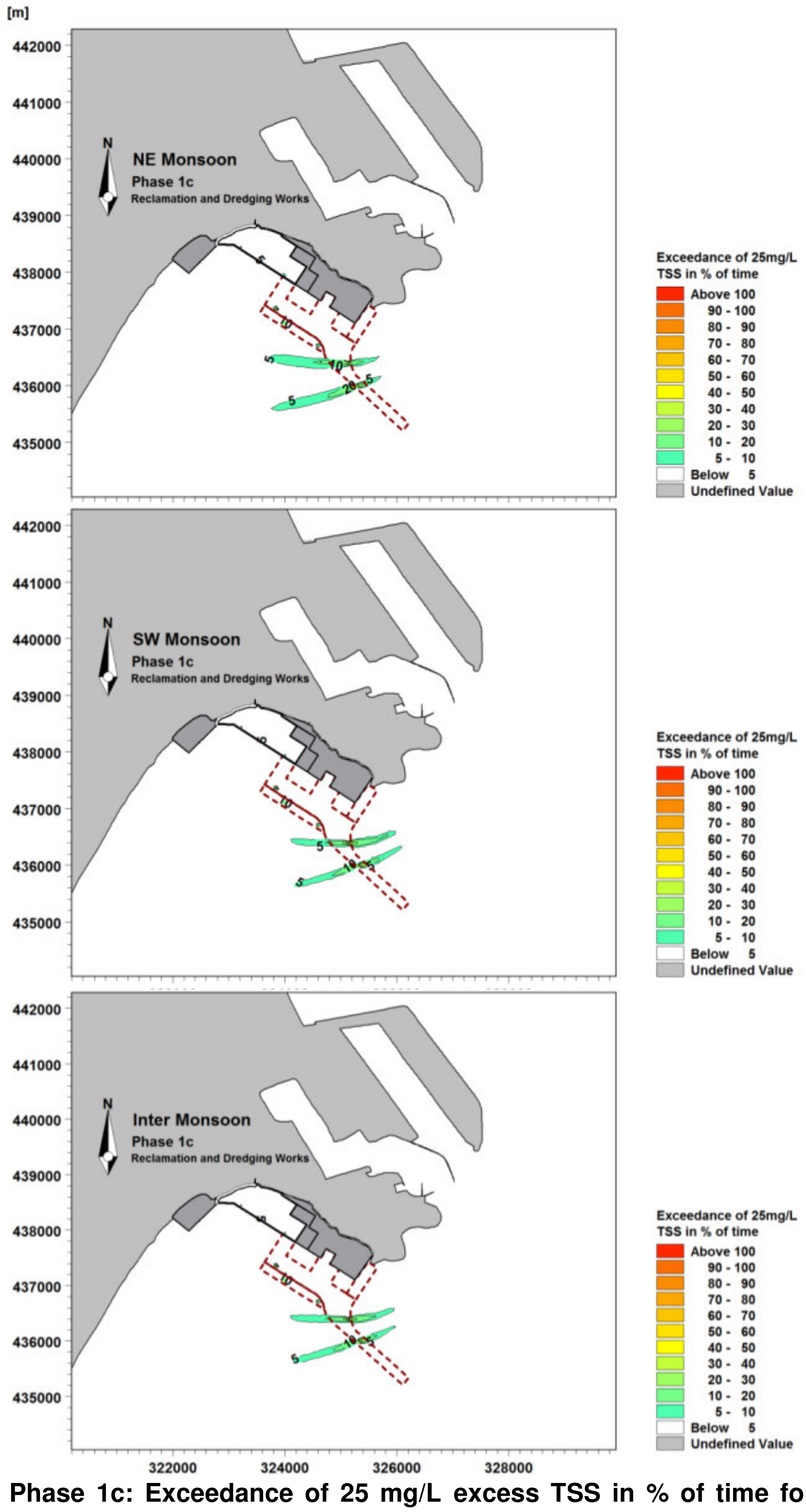


Figure 7.2.27: Phase 1c: Exceedance of 25 mg/L excess TSS in % of time for NE (top), SW (middle) and Inter (bottom) monsoons.

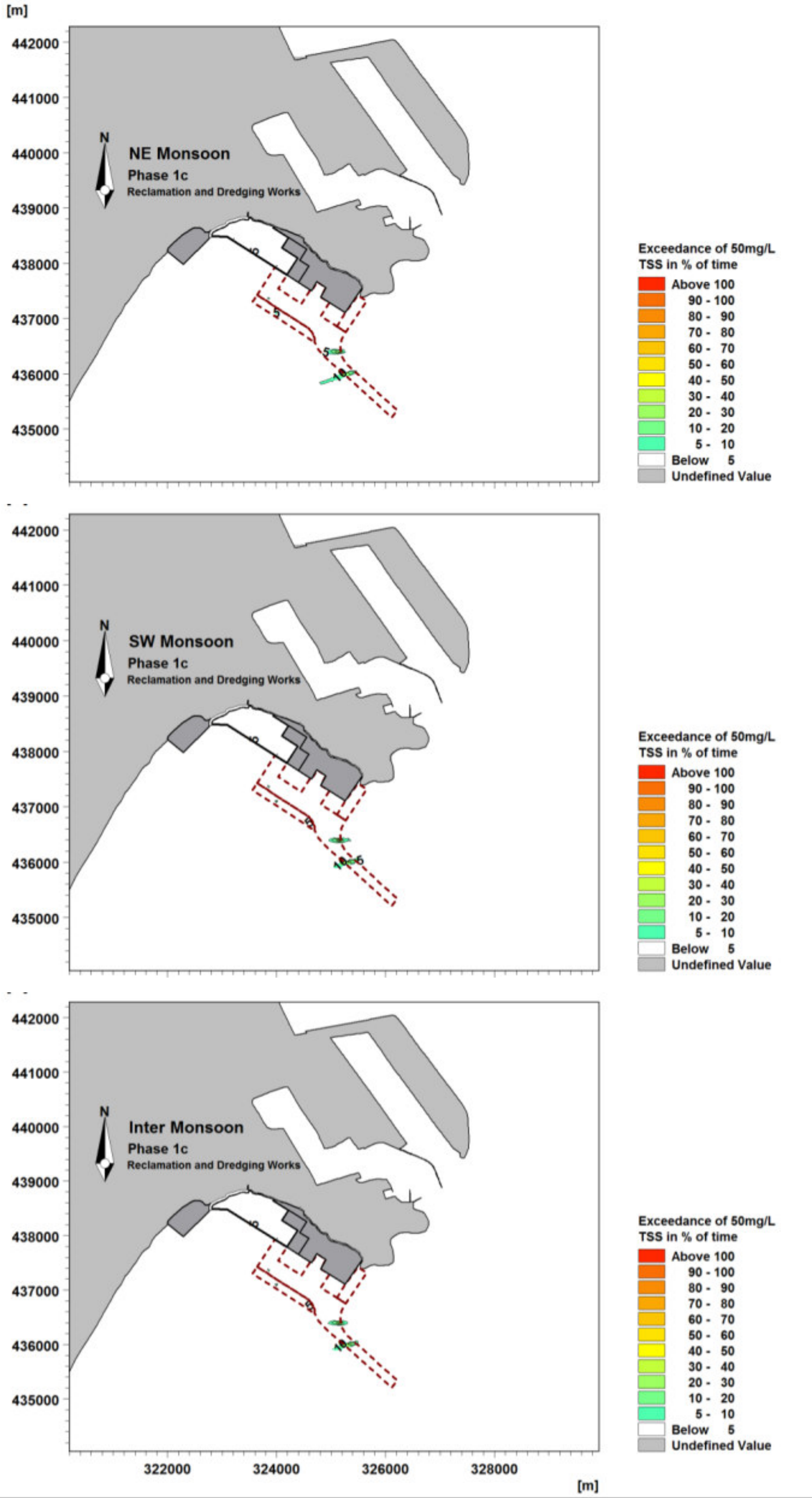


Figure 7.2.28: Phase 1c: Exceedance of 50 mg/L excess TSS in % of time for NE (top), SW (middle) and Inter (bottom) monsoons.

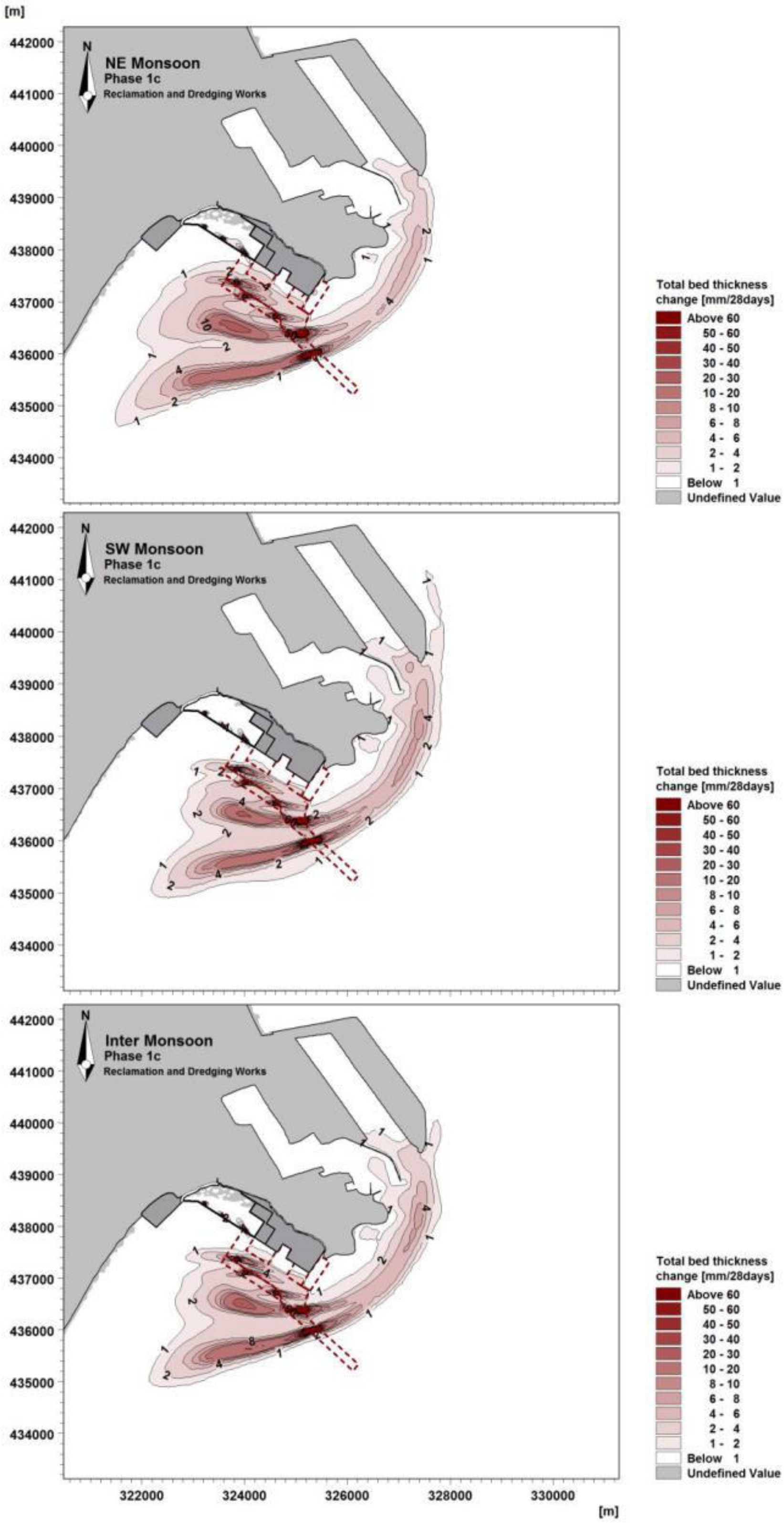


Figure 7.2.29: Phase 1c: Total bed thickness change within 28days for NE (top), SW (middle) and Inter (bottom) monsoons.

7.2.2.1.5 Phase 2

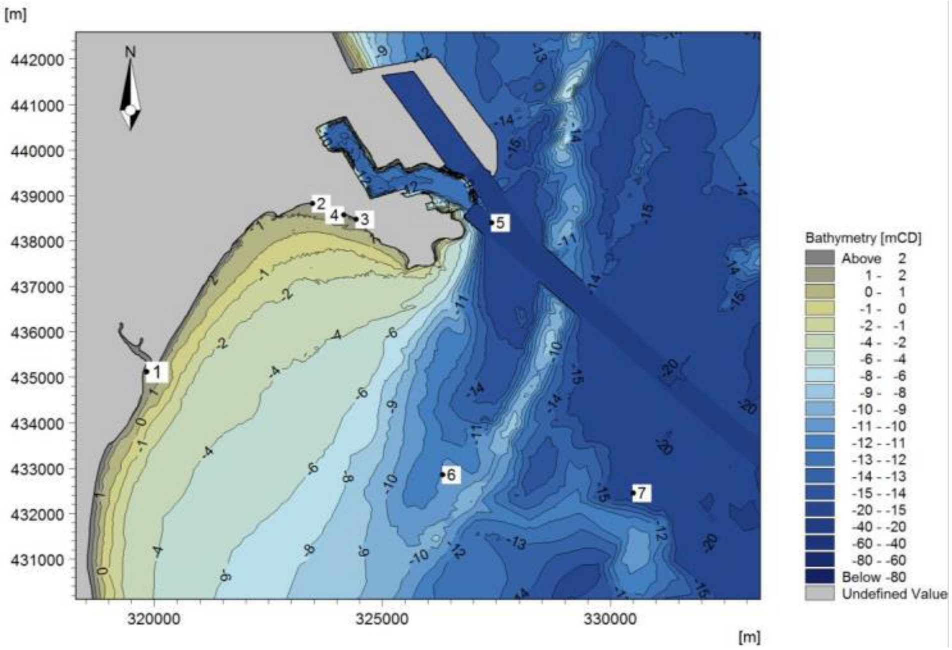
The predicted sediment plume results for Phase 2 are presented as follows:

Figure	Descriptions
Figure 7.2.30	Phase 2: Simulated **mean** excess TSS levels during NE (top), SW (middle) and inter (bottom) monsoons.
Figure 7.2.31	Phase 2: Simulated **maximum** excess TSS levels
Figure 7.2.32	Phase 2: **Exceedance of 5 mg/L** excess TSS in % of time for NE (top), SW (middle) and Inter (bottom) monsoons.
Figure 7.2.33	Phase 2: **Exceedance of 10 mg/L** excess TSS in % of time for NE (top), SW (middle) and Inter (bottom) monsoons.
Figure 7.2.34	Phase 2: **Exceedance of 25 mg/L** excess TSS in % of time for NE (top), SW (middle) and Inter (bottom) monsoons.
Figure 7.2.35	Phase 2: **Exceedance of 50 mg/L** excess TSS in % of time for NE (top), SW (middle) and Inter (bottom) monsoons.
Figure 7.2.36	Phase 2: **Total bed thickness change** within 28days for NE (top), SW (middle) and Inter (bottom) monsoons. Phase 1a (Case A): Exceedance of 50 mg/L excess TSS in % of time for NE (top), SW (middle) and Inter (bottom) monsoons.

The modelling results show:

- The geometry of the sediment plume aligns with the current direction (i.e. north-east and south-west). The pattern of sediment plume does not change significantly across the difference monsoon periods.
- Localised plume of 5 mg/L mean excess suspended sediment concentrations are predicted around the study area.
- The maximum excess suspended sediment concentration of 10 mg/L are predicted about 4 km north-east and 4 km south-west from the source.
- 5 mg/L excess concentration is exceeded 5% of the time at about 3.5 km north-east and 3.5 km south-west from the source.
- 10 mg/L excess concentration is exceeded 5% of the time at about 2 km north-east and 2 km south-west from the source.
- Localised 25 and 50 mg/L excess concentration is exceeded 5% of the time at around the sediment spill source.
- The excess TSS levels have been extracted at 7 defined spots and summarised in **Table 7.2.6**.
- The predicted sedimentation rate and impacted areas in Kuantan Port channel induced by construction works of proposed development Phase 2 is shown in **Figure 7.2.36**. However, it should be highlighted that this temporary sedimentation impact will not exist after the project completion.

Table 7.2.6: Phase 2: Summary of predicted excess TSS levels at specific spots.



Phase 2 Points	Excess Mean TSS (mg/L)			Excess Maximum TSS (mg/L)			Exceedance of 5 mg/L in % of time		
	NE	SW	Inter	NE	SW	Inter	NE	SW	Inter
P1	<2	<2	<2	<5	<5	<5	<5	<5	<5
P2	<2	<2	<2	<5	<5	<5	<5	<5	<5
P3	<2	<2	<2	<5	<5	<5	<5	<5	<5
P4	<2	<2	<2	<5	<5	<5	<5	<5	<5
P5	2	2	2	12	13	14	10	15	12
P6	<2	<2	<2	<5	<5	<5	<5	<5	<5
P7	<2	<2	<2	<5	<5	<5	<5	<5	<5

Phase 2 Points	Exceedance of 10 mg/L in % of time			Exceedance of 25 mg/L in % of time)			Exceedance of 50 mg/L in % of time		
	NE	SW	Inter	NE	SW	Inter	NE	SW	Inter
P1	<5	<5	<5	<5	<5	<5	<5	<5	<5
P2	<5	<5	<5	<5	<5	<5	<5	<5	<5
P3	<5	<5	<5	<5	<5	<5	<5	<5	<5
P4	<5	<5	<5	<5	<5	<5	<5	<5	<5
P5	<5	<5	<5	<5	<5	<5	<5	<5	<5
P6	<5	<5	<5	<5	<5	<5	<5	<5	<5
P7	<5	<5	<5	<5	<5	<5	<5	<5	<5

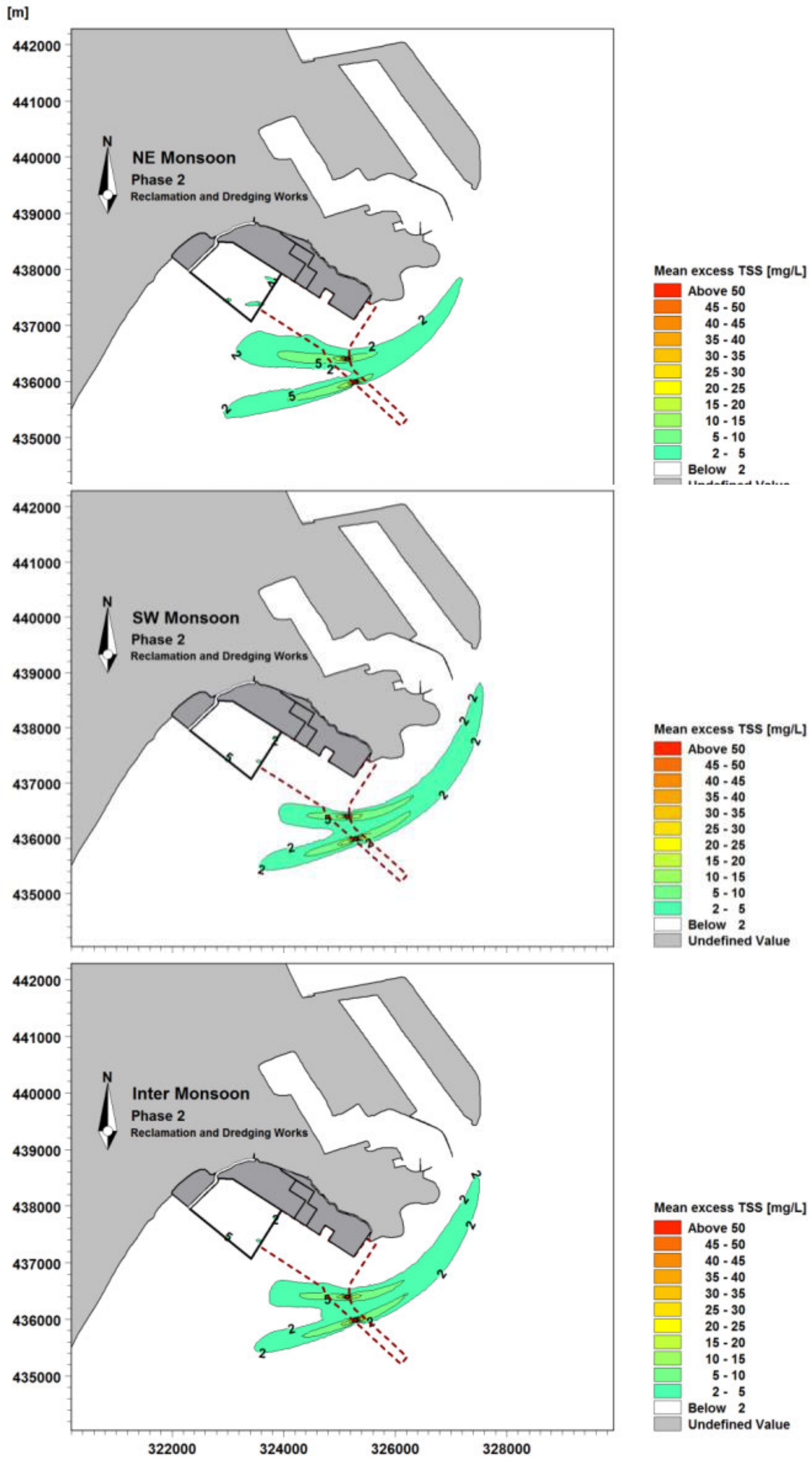


Figure 7.2.30: Phase 2: Simulated mean excess TSS levels during NE (top), SW (middle) and inter (bottom) monsoons.

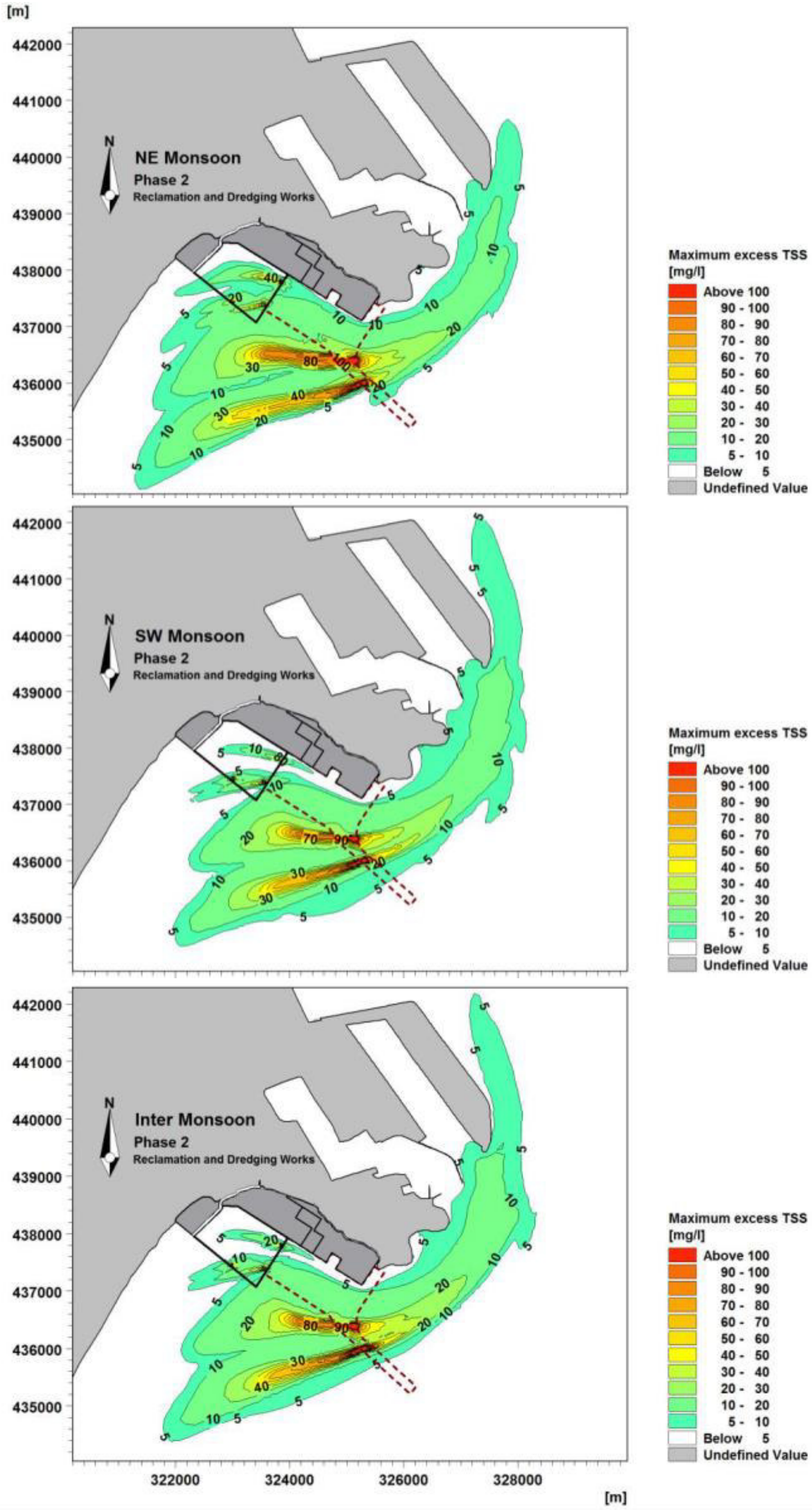


Figure 7.2.31: Phase 2: Simulated maximum excess TSS levels during NE (top), SW (middle) and inter (bottom) monsoons.