Contents

Appendices

Figures

9 WATER QUALITY

9.1 Introduction

9.1.1.1 This section presents the assessment on water quality impact arising from the construction and operation of the Hong Kong-Zhuhai-Macao Bridge Hong Kong Boundary Crossing Facilities (HKBCF) and the Hong Kong Link Road (HKLR).

9.1.1.2 Modelling tools have been used to predict the hydrodynamic and water quality conditions before, during and after implementation of the above-mentioned proposed Projects. Modelling results are compared with the relevant water quality objectives and criteria to check for compliance. Mitigation measures are then proposed to mitigate the impacts to safeguard the aquatic environment in the potentially affected areas. This section also includes assessment of the potential cumulative water quality impacts taking account of other concurrent projects.

9.2 Description of the Project

HKBCF

9.2.1.1 HKBCF will involve approx. 130 ha of reclamation. As discussed in **Section 4**, two options are formulated as regards the construction sequence of the reclamation works for HKBCF. The reclamation layouts of these two options are shown in **Figures 4.6 and 4.7** in **Section 4**; they are referred to as Sequence A and Sequence B.

9.2.1.2 A comparison of the key aspects of Sequence A and Sequence B is given in **Section 4**. As explained therein, Sequence B should be adopted as it is environmentally more advantageous and as it can still just meet the vital programme target. However, for such a complicated project as HKBCF, there is a possibility that the need to change to Sequence A may occur; for instance, in case of unforeseen delay in the earlier tasks, a change from Sequence B to Sequence A will enable the project to gain back time to compensate for earlier delay. In view of the above, though the planning of HKBCF should be based on Sequence B, it is also necessary to consider Sequence A in the assessment of water quality impacts as the worse scenario.

9.2.1.3 The reclamation layout and envisaged construction programme of HKBCF based on Sequence B are shown in **Figures 9A2-1** and **9A2-2** in **Appendix 9A2**. In general, it is envisaged that the seawall at the peripheral of HKBCF site would be carried out first and the reclamation would start when substantial length of seawall is constructed to protect the reclamation filling. Temporary steel sheet pile wall would be installed near the northern edge of HKBCF site so as to protect silt curtain against current. A detailed description and drawings showing the reclamation sequence is attached in **Appendix 9A2**.

9.2.1.4 The reclamation layout and envisaged construction programme of HKBCF based on Sequence A are shown in **Figures 9A1-1** and **9A1-2** in **Appendix 9A1**. When compared to Sequence B, Sequence A adopts a series of interim/temporary seawalls around the proposed locations of Passengers Clearance Building (PCB) and the Government Buildings so as to minimise the extent of reclamation to enable early completion of Phase 1 of HKBCF. It is envisaged that the reclamation works would start at Portion A of HKBCF Phase 1 first. In order to minimise the impact to the water quality, Portion A of HKBCF Phase 1 would be enclosed by a temporary seawall with a gap of about 100m for marine access before the reclamation filling. Upon completion of reclamation filling in Portion A of HKBCF Phase 1, substantial length of seawalls would have been completed in Portions B and C of HKBCF Phase 1. Then the reclamation would be carried out in the sequence of Portion B, Portion C, Portion D of HKBCF Phase 1 and finally

HKBCF Phase 2. A detailed description and drawings showing the reclamation sequence is attached in **Appendix 9A1.**

9.2.1.5 The estimated volume of dredging and filling for Sequence A and Sequence B is summarised in **Table 9.1**.

Table 9.1 Estimated volume of dredging and filling in HKBCF

Option	Bulk Volume of Marine Deposit to be Dredged (million m^3) [1] [2]	Bulk volume of filling (million m^3) [1], [3]
Sequence A	29.90	52.0
Sequence B	18.70	40.8

Notes:
1) A bulk factor of 1.3 is applied to the insitu volume.
2) The volume of dredging includes dredging to form the pits for Mf sediment and excavation of sediment in bored pile excavation after the land is reclaimed.
3) The filling includes sandfill and public fill (excluding rockfill) for seawalls and reclamation.

9.2.1.6 As shown in **Table 9.1** above, Sequence A would involve more dredging and more reclamation filling due to the need of interim/temporary seawalls and adoption of fully dredge method at some critical areas of HKBCF reclamation. In addition, Sequence A aims for a shorter construction time to complete Phase 1 of HKBCF by End 2014, whilst Sequence B would allow longer construction time to complete Phase 1 of HKBCF by End 2015. Therefore, the dredging and filling works in Sequence A are more intensive than those in Sequence B, thus entailing larger water quality impacts. Based on the overall programme and sediment loss rates for Sequence A and Sequence B, a comparison of the sediment loss rate between these two reclamation sequences is attached in **Appendix 9B**. The comparison shows that sediment loss rate of Sequence B is substantially less than that in Sequence A. Therefore, it is more conservative to adopt Sequence A than Sequence B in assessing the water quality impacts.

9.2.1.7 In view of the above, the assessment of water quality in this Chapter will be based on Sequence A for conservatism. In order to demonstrate that Sequence B will perform better than Sequence A from the water quality perspective, additional modeling of the worse construction scenario of Sequence B has been carried out and a comparison of the water quality impacts due to Sequence A and Sequence B will be presented in the relevant Sections below.

HKLR

9.2.1.8 The layout and envisaged construction programme/sequence of HKLR including its marine substructures and its reclamation work are shown in **Figures 9C1 to 3** in **Appendix 9C**. Based on the available site investigation results, the estimated quantity of dredging and filling for HKLR is about 5.5 Mm^3 (bulk volume) and 7.0 Mm^3 (bulk volume) respectively.

9.2.1.9 The reclamation layout and sequence of HKLR are shown in **Appendix 9C.** In general, it is anticipated that the reclamation work of HKLR would be carried out in three portions. The general reclamation is as follows:

- Construct the seawall at Portion 1 (i.e. the southern portion of relcamation site) – A gap of about 100m will be allowed at the seawall for marine access during reclamation works. The portion of seawall at this gap would be completed after the reclmation filling;
- Dredging and filling for the reclamation in Portion 1;
- Dredging and filling for the reclamation and seawalls in Portion 2 (i.e. the portion at the middle of reclamation site). As the reclamation in Portion 2 is

small, it is envisaged that the dredging and filling works for reclamation and seawall would be carried out at the same time;

- Dredging and filling for the reclamation and seawalls in Portion 3 (i.e. the northern portion of reclamation site). Similar to the case in Portion 2, the dredging and filling works for reclamation and seawall would be carried out at the same time.

9.2.1.10 As the construction of HKLR and HKBCF will be carried out independently in different works contracts, the construction programme/sequence of HKLR is not affected by the adoption of Sequence A or Sequence B of HKBCF reclamation. To assess the water quality impacts due to concurrent projects, Sequence A of HKBCF reclamation is assumed in the water quality model for conservatism as discussed in **Section 9.2.1.7** above.

9.3 Environmental Legislation, Standards and Criteria

9.3.1 Environmental Impact Assessment Ordinance (Cap. 499)

9.3.1.1 Both the HKBCF and HKLR are Designated Projects under Schedule 2 of the EIAO. Under Section 16 of the Ordinance, the Environmental Protection Department (EPD) issued the Technical Memorandum on Environmental Impact Assessment Process (TM-EIAO) which specifies the assessment methods and criteria for the EIA. Annexes 6 and 14 of the TM-EIAO stipulate the "Criteria for Evaluating Water Pollution" and "Guidelines for the Assessment of Water Pollution" respectively.

9.3.2 Water Pollution Control Ordinance (Cap. 358)

9.3.2.1 The Water Pollution Control Ordinance (WPCO) is the principal legislation governing the marine water quality in Hong Kong. Under the provision of the WPCO, Hong Kong's waters have been divided into a series of Water Control Zones (WCZs). Water Quality Objectives (WQOs) have been declared to protect the specific beneficial uses and conservation goals of each of the zones. The proposed projects of HKBCF and HKLR are situated within the North- western Water Control Zone (WCZ), which is identified with the following beneficial uses:

- Source of food for human consumption;
- Commercial fisheries resource;
- Habitat for marine organisms generally;
- Recreational bathing beach;
- Secondary contact recreation including diving, sailing and windsurfing;
- Domestic and industrial supply;
- Navigation and shipping;
- Aesthetic enjoyment.

9.3.2.2 The relevant Water Quality Objectives (WQOs) applicable to the North Western WCZ are summarised in **Table 9.2**.

Table 9.2 WQOs of North Western WCZ

Water Quality Objectives
Aesthetic Appearance
• There should be no objectionable odours or discolouration of the water; • Tarry residues, floating wood, articles made of glass, plastic, rubber or any other substances should be absent; • Mineral oil should not be visible on the surface; • There should be no recognisable sewage derived debris; and • Floating, submerged and semi-submerged objects of a size likely to interfere with the free movement of vessels, or cause damage to vessels, should be absent.
Bacteria
• The levels of *E coli* should not exceed 180 counts per 100 ml at bathing beaches, calculated as the geometric mean of all samples collected from March to October inclusive. Samples have to be taken at least 3 times a month at intervals of between 3 and 14 days; • The levels of *E coli* should not exceed 610 counts per 100 ml at secondary contact recreation sub-zones, calculated as the geometric annual mean; and • Waste discharges shall not cause a risk to any beneficial use of the aquatic environment.
Dissolved Oxygen
• The depth averaged concentration of dissolved oxygen should not fall below 4 mg/l for 90% of the sampling occasions during the whole year; and • The concentration of dissolved oxygen should not be less than 2 mg/l within 2m of the seabed for 90% of the sampling occasions during the whole year.
pH
• The pH of the water should be within the range 6.5-8.5 units; and • Human activity should not cause the natural pH range to be extended by more than 0.2 units.
Temperature
• Waste discharges shall not cause the natural daily temperature range to change by more than 2.0°C.
Salinity
• Waste Discharges shall not cause the natural ambient salinity to change by more than 10%.
Suspended Solids
• Human activity should neither cause the natural ambient level to be raised by more than 30% nor give rise to accumulation of suspended solids which may adversely affect aquatic communities.
Ammonia
• The un-ionised ammoniacal nitrogen level should not be more than 0.021 mg/l calculated as the annual average (arithmetic mean).
Nutrients
• Nutrients should not be present in quantities sufficient to cause excessive or nuisance growth of algae or other aquatic plants; and • Without limiting the generality of the above point, the level of inorganic nitrogen should not exceed 0.5 mg/l, or 0.3 mg/l within Castle Peak sub-zone, expressed as the annual water column average.
Toxins
• Waste discharges shall not cause the toxins in water to attain such a level as to produce significant toxic, carcinogenic, mutagenic or teratogenic effects in humans, fish or other aquatic organisms, with due regard to biologically cumulative effects in food chains and to interactions of toxic substances with each other.

9.3.3 Technical Memorandum on Standards for Effluents Discharged into Drainage and Sewerage Systems

9.3.3.1 Discharges of effluents are subject to control under the WPCO. The *Technical Memorandum on Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters* sets limits for effluent discharges. Specific limits apply for different areas and are different between surface waters and sewers. The limits vary with the rate of effluent flow. Standards for effluent discharged into the inshore waters and marine waters of North-western WCZ are summarized in **Tables 9.3a and 9.3b.**

Table 9.3a Standards for Effluents Discharged into the Inshore Waters of North Western Control Zones

Flow rate (m^3/day)	≤10	>10 and ≤200	>200 and ≤400	>400 and ≤600	>600 and ≤800	>800 and ≤1000	>1000 and ≤1500	>1500 and ≤2000	>2000 and ≤3000
pH (pH units)	6-9	6-9	6-9	6-9	6-9	6-9	6-9	6-9	6-9
Temperature (°C)	40	40	40	40	40	40	40	40	40
Colour (lovibond units) (25mm cell length)	1	1	1	1	1	1	1	1	1
Suspended solids	50	30	30	30	30	30	30	30	30
BOD	50	20	20	20	20	20	20	20	20
COD	100	80	80	80	80	80	80	80	80
Oil & Grease	30	20	20	20	20	20	20	20	20
Iron	15	10	10	7	5	4	3	2	1
Boron	5	4	3	2	2	1.5	1.1	0.8	0.5
Barium	5	4	3	2	2	1.5	1.1	0.8	0.5
Mercury	0.1	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Cadmium	0.1	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Other toxic metals individually	1	1	0.8	0.7	0.5	0.4	0.3	0.2	0.15
Total toxic metals	2	2	1.6	1.4	1	0.8	0.6	0.4	0.3
Cyanide	0.2	0.1	0.1	0.1	0.1	0.1	0.05	0.05	0.03
Phenols	0.5	0.5	0.5	0.3	0.25	0.2	0.1	0.1	0.1
Sulphide	5	5	5	5	5	5	2.5	2.5	1.5
Total residual chlorine	1	1	1	1	1	1	1	1	1
Total nitrogen	100	100	80	80	80	80	50	50	50
Total phosphorus	10	10	8	8	8	8	5	5	5
Surfactants (total)	20	15	15	15	15	15	10	10	10
E. coli (count/100ml)	1000	1000	1000	1000	1000	1000	1000	1000	1000

Note: All units in mg/L unless otherwise stated; all figures are upper limits unless otherwise indicated

Table 9.3b Standards for Effluents Discharged into the Marine Waters of North Western Control Zones

Flow rate (m^3/day)	≤10	>10 and ≤200	>200 and ≤400	>400 and ≤600	>600 and ≤800	>800 and ≤1000	>1000 and ≤1500	>1500 and ≤2000	>2000 and ≤3000
pH (pH units)	6-10	6-10	6-10	6-10	6-10	6-10	6-10	6-10	6-10
Temperature (°C)	45	45	45	45	45	45	45	45	45
Colour (lovibond units) (25mm cell length)	4	1	1	1	1	1	1	1	1
Suspended solids	500	500	500	300	200	200	100	100	50
BOD	500	500	500	300	200	200	100	100	50
COD	1000	1000	1000	700	500	400	300	200	150
Oil & Grease	50	50	50	30	25	20	20	20	20
Iron	20	15	13	10	7	6	4	3	2
Boron	6	5	4	3.5	2.5	2	1.5	1	0.7
Barium	6	5	4	3.5	2.5	2	1.5	1	0.7

Flow rate (m³/day)	≤10	>10 and ≤200	>200 and ≤400	>400 and ≤600	>600 and ≤800	>800 and ≤1000	>1000 and ≤1500	>1500 and ≤2000	>2000 and ≤3000
Mercury	0.1	0.1	0.1	0.001	0.001	0.001	0.001	0.001	0.001
Cadmium	0.1	0.1	0.1	0.001	0.001	0.001	0.001	0.001	0.001
Other toxic metals individually	2	1.5	1.2	0.8	0.6	0.5	0.32	0.24	0.16
Total toxic metals	4	3	2.4	1.6	1.2	1	0.64	0.48	0.32
Cyanide	1	0.5	0.5	0.5	0.4	0.3	0.2	0.15	0.1
Phenols	0.5	0.5	0.5	0.3	0.25	0.2	0.13	0.1	0.1
Sulphide	5	5	5	5	5	5	2.5	2.5	1.5
Total residual chlorine	1	1	1	1	1	1	1	1	1
Total nitrogen	100	100	80	80	80	80	50	50	50
Total phosphorus	10	10	8	8	8	8	5	5	5
Surfactants (total)	30	20	20	20	15	15	15	15	15
E. coli(count/100ml)	4000	4000	4000	4000	4000	4000	4000	4000	4000

Note: All units in mg/L unless otherwise stated; all figures are upper limits unless otherwise indicated

9.3.4 Practice Note for Professional Persons on Construction Site Drainage

9.3.4.1 The Practice Note for Professional Persons on Construction Site Drainage (ProPECC Note PN1/94) provides guidelines for the handling and disposal of construction discharges. This note is applicable for control of site runoff and wastewater generated during the construction phase of the HKBCF and HKLR. The types of discharges from construction sites outlined in the ProPECC Note PN1/94 that are relevant would include:

- Surface run-off;
- Boring and drilling water;
- Wastewater from concrete batching and precast concrete casting;
- Wheel washing water; and
- Wastewater from construction activities and site facilities.

9.4 Description of Existing Environment

9.4.1 Background

9.4.1.1 The North-western waters are situated at the mouth of the Pearl River Estuary and as such are heavily influenced by the massive freshwater flows from the hinterland. The area shows a distinct seasonality as a result of the seasonal influx of freshwater from the Pearl River. The estuarine influence is especially pronounced in the wet summer months when the freshwater flows are greatest and a strong salinity and temperature stratification are evident. During winter months, water conditions are more typical marine and the salinity and other parameters vary less with depth. Ebb tide currents are towards the southeast where the flood tide currents move to the northwest. Current velocities in areas near to the project area have been predicted in previous studies to be less than 2.0 m/s on the surface and rarely exceeding 0.25 m/s near seabed (ERM, 1997, 2005)

9.4.1.2 Water temperature ranges between about 15°C and 30°C over an annual cycle with a mean of about 22-23°C. Salinity typically varies within the range 10-32ppt.

9.4.1.3 The Pearl River carries very heavy loads of suspended sediment and nitrates and as a consequence concentrations of these parameters within North-western waters are variable but generally far higher than in the more oceanic influenced waters to the south and east of Hong Kong.

9.4.2 Pollution Sources

9.4.2.1 The North Western WCZ contains several significant sewage outfalls (Pillar Point, Northwest New Territories and Siu Ho Wan) and cooling water discharges from a number of users including Castle Peak Power Station, Hong Kong International Airport (HKIA) and Shiu Wing Steelworks.

9.4.2.2 In the past, dredging of marine mud and sand extraction has been extensive in the North-western Waters coastal area for reclamation projects including the land to be occupied by the Permanent Aviation Fuel Facility site (PAFF) at Tuen Mun Area 38, River Trade Terminal, Tin Shui Wai New Town and Hong Kong International Airport platform at Chek Lap Kok. Mud dredging to construct and maintain the navigation channel in Urmston Road and the berthing area at Castle Peak Power Station is periodic and on-going and the present temporary Aviation Fuel Receiving Facility (AFRF) at Sha Chau required the construction of a navigation channel and berthing area, which is, also, subject to maintenance dredging. The recently constructed Tonggu Channel just outside the HKSAR boundary will also require periodic maintenance dredging. To date, no adverse environmental impacts have been reported for any of these previous dredging exercises.

9.4.2.3 Disposal of contaminated dredged material, which began in 1992, is also on-going at the Contaminated Mud Pits (CMP) at East of Sha Chau. The capacity of the existing pits were predicted to be exhausted by early 2009 and two potential sites for future CMPs near the HKIA have been identified (**Figures 9.4 and 9.5**) and the EIA for the tentative sites have been approved by the Director of Environmental Protection (DEP). Disposal of Category M material that passes biological screening/uncontaminated dredged material continues intermittently at the North Brothers which has a remaining capacity of about 5 Mm^3. The operation of the open sea disposal ground at North Lantau Borrow pit has been suspended since 2000 and there is currently no schedule for the reopening of the facility.

9.4.2.4 Commercial trawling is undertaken over much of the North-western waters and the Urmston Road is a very busy shipping channel for river trade vessels, high speed ferries, large coal vessels servicing Castle Peak Power Station and the existing temporary Aviation Fuel Receiving Facility delivery vessels.

9.4.2.5 The locations of the principal areas of seabed disturbance and the major sewage outfalls in the study area are indicated in **Figure 9.4**.

9.4.3 Sensitive Receivers

9.4.3.1 There are a number of important water sensitive receivers (WSRs) within the study area as shown in **Figure 9.5.** These include areas of ecological sensitivity and conservation importance, commercial fishing resources, areas of direct human contact, e.g. bathing beaches, and various points where seawater is abstracted for domestic, commercial or industrial purposes.

9.4.3.2 The Indo-Pacific humpback dolphin (Sousa chinensis) is frequently observed within the study area and in and around Sha Chau and Lung Kwu Chau Marine Park, with the areas close to the Brothers Islands being shown to be a recent key site for the dolphins (see **Section 10**). The North-western waters of Hong Kong actually represent the eastern range of the Pearl River Estuary dolphin population which extends far into the mainland Chinese waters.

9.4.3.3 Not Used.

9.4.3.4 Other features of conservation concern in the wider study area include the mangrove stands and seagrasses (*Zostera japonica, Halophilia ovata and Halopila beccarii*) at Tai Ho and along the Tung Chung Channel south of the HKIA at Sha Lo Wan and San Tau. This area also provides the preferred habitat for horseshoe crab (*Tachypleus tridentatus* and *Carcinoscorpius rotundicauda*) which have been also observed near the beaches of Lung Kwu Tan, Lung Kwu Chau, the Brothers, San Tau and Tai Ho Wan. Previous surveys near Sha Chau have identified the presence of the stone coral Faviidea as well as gorgonians and sea pens which are of ecological interest.

9.4.3.5 The study area contains two ungazetted bathing beaches at Lung Kwu Tan as well as a number of gazetted bathing beaches in Tuen Mun and along Castle Peak Road. The Butterfly Beach is the nearest to the study area, which is located about 1 km to the east of the proposed northern landing in Tuen Mun. Further east towards Castle Peak Road are the Castle Peak Beach, Kadoorie Beach, Cafeteria Old and New Beaches and Golden Beach. These beaches have historically suffered from high sewage derived bacterial loads. However, as a result of recent pollution enforcement activities and sewerage infrastructure improvements, the water quality at all the gazetted beaches in the North West WCZ is now deemed 'fair' according to the EPD's criteria and suitable for bathing.

9.4.3.6 As part of the mitigation for the temporary aviation fuel line at Sha Chau, artificial reefs have been deployed in the Sha Chau and Lung Kwu Chau Marine Park. These reefs are designed to enhance fisheries resources and promote feeding opportunities for the Chinese White Dolphins which frequent the area. In addition, the Hong Kong Jockey Club, with the support from the AAHK, financed a project to deploy artificial reefs in the Chek Lap Kok Marine Exclusion Zone off the north eastern corner of the HKIA.

9.4.3.7 There are a number of major seawater intakes in the study area serving Tung Chung new town, the HKIA and industrial users, particularly the Castle Peak Power Station and Shiu Wing Steelworks immediately to the west of Tuen Mun Area 38. For the Castle Peak Power Station intake, there is a specific requirement that suspended sediment concentrations in water must be maintained below a level of 150 mg/l within a 5 km radius of the intake.

9.4.3.8 Based upon the above, a series of specific points and sensitive receivers for inclusion in the water quality modelling have been defined. These are shown in **Figure 9.5** and detailed in **Table 9.5** below.

Table 9.5 Observation Points and Water Sensitive Receivers for Water Quality Modelling

Code	Description	Impact
WSR 7	Black Point Cooling Water Intake	Operation
WSR 8	Lung Kwu Sheung Tan (non-gazetted beach)	Construction
WSR 9a	Urmston Road (Main Channel)	Construction and Operation
WSR 10	Sha Chau and Lung Kwu Chau Marine Park	Construction and Operation
WSR 11	Castle Peak Power Station Cooling Water Intake	Construction
WSR 12	Butterfly Beach	Construction and Operation
WSR 13	WSD Seawater Intake at Tuen Mun	Construction
WSR 15	Gazetted Beaches at Tuen Mun	Construction
WSR 18	Gazetted beaches along Castle Peak Road	Construction
WSR 19	Gazetted beaches at Ma Wan	Construction
WSR 20	Ma Wan Fish Culture Zone	Construction and Operation
WSR 21	Proposed Ta Pang Po Intake (Pumping Station)	Construction
WSR 22a	Tai Ho Wan Inlet (inside)	Construction
WSR 22b	Tai Ho Bay (inner), Near Tai Ho Stream SSSI	Construction and Operation
WSR 22c	Tai Ho Wan Inlet (outside)	Construction and Operation
WSR 23	Future seawater intake for LLP	Operation

Code	Description	Impact
WSR 24	Future seawater intake point for Tung Chung	Operation
WSR 25	Cooling water intake at HK International Airport	Construction and Operation
WSR 26	HKBCF South	Operation
WSR 27	San Tau Beach SSSI	Construction and Operation
WSR 28	Cooling water intake at HK International Airport	Construction and Operation
WSR 29	Hau Hok Wan (Horseshoe Crab Habitat)	Construction and Operation
WSR 30	Sha Lo Wan (Horseshoe Crab Habitat)	Construction and Operation
WSR 31	Sham Wat Wan (Mangrove and Horseshoe Crab Habitat)	Construction
WSR 32	Tai O (Mangrove Habitat)	Construction and Operation
WSR 34	Yi O (Mangrove and Horseshoe Crab Habitat)	Construction and Operation
WSR 40	Cheung Sha Wan Fish Culture Zone	Operation
WSR 41	Artificial Reef at NE Airport	Construction and Operation
WSR 42	Artificial Reef at Sha Chau	Construction
WSR 43	Future seawater intake for Tung Chung	Operation
WSR 44	Future HKBCF Intake	Operation
WSR 45c	Sham Shui Kok	Construction
WSR 46	Tai Mo To deep water channel	Construction
WSR 47a	River Trade Terminal	Construction
WSR 47b	River Trade Terminal	Construction
WSR 48	Airport Channel western end	Construction
WSR 49	Tai Mo To (Dolphin Habitat)	Construction and Operation
WSR 50	Potential embayed area for HKBCF	Operation

9.4.4 Baseline Water Quality

9.4.4.1 The existing water quality in the North Western waters have been monitored for many years as part of the EPD's routine monitoring programme. The water quality is monitored monthly at six stations within the North-western WCZ as shown in **Figure 9.5**. A summary of the EPD's Routine Water Quality Data for the North-western WCZ (2006 and 2007) is given in **Tables 9.6a and 9.6b** below.

Table 9.6a Summary of EPD's Routine Water Quality Data for North Western WCZ (2006 – 2007)

Parameters	Monitoring Station					
	NM1		NM2		NM3	
	2006	2007	2006	2007	2006	2007
Temperature (°C)	23.7 (17.6 – 27.4)	23.0 (17.2 – 27.8)	23.8 (17.5 – 27.6)	23.4 (17.3 – 28.4)	23.7 (17.7 – 27.6)	23.2 (17.3 – 28.2)
Salinity (ppt)	29.6 (22.2 – 33.1)	30.9 (26.1 – 33.1)	28.6 (19.0 – 33.1)	29.5 (18.8 – 33.1)	29.4 (23.7 – 33.1)	30.1 (24.9 – 33.1)
Dissolved Oxygen (mg/L)	6.3 (4.4 – 8.0)	5.7 (3.5 – 9.2)	6.5 (4.9 – 8.4)	6.0 (3.3 – 9.7)	6.3 (4.4 – 8.3)	5.8 (3.2 – 9.6)
BOD5 (mg/L)	0.6 (0.4 – 1.1)	1.0 (0.4 – 1.9)	0.6 (0.2 – 1.0)	1.0 (0.4 – 2.5)	0.7 (0.4 – 1.2)	1.1 (0.5 – 2.5)
SS (mg/L)	7.4 (2.5 – 17.4)	8.2 (2.3 – 14.7)	6.4 (2.9 – 21.3)	5.8 (1.8 – 9.3)	8.1 (3.0 – 14.0)	7.4 (3.9 – 11.7)

Parameters	Monitoring Station					
	NM1		NM2		NM3	
	2006	2007	2006	2007	2006	2007
TIN (mg/L)	0.43 (0.17 – 0.75)	0.39 (0.09 – 0.70)	0.49 (0.18 – 0.85)	0.48 (0.09 – 1.05)	0.50 (0.22 – 0.80)	0.47 (0.13 – 0.87)
NH3 – N (mg/L)	0.005 (<0.001 – 0.010)	0.005 (0.001 – 0.007)	0.005 (0.001 – 0.011)	0.006 (0.001 – 0.010)	0.005 (0.001 – 0.011)	0.006 (0.001 – 0.012)
Chlorophyll-*a* (μg/L)	3.6 (0.8 – 19.2)	5.4 (0.7 – 17.7)	2.8 (0.8 – 10.6)	6 (0.7 – 20.7)	3.3 (1.0 – 7.7)	5.9 (1.0 – 22.0)
E. coli (cfu/100mL)	<u>1100</u> (340 – 2600)	<u>670</u> (56 – 3100)	470 (280 – 1900)	360 (49 – 1900)	500 (140 – 2100)	430 (45 – 2400)

Notes:
[1] Data presented are depth averaged (except as specified) and are the annual arithmetic mean except for *E coli* (geometric mean)
[2] Data in brackets indicate ranges
[3] Underlined indicates occurrence of non-compliance with that parameter of WQO

Table 9.6b Summary of EPD's Routine Water Quality Data for North Western WCZ (2006 – 2007)

Parameters	Monitoring Station					
	NM5		NM6		NM8	
	2006	2007	2006	2007	2006	2007
Temperature (°C)	24.0 (17.9 – 27.8)	23.4 (17.3 – 28.3)	24.0 (17.7 – 29.2)	23.8 (17.3 – 30.3)	23.8 (17.5 – 28.3)	23.6 (17.1 – 30.6)
Salinity (ppt)	27.2 (16.4 – 32.8)	28.6 (23.0 – 33.0)	26.0 (10.5 – 33.3)	27.5 (12.0 – 33.0)	27.6 (11.9 – 33.4)	28.9 (9.7 – 33.5)
Dissolved Oxygen (mg/L)	6.3 (4.3 – 8.2)	5.7 (3.0 – 9.3)	6.7 (4.8 – 8.7)	6.4 (3.2 – 10.0)	6.8 (4.8 – 8.2)	6.8 (3.7 – 9.8)
BOD5 (mg/L)	0.7 (0.5 – 0.9)	1.1 (0.5 – 2.7)	0.7 (0.3 – 1.3)	1.1 (0.5 – 2.7)	0.7 (0.3 – 1.9)	1.1 (0.4 – 2.1)
SS (mg/L)	15.7 (3.8 – 53.8)	11.1 (4.3 – 18.7)	12.6 (4.1 – 35.9)	10.0 (3.5 – 27.7)	15.8 (2.7 – 56.7)	11.6 (3.5 – 27.7)
TIN (mg/L)	<u>0.67</u> (0.29 – 1.07)	<u>0.64</u> (0.22 – 1.06)	<u>0.66</u> (0.09 – 1.40)	<u>0.58</u> (0.12 – 1.40)	0.44 (0.06 – 1.20)	0.44 (0.07 – 1.48)
NH3 – N (mg/L)	0.008 (0.03 – 0.017)	0.008 (0.001 – 0.014)	0.006 (0.002 – 0.022)	0.006 (0.001 – 0.012)	0.004 (0.001 – 0.019)	0.004 (<0.001 – 0.009)
Chlorophyll-*a* (μg/L)	4.2 (1.3 – 17.4)	5.5 (1.3 – 23.0)	3.9 (1.1 – 12.0)	7.4 (1.2 – 26.3)	3.5 (1.3 -14.7)	8.3 (0.8–20.7)
E. coli (cfu/100mL)	<u>900</u> (220 – 2600)	<u>1300</u> (160- 3600)	64 (2 – 1900)	46 (2 – 2400)	5 (1 – 420)	12 (1 – 240)

Notes:
[1] Data presented are depth averaged (except as specified) and are the annual arithmetic mean except for *E. coli* (geometric mean)
[2] Data in brackets indicate ranges
[3] Underlined indicates occurrence of non-compliance with that parameter of WQO

9.4.4.2 Some temporal and spatial variability is evident in this dataset, but compliance is usually observed with the key WQOs for unionised ammonia notwithstanding generally eutrophic conditions resulting from the heavy nutrient load carried by the Pearl River. Compliance with the total inorganic nitrogen objective was remained the same during 2006 and 2007. In general, the water quality parameters recorded in 2007 were largely stable compared with 2006.

9.4.4.3 A drop in the compliance with the dissolved oxygen objective was noted. EPD suggested that the drop was related to the general occurrence of low DO starting June 2007 in Marine Water Quality in Hong Kong 2007.

9.4.4.4 Of particular relevance to this assessment, the EPD data for these two years indicate that suspended solid concentrations demonstrated a drop for all stations from 2006 to 2007. Suspended solid concentrations typically lie in the range of 2.5 to 57 mg/l with the highest recorded value being 56.7 mg/l at the Chek Lap Kok West station NM8 in 2006 while that the range drops to of 1.8 to 28 mg/l with the highest recorded value being 27.7 mg/l at the Chek Lap Kok North and West stations NM6 and NM8 in 2007.

9.4.4.5 Compliance with the WQO for dissolved oxygen was not achieved at NM1, NM3 and NM5. Occasional drops in depth average measurements below the compliance value of 4 mg/l was also observed at all monitoring stations. Oxygen super-saturation is, also, observed, particularly at the south-western station NM8, again indicated that eutrophication predominantly influenced by the Pearl River discharge.

9.4.4.6 In addition to EPD's long term programme, comprehensive water quality data sets have been obtained from various construction related environmental monitoring programmes, the most significant ongoing programme being that for the management of the Contaminated Mud Pits at East of Sha Chau. These data are essentially comparable with the longer-term EPD dataset and show general compliance with the WQOs in the region of the mud dumping operations. Data obtained to date from this programme support the hypothesis that the disposal activities have not had any significant adverse effect on water quality beyond the pit areas during dumping. Suspended sediment concentrations are again observed to range from less than 10 mg/L to over 80 mg/L although mean values tend to be a bit higher than reported by EPD. Over the period 1994 to 1997, for example, annual mean depth averaged suspended sediment concentrations ranged from about 18 to 40 mg/L illustrating the considerable variability for this parameter. Depth averaged dissolved oxygen at East Sha Chau varies within the range from 4 to 10 mg/L with a mean value of about 6.7 mg/L.

9.4.4.7 The AAHK has also conducted a serious of non-statutory water quality monitoring for the periods 1999-2000, 2002-2003 and 2005-2006 and the average concentrations of suspended sediment recorded at mid-depth was 11.3 mg/L and the values ranged between 3 to 40 mg/l (Meinhardt, 2006b). The concentrations of dissolved oxygen recorded mid-depth ranged between 2.9 to 15.8 mg/L with an average of 7.0 mg/L.

9.4.4.8 The statutory WQO for suspended sediments is not defined in absolute numerical terms but instead is worded to require that human activities should not result in an elevation of more than 30% above ambient levels (**Table 9.2**). This in part reflects the difficulty in trying to apply a single numerical value for environmental management purposes in the context of the naturally highly variable characteristics of Hong Kong's marine waters. Previous workers assessing the environmental impacts associated with the temporary AFRF at Sha Chau adopted a value of up to 34 mg/L to represent ambient suspended solid concentrations in essentially the same study area as is being considered in this assessment.

9.4.4.9 However, for the purposes of this assessment, the WQO for suspended solids at each sensitive receiver will be based on an analysis of the EPD routine monitoring data from 1998 to 2007 at the nearest EPD monitoring station, as described in **Section 9.5** below.

9.4.5 Baseline Sediment Quality

9.4.5.1 There is a wealth of sediment quality data for the study area, from EPD's routine monitoring, previous project surveys and, also, from project specific investigation undertaken for the projects of HKBCF, HKLR and HKBCF. Details of the findings from the various sources are presented in the sections below.

EPD Routine Sediment Quality Monitoring

9.4.5.2 Some existing sediment quality data from EPD sediment monitoring station in the North Western WCZ are available within the study area, which are monitored by the EPD every six months at four stations: NS2, NS3, NS4 and NS6 as shown in **Figure 9.5**. NS5 is not included in this evaluation as it is located in Tuen Mun Typhoon Shelter which is not relevant to this evaluation. The locations of the EPD stations are as follows:

- NS2 is located to the north of Siu Mo To at ~2.5km east of the preferred alignment;
- NS3 is located in the waters off the tip of River Trade Terminal in Tuen Mun and is about 500m from the proposed north reclamation landing at Tuen Mun;
- NS4 is located between Lung Kwu Chau and Lung Kwu Tan; and
- NS6 is near the western end of the airport runway. As both are far (>5km) from the Project site, they are not considered relevant to this project.

9.4.5.3 The monitoring results of NS2, NS3 in 2003-2007 are summarised in **Tables 9.7a and 9.7b,** with reference to the ETWB TC(W) 34/2002 criteria, as well as nitrogen and phosphorus nutrient contents.

Table 9.7a EPD's Sediment Quality Monitoring Data for NS2 and NS3 within North Western Waters (2003-2007)

Contaminants[1]	Unit	NS2[2]	NS3[2]	LCEL	UCEL
Arsenic	mg/kg dry wt	7.2 – 14	8.3 – 14	12	42
Cadmium	mg/kg dry wt	<0.1 – 0.1	<0.1 – 0.1	1.5	4
Chromium	mg/kg dry wt	24 – 43	20 – 42	80	160
Copper	mg/kg dry wt	28 – 42	18 – 48	65	110
Mercury	mg/kg dry wt	0.07 – 0.13	0.06 – 0.15	0.5	1
Nickel	mg/kg dry wt	15 – 27	11 – 24	40	40
Lead	mg/kg dry wt	31 – 50	27 – 45	75	110
Silver	mg/kg dry wt	0 – 1	0 – <1	1	2
Zinc	mg/kg dry wt	77 – 130	62 – 120	200	270
Low Molecular Weight PAH[3]	μg/kg dry wt	14 – 67	18 – 64.5	550	3,160
High Molecular Weight PAH[3]	μg/kg dry wt	35.5 – 123.5	38 – 113.5	1,700	9,600
Total PCBs	μg/kg dry wt	18 – 18	18 – 18	23	180
Particle Size Fraction <63μm	%	35 – 63	23 – 87	--	--
Total Kjeldahl Nitrogen (TKN)	mg/kg dry wt	120 – 520	120 – 440	--	--
Ammonia Nitrogen	mg/kg dry wt	0.12 – 8.2	<0.05 – 16	--	--
Total Phosphorus	mg/kg dry wt	84 – 290	86 – 250	--	--

1 Based on bulk samples;
2 The presented results are in range (min-max) and values exceeding the LCELs are shown in underlined; and
3 Mostly below analytical reporting limits and numeric values shown are calculated from the available components with <RL substituted with ½RL.

Table 9.7b EPD's Sediment Quality Monitoring Data for NS4 and NS6 within North Western Waters (2003-2007)

Contaminants[1]	Unit	NS4[2]	NS6[2]	LCEL	UCEL
Arsenic	mg/kg dry wt	9.1 – 11	7.1 – 16	12	42
Cadmium	mg/kg dry wt	<0.1 – 0.1	<0.1 - 0.1	1.5	4
Chromium	mg/kg dry wt	26 – 36	18 – 37	80	160
Copper	mg/kg dry wt	18 – 42	8 – 27	65	110
Mercury	mg/kg dry wt	0.06 – 0.23	<0.05– 0.1	0.5	1
Nickel	mg/kg dry wt	16 – 22	10 – 24	40	40
Lead	mg/kg dry wt	29 – 46	20 – 46	75	110
Silver	mg/kg dry wt	<1 – 0	<1 – 0	1	2
Zinc	mg/kg dry wt	99 – 110	42 – 100	200	270
Low Molecular Weight PAH[3]	μg/kg dry wt	90 – 99	90 – 94	550	3,160
High Molecular Weight PAH[3]	μg/kg dry wt	35 – 120	16 – 49	1,700	9,600
Total PCBs	μg/kg dry wt	18 – 18	18 – 18	23	180
Particle Size Fraction <63μm	%	12 – 61	10 – 81	--	--
Total Kjeldahl Nitrogen (TKN)	mg/kg dry wt	160 – 350	130 – 400	--	--
Ammonia Nitrogen	mg/kg dry wt	0.19 – 30	0.05 – 13	--	--
Total Phosphorus	mg/kg dry wt	92 – 230	100 – 260	--	--

1 Based on bulk samples;
2 The presented results are in range (min-max) and values exceeding the LCELs are shown in underlined; and
3 Mostly below analytical reporting limits and numeric values shown are calculated from the available components with <RL substituted with ½RL.

9.4.5.4 It is observed that of all parameters except arsenic are lower than the LCELs. Only the upper range arsenic concentrations were observed to exceed the LCEL. Based on the EPD's Marine Water Quality in Hong Kong 2000, the arsenic concentrations might be due to the high natural arsenic levels in the soil of some areas of the northern New Territories (e.g. Lok Ma Chau, Ngau Tam Mei and Pat Heung) which could have been transported to the marine environment through river discharges and storm runoff.

9.4.5.5 There were 6 occasions over the past 5 years have EPD detected arsenic concentrations in the North-western waters marine sediment above the UCEL criterion adopted to define a level above which adverse biological toxicological effects would be expected. Given that the arsenic concentrations in this region are likely to represent the result of gradual natural erosive processes over geologic timescales, it seems reasonable to assume that the existing ecosystem is tolerant to the widespread presence of this element.

East Sha Chau Contaminated Mud Disposal Pit

9.4.5.6 In addition to the EPD's routine monitoring programme, comprehensive water quality data sets have been obtained from various environmental monitoring programmes, with the most significant on-going one being that for the management of Contaminated Mud Pits at East of Sha Chau. **Figure 9.6** shows the locations of the monitoring stations used. These data are essentially comparable to the EPD's routine monitoring dataset and show a general compliance with WQOs in the area near the mud dumping operations. Data obtained to date support the hypothesis that disposal activities have not had any significant adverse effects on the water quality beyond the immediate confines of the mud pit areas during dumping. Suspended sediment concentrations are observed to range from <10 mg/l to >80 mg/l, although mean values tend to be higher than those reported by the EPD. For examples, over the period of 1994-1997, the annual mean depth averaged suspended sediment concentrations ranged ~18-40 mg/l, illustrating the variability of this parameter. The depth averaged dissolved oxygen concentration at East Sha Chau varies within the range of 4-10 mg/l, with a mean value of ~6.7 mg/l.

Hong Kong Section of HZMB and Connection with North Lantau Highway (EIA in 2004)

9.4.5.7 A review of previous environmental marine ground investigation (GI) of the airport east conducted in 2004 has been conducted under the HyD's Agreement No. CE26/2003 (HY) Hong Kong Section of Hong Kong-Zhuhai-Macao Bridge and Connection with North Lantau Highway – Investigation. Vibrocores and grab samples were collected at 23 locations and surface grab samples were collected at another 18 locations along the proposed route alignment of the Hong Kong Section of the HZMB in the western waters to the airport island, within the airport channel, and in northern waters of Tung Chung as shown in **Figure 9.7**. Elutriate testing of the surface grab samples was also carried out.

9.4.5.8 Sediment samples were tested for the suite of metals, metalloids and organic pollutants (PAHs, PCBs and TBT) as specified in the ETWB TC(W) No.34/2002. Chlorinated pesticides (11 components: α-BHC, β- & γ-BHC, δ-BHC, aldrin, endosulfan 1, endosulfan sulfate, heptachlor, heptachlor-epoxide, p,p'-DDE, p,p'-DDD, p,p'-DDT) were also tested for the 0-1m (surface) sub-samples. In addition to these parameters, elutriate testing of sediment samples was also conducted for nitrogen (ammonia, nitrate, nitrate and TKN) and phosphorus (total phosphorus and reactive phosphorus) nutrients.

9.4.5.9 There were 46 Category M samples with slightly exceedance of arsenic concentration for the LCEL (maximum: 22 mg/kg dry weight). There were 4 Category H samples with exceedance of nickel concentration for the UCEL (maximum: 59 mg/kg dry weight), chromium concentration for the LCEL (n=1, 88 mg/kg dry weight) or zinc concentration for the LCEL (n=3, maximum: 257 mg/kg dry weight). It should be noted that all tested samples had their total PAHs, total PCBs, TBT in interstitial water, and chlorinated pesticides below their respective analytical reporting limit (total PAHs: low molecular weight PAHs <55 µg/kg dry weight and high molecular weight PAH <170 µg/kg dry weight; total PCBs: <2 µg/kg dry weight; TBT in interstitial water: <0.015 µg/l; and chlorinated pesticides: <0.2 mg/kg dry weight). The 46 Category M samples (36.5% of 126 samples) were further tested for the biological screening in accordance with the ETWB TC(W) No.34/2002, in which 26 composite samples were formed. Half of the samples failed the biological screening.

9.4.5.10 There were 43 sediment samples tested for the elutriate testing. All the elutriate samples had the following parameters to be determined below the respective analytical reporting limits: cadmium <0.2 µg/l; mercury <0.1 µg/l; silver <1 µg/l; total PAHs: low molecular weight PAHs <0.1 µg/l per component and high molecular weight PAHs <0.1 µg/l per component; total PCBs <0.01 µg/l per congener; TBT <0.015 µg/l; and chlorinated pesticides <0.02 µg/l. Chromium was only detected in 2 samples (maximum: 2 µg/l), while lead was detected in 3 samples (maximum: 18 µg/l). Copper (range: <1-2.7 µg/l), nickel (range: <1-5.2 µg/l) and zinc (<4-14 µg/l) were occasionally detected, while arsenic was always detected (range: <2-9.8 µg/l). Ammonia (range: 130-2,100 µg/l), nitrite (range: 10-

460 µg/l), nitrate (8-600 µg/l), TKN (range: 160-2,600 µg/l), total phosphorus (range: 0.1-0.27 mg/l) and reactive phosphorus (range: <2-110 µg/l) were detected in almost all elutriate samples.

AAHK – Non-Statutory Marine Environmental Monitoring

9.4.5.11 The AAHK has undertaken a programme of non-statutory marine environmental monitoring to verify the environmental performance of the airport platform. The programme included the collection of sediments using surface grab and three rounds of non-statutory monitoring have been conducted so far. The first round was conducted in 1999-2000 which included two sampling events. The second round was conducted in 2002-2003 which included 1 sampling event. The third round was conducted in 2005-2006 which also included 1 sampling event. The sediment monitoring stations were the same over the 3 rounds of monitoring although fewer stations were monitored in the second and third rounds. The locations of the latest monitoring stations are shown in **Figure 9.7**.

9.4.5.12 Sediment samples were analysed for the same suite of contaminants as listed in the ETWB TC(W) No.34/2002 including metals, metalloid, total PAHs and total PCBs, but there was no TBT. Chlorinated pesticides (15 components) were also analysed.

9.4.5.13 The monitoring results are summarised in **Table 9.8** for the ETWB TC(W) No.34/2002 criteria on metals and metalloid. The total PAHs, total PCBs and chlorinated pesticides were below the analytical reporting limits (comparable to the requirement of ETWB TC(W) No.34/2002) and the results are not presented.

Table 9.8 Summary of AAHK Non-statutory Sediment Quality Monitoring Results (1999-2006)

Contaminant	Unit	Range	LCEL	UCEL
As	mg/kg dry weight	6.4 - 24.7	12	42
Cd	mg/kg dry weight	<0.05 - 0.29	1.5	4
Cr	mg/kg dry weight	16 - 60	80	160
Cu	mg/kg dry weight	16 - 52	65	110
Hg	mg/kg dry weight	<0.05 - 0.21	0.5	1
Ni	mg/kg dry weight	10 - 39	40	40
Pb	mg/kg dry weight	26 - 62	75	110
Ag	mg/kg dry weight	0.1 - <1	1	2
Zn	mg/kg dry weight	63 - 157	200	270

Study for New Contaminated Mud Disposal Facility (East of Sha Chau Pit V)

9.4.5.14 Sediment quality analyses were conducted under the Agreement No. CE 12/2002(EP) Detailed Site Selection Study for a Proposed Contaminated Mud Disposal Facility within the Airport East/East of Sha Chau Area. There were 12 vibrocores collected (**Figure 9.7**), yielding 68 sub-samples with a maximum depth of 20m investigated. The results suggested that most of the sediment samples were uncontaminated, but 2 sub-samples (10.9-11.9m of V10 and 14.9-15.9m of V11) indicated the exceedance of UCEL for nickel and zinc concentrations. Some sub-samples of V2 (15-16m), V7 (0.9-1.9m), V8 (9.9-10.9m, 18.8-19.8m) and V9 (0-0.9m, 0.19-1.9m and 1.9-2.9m) also exhibited marginal exceedance of the

LCEL for arsenic, except a sub-sample of V2 (15-16m, exceeding LCEL of silver) and V9 (0-0.9m, marginal exceedance of LCEL for arsenic and mercury). Concentrations of total PAHs and total PCBs of all samples were determined to be below the analytical report limits. There were 4 out of 8 composite Category M samples have failed the subsequent biological test. Based on the test results, 84% of samples were uncontaminated (Category L), 13% were moderately contaminated (Category M) and 3% were highly contaminated (Category H).

HKBCF and HKLR (EIAs)

9.4.5.15 The details for the sediments sampling and results are presented in **Section 7** and a summary is provided below.

9.4.5.16 There were 80 sub-samples from 10 vibrocores and 37 sub-samples from 6 vibrocores undertaken in the marine investigation for the reclamation of HKBCF and HKLR, respectively, in 2008 and 2009.

9.4.5.17 With reference to the chemical tests under the ETWB TC(W) No.34/2002, 90 samples exhibited compliance with the LCEL, but 27 samples showed exceedance of LCEL, which required biological tests to confirm their disposal options. All chemical exceedances were due to the metalloid arsenic (As) concentrations, except one case which was due to lead (Pb). Biological screening results for the samples from the HKBCF showing exceedance of the LCELs indicated that some of them should be disposed of at the confined mud pit, whilst some of them could be considered for Open Sea Disposal (Dedicated Sites).

9.4.5.18 Elutriate tests and porewater tests of sediment samples were carried out for the purpose of assessing the potential extent of contaminant release when dredging activities take place. The testing parameters for both tests included heavy metals (cadmium, chromium, copper, mercury, nickel, lead, zinc and silver), metalloid (arsenic) and organic micro-pollutants (PCB, PAHs and TBT), chlorinated pesticides and nutrients including TKN, NO_3-N, NO_2-N, NH_4-N, PO_4-P and total phosphorus. In respect of the elutriate test results, in general, the levels of cadmium, chromium, mercury, silver, TBT, PAHs, PCBs and Pesticides were mostly below the reporting limits, whereas other metals and metalloid including copper, nickel, zinc and arsenic, and nutrients including NH_3-N, NO_2-N, NO_3-N, TKN, PO_4-P and total phosphorus in elutriates varied among sediment samples from different locations. For porewater, the levels of cadmium, chromium, mercury, silver, PAHs, PCBs, TBT and Pesticides were mostly below the reporting limits, whereas other metals and metalloid including copper, nickel, lead, zinc and arsenic, and nutrients including NH_3-N, NO_2-N, NO_3-N, TKN, PO_4-P and total phosphorus in porewater samples varied among sediment samples from different locations.

TMCLKL

9.4.5.19 Sampling works were conducted by the Term Contractor of Geotechnical Engineering Office (GEO) of the Civil Engineering and Development Department (CEDD) between September and October 2008. Vibrocoring at 10 locations was undertaken for the TMCLKL, as shown in **Figure 9.7** to reflect the areas of the preferred reclamation landfalls and marine viaduct alignment. The details for the sediments sampling and results are presented in **Appendix 9D1** and a summary provided below.

9.4.5.20 There were 23 sediment sub-samples at the 10 vibrocore locations near the proposed route alignment and reclamation landfalls of the TMCLKL. With reference to the chemical tests under the ETWB TC(W) No.34/2002, 18 samples exhibited compliance with the LCEL, but 5 samples showed exceedance of LCEL, which required biological tests to confirm their disposal options. The chemical exceedance included metal (Pb), metalloid (As) and micro-organic pollutants (high molecular weight PAHs) concentrations. However, all of these 5 samples with exceedances of the LCEL passed the biological test. In summary, two classifications of sediment material have been identified, comprising Category L and Category M, that passes the biological testing (M_p). The materials are suitable for disposal in Type 1 open sea and Type 1 Open Sea (Dedicated) disposal, respectively.

9.4.5.21 Elutriate tests and porewater tests of the grab sediment samples were, also, carried out for the purpose of assessing the potential extent of contaminant release when dredging activities take place. The testing parameters for both tests included heavy metals (cadmium, chromium, copper, mercury, nickel, lead, zinc and silver), metalloid (arsenic) and organic micro-pollutants (PCB, PAHs and TBT), chlorinated pesticides and nutrients including TKN, NO_3-N, NO_2-N, NH_4-N, PO_4-P and total phosphorus. In respect of the elutriate test results, in general, the levels of cadmium, silver, TBT, PAHs, PCBs and Pesticides were all below the reporting limits, whereas other metals and metalloid including chromium, copper, mercury, nickel, lead, zinc and arsenic, and nutrients including NH_3-N, NO_2-N, NO_3-N, TKN, PO_4-P and total phosphorus in elutriates varied among sediment samples from different locations. For porewater, the levels of cadmium, lead, mercury, silver, PAHs, PCBs and TBT were all below the reporting limits, whereas other metals and metalloid including chromium, copper, nickel, zinc and arsenic, nutrients including NH_3-N, NO_2-N, NO_3-N, TKN, PO_4-P and total phosphorus in porewater samples varied among sediment samples from different locations.

Summary of Sediment Quality

9.4.5.22 In conclusion, there is an abundance of sediment quality data pertaining to the study area for this assessment which indicates that the sediments are overall not contaminated with only a few exceptions.

9.5 Assessment Criteria

9.5.1 Water Quality Objectives

9.5.1.1 For the WCZs of interest, the WQO for suspended solids is defined as "waste discharge not to raise the natural ambient level by 30% nor cause the accumulation of suspended solids which may adversely affect aquatic communities". It is expected that the North Western WCZ will experience the largest impact from the construction works but the Western Buffer WCZ could also be impacted to some extent. As a result, in order to determine the ambient suspended solids concentrations in the waters likely to be impacted by the construction works, data in the North Western and Western Buffer WCZs from EPD's routine water quality monitoring programme from 1998 to 2007 at Stations NM1, NM2, NM3, NM5, NM6, NM8 and WM4 and WM3 (see **Figure 9.5**) have been analysed.

9.5.1.2 The EPD data is obtained near the sea surface, mid-depth and near the seabed and a summary of the statistics are presented below in **Tables 9.9a and 9.9b**, where the wet season has been taken to be from mid-April until the end of September each year.

Table 9.9a Suspended solids concentrations from EPD Routine Monitoring Programme (1998-2007)

Station	Suspended Solids Concentrations (mg/L) 1998 - 2007							
	Surface		Middle		Bed		Depth Averaged	
	Dry Season	Wet Season	Dry Season	Wet Season	Dry Season	Wet Season	Dry Season	Wet Season
NM1	7.3	5.4	9.8	6.5	13.4	12.3	10.2	7.9
	(43-1)	(25-0.7)	(43-1.1)	(21-1.3)	(53-1.4)	(45-1.2)	(41-1.5)	(20.5-3.1)
NM2	6.7	4.4	8.7	4.9	12.1	7.7	9.1	5.6
	(21-1.1)	(9.7-1.2)	(28-1.6)	(14-1)	(47-2.2)	(32-1.7)	(30-1.7)	(17.3-2.4)
NM3	7.1	5.3	9.3	7.2	15.4	13.8	10.6	8.8
	(16-1.6)	(15-1.2)	(21-1.2)	(20-1.4)	(71-2.3)	(46-2.1)	(32.3-1.9)	(23-2.7)
NM5	8.4	6.5	10.4	7.9	20.8	27.7	13.2	14
	(19-1.6)	(17-1.2)	(29-1.6)	(44-2.3)	(81-2.3)	(210-3.2)	(37.7-2)	(86.9-3.3)
NM6	10.2	5.4	11.4	6.2	16.0	12.4	12.5	8.3
	(32-2.9)	(12-0.9)	(40-2.1)	(12-1.8)	(60-3.2)	(84-2.4)	(42.7-2.8)	(35.7-2.6)
NM8	11.6	5.9	14.7	8.8	21.9	16.5	16	10.3
	(48-1.3)	(17-2.4)	(63-2.6)	(25-2.0)	(73-3.6)	(63-2.4)	(56.7-2.7)	(30.5-4.5)
WM4	6.9	3.9	11.1	6.2	14.8	12.7	10.9	7.6
	(21-0.8)	(7.9–0.9)	(52-0.6)	17-1.2	(80-1.5)	(110-1.2)	(49-1.3)	(40-1.2)
WM3	6.6	4.7	8.1	6.4	11.1	8.5	8.7	6.7
	(17-1.4)	(18-1.0)	(19-1.0)	(26-1.2)	(32-1.4)	(30-1.2)	(19.8-1.3)	(17.3-1.1)

Notes The date are presented as the arithmetic mean and range (max – min) of the suspended solids concentrations at each station at the three monitoring levels and as the depth averaged concentrations.

Table 9.9b 90th Percentile Suspended solids from EPD Routine Monitoring Programme (1998-2007)

Station	90th Percentile Suspended solids Concentrations (mg/L)							
	Surface		Middle		Bed		Depth Averaged	
	Dry Season	Wet Season	Dry Season	Wet Season	Dry Season	Wet Season	Dry Season	Wet Season
NM1	14.6	8.1	17.6	11.2	34.0	21.0	20.4	12.4
NM2	11.1	6.9	17.5	8.2	20.2	13.0	15.5	9.4
NM3	12.0	8.2	16.0	12.5	27.0	23.2	17.9	13.5
NM (1,2,3)	12.0	7.7	17.0	10.9	27.0	20.0	18.5	12.2
NM5	15.2	11.6	18.4	11.0	46.2	46.2*	26.9	21.0*
NM6	21.0	8.4	22.8	9.6	31.0	23.6	25.8	13.0
NM8	21.5	10.2	28.0	18.1	43.2	28.8	30.6	18.8
NM(5,6,8)	19.0	10.0	25.8	12.0	39.4	34.4	27.7	18.7
WM4	13.0	5.7	20.0	9.5	30.0	20.0*	20.2	11.3*

Notes *=outliers (unusual high SS removed) before the percentile calculation.
NM(1,2,3) = pooled results by combining the data set from NM1, NM2 and NM3
NM(5,6,8)=pooled results by combining the data set from NM5, NM6 and NM8

9.5.1.3 In the current study, rather than averaging the 90th percentile concentrations over the whole area which could be impacted by the construction works, it is proposed to assign each sensitive receiver to the nearest EPD water quality monitoring station and to set the WQO at each station as 30% of the 90th percentile at that station.

9.5.1.4 As indicated in **Table 9.9a** above, monitoring results of the NM1, NM2 and NM3 at the eastern half of the NWWCZ is fairly homogenous and reasonably distinct from the NM5, NM6 and NM6 at western side of NWWCZ. Based on the hydrodynamic of the NWWCZ, major flows at the western side is mainly north-south and more heavily influenced by the Pearl River discharge and this would also accounted for the higher ambient SS level recorded. Based on the data pattern, it is proposed to group the stations of similar characteristics with respect to the SS together into two parts, the eastern NM(1,2,3) and western NM(5,6,8). This simplified the WQO assignment exercise although the calculated 90 percentile for each individual station is also included in **Table 9.9b** as reference. The delineation of the eastern and western parts and also the EPD stations are presented in **Figure 9.5**.

9.5.1.5 The WQO is usually interpreted as applying to the depth averaged Suspended solids concentrations. However, near bed suspended solids concentrations, especially when impacted by dredging and filling works, can be significantly larger than the depth averaged suspended solids concentrations. As a result, when assessing the impacts of the dredging and filling works on the suspended solids concentrations, it is proposed that while the principal assessment criteria shall be the depth averaged 90th%ile concentrations in **Table 9.9b**, a secondary WQO criteria for each depth shall also be referenced in the assessment, especially when a higher SS elevation at the bottom level can be expected and that SS at bottom level are naturally higher than the water column. The WQO for each EPD monitoring station derived in this way are presented in **Table 9.10.**

Table 9.10 Water Quality Objectives for the Assessment of Elevations in Suspended Solids Concentrations (mg/L) due to Construction Impacts

Station	90th Percentile Suspended solids Concentrations (mg/L)							
	Surface		Middle		Bed		Depth Averaged	
	Dry Season	Wet Season	Dry Season	Wet Season	Dry Season	Wet Season	Dry Season	Wet Season
NM1	4.4	2.4	5.3	3.4	10.2	6.3	6.1	3.7
NM2	3.3	6.1	5.3	2.5	6.1	3.9	4.6	2.8
NM3	3.6	2.4	4.8	3.8	8.1	7.0	5.4	4.1
NM (1,2,3)	3.6	2.3	5.1	3.3	8.1	6.0	5.5	3.7
NM5	4.6	3.5	5.5	3.3	13.9	13.9*	8.1	6.3*
NM6	6.3	2.5	6.8	2.9	9.3	7.1	7.8	3.9
NM8	6.5	3.1	8.4	5.4	13.0	8.6	9.2	5.7
NM(5,6,8)	5.7	3.0	7.7	3.6	11.8	10.3	8.3	5.6
WM4	3.9	1.7	6.0	2.8	9.0	6.0*	6.1	3.4*

Notes *=outliers (unusual high SS removed) before the percentile calculation.
NM(1,2,3) = pooled results by combining the data set from NM1, NM2 and NM3
NM(5,6,8)=pooled results by combining the data set from NM5, NM6 and NM8

9.5.1.6 Based upon the values detailed in **Table 9.10** above, each specific point / sensitive receiver that will be included in the water quality model has been assigned a specific WQO for suspended solids, as detailed in **Table 9.11**.

Table 9.11 Water Quality Objectives for Observation Points and Water Sensitive Receivers

Observation Points	Point SR	Name	Associated EPD Station	WQO/WQC							
				Dry Season				Wet Season			
				S	M	B	DA	S	M	B	DA
WSR 08	Yes	Lung Kwu Sheung Tan (non-gazetted beach)	NM5,6,8	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 09a	No	Urmston Road (Main Channel)	NM5,6,8	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 10	Yes	Sha Chau and Lung Kwu Chau Marine Park	NM5,6,8	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 11	Yes	Castle Peak Power Station Cooling Water Intake (Note 1)	-	764	764	764	764	764	764	764	764
WSR 12	Yes	Butterfly Beach (gazetted beach)	NM1,2,3	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 13	Yes	WSD Seawater Intake at Tuen Mun	NM1,2,3	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 15	Yes	Gazetted Beaches at Tuen Mun	NM1,2,3	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 18	Yes	Gazetted Beaches along Castle Peak Road	NM1,2,3	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 19	Yes	Gazetted Beaches at Ma Wan	WM4	3.9	6.0	9.0	6.1	1.7	2.8	6.0	3.4
WSR 20	Yes	Ma Wan Fish Culture Zone (Note 2)	-	39.1	39.1	39.1	39.1	43.0	43.0	43.0	43.0
WSR 21	Yes	Ta Pang Po (near Sunny Bay Mangrove)	NM1,2,3	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 22a	No	Tai Ho Wan Outlet (inside)	NM1,2,3	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 22b	Yes	Tai Ho Wan (inner), Near Tai Ho Stream SSSI	NM1,2,3	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 22c	Yes	Tai Ho Wan Outlet (outside) / Near coral site	NM1,2,3	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 23[4]	Yes	Future seawater intake for LLP	---	10	10	10	10	10	10	10	10
WSR 24[4]	Yes	Future seawater intake point for Tung Chung	---	10	10	10	10	10	10	10	10
WSR 25	Yes	Airport Cooling Water Intake (NE)	NM1,2,3	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 27	Yes	San Tau Beach SSSI	NM5,6,8	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 28	Yes	Airport Channel / Airport Cooling Water Intake (S)	NM1,2,3	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 29	Yes	Hau Hok Wan (Horseshoe Crab Habitat)	NM5,6,8	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6

Observation Points	Point SR	Name	Associated EPD Station	WQO/WQC							
				Dry Season				Wet Season			
				S	M	B	DA	S	M	B	DA
WSR 30	Yes	Sha Lo Wan (Horseshoe Crab Habitat)	NM5,6,8	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 31	Yes	Sham Wat Wan (Mangrove and Horseshoe Crab Habitat)	NM5,6,8	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 32	Yes	Tai O (Mangrove Habitat)	NM5,6,8	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 34	Yes	Yi O (Mangrove and Horseshoe Crab Habitat)	NM5,6,8	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 41	Yes	Artificial Reef at NE Airport	NM1,2,3	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 42	Yes	Artificial Reef at Sha Chau	NM5,6,8	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 43[4]	Yes	Future seawater intake for Tung Chung	---	10	10	10	10	10	10	10	10
WSR 45c	No	Sham Shui Kok (CWD habitat range)	NM1,2,3	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 46	No	Tai Mo To (near coral / CWD habitat range)	NM1,2,3	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 47a	No	River Trade Terminal	NM1,2,3	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 47b	Yes	River Trade Terminal (near coral site)	NM1,2,3	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 48	No	Airport Channel western end	NM5,6,8	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 49	No	Tai Mo To (Deep Channel / CWD habitat range)	NM1,2,3	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7

Notes:
1. The stations at Deep Bay (DMx) and South Lantau (SMx) are considered too far to be affected by the projects plumes and the criteria are not derived.
2. There is a specific requirement for the Castle Peak Power Station intake and the SS should be maintained at below 150 mg/L (ERM, 2005)
3. General water quality protection guideline for FCZ (CityU, 2001)
4. WSD's Water Quality Criteria for Flushing Water at Sea Water Intakes. Values present represent absolute values.

9.5.2 Others

9.5.2.1 In addition to the general WQO described above, other beneficial uses of the coastal waters, for example, fish culture zones and seawater abstraction pumping stations, may also set specific limit levels on the absolute maximum suspended solids concentrations at the intake points.

9.5.2.2 Not Used.

9.5.2.3 The Water Quality Objectives of Sea Water for Flushing Supply (at intake point) issued by the Water Supplies Department (WSD) specify the criteria for assessing the water quality impacts on WSD's seawater intakes. Table 9.12a tabulates a list of the criteria.

Table 9.12a WSD's Water Quality Criteria for Flushing Water at Sea Water Intakes

Paramter	Concentration (mg/L)
Colour (H.U.)	< 20
Turbidity (N.T.U)	< 10
Threshold Odour No.	< 100
Ammonia Nitrogen	< 1
Suspended Solids	< 10
Dissolved Oxygen	> 2
Biological oxygen Demand	< 10
Synthetic Detergents	< 5
E. coli / 100 ml	< 20,000

9.5.2.4 The Ma Wan fish culture zone could be impacted by the dredging and filling works and an additional limit level of 50mg/L will be set for the fish culture zone as local study has indicated that general tolerance of fishes to high suspended solids (CityU, 2001).

9.5.2.5 Deposition of fine sediment in ecologically sensitive areas including coral sites could also have an adverse impact on the marine ecosystem. In previous studies (Binnie 1996, Meinhardt 2007, Mouchel 2002), an indicator level above which sustained deposition could harm sediment sensitive hermatypic corals of 200 $g/m^2/day$ has been used. Soft corals typical of the north western coastal waters where the sediment regime is more dynamic than in other parts of Hong Kong's coastal waters are expected to be even more tolerant of deposition. In a recent study in Tolo Harbour and north eastern waters (ERM 2003), however, an impact criterion of $100g/m^2/day$ has been used but this may be overly conservative in the North-western waters. In the current study, it is proposed that an upper limit of $200g/m^2/day$ is set but that any areas subject to deposition rates of over $100g/m^2/day$ are, also, assessed to ensure any particularly sensitive areas are protected.

9.5.2.6 Elutriate tests were conducted to estimate the amount of pollutants that would be released into the water during seawall dredging and filling. However, there are no relevant standards in Hong Kong for assessment of acceptable concentrations of heavy metals and micro-pollutants in marine water. For the heavy metals (except Ag), PCB and PAH, the European Environmental Quality Standards for have been adopted. For Ag and TBT, the US standards have been referred. The European Environmental Quality Standards for metals and metalloids are detailed in **Table 9.12b**. The assessment criteria for organic micro pollutants are also summarized in **Table 9.12c**.

Table 9.12b European Union Environmental Quality Standard (EQS) Values to Protect Marine Life

Metals and Metalloid	Water Quality Standard (as dissolved metal) (µg/L)
Arsenic	25
Cadmium	2.5
Chromium	15
Copper	5
Lead	25
Mercury	0.3
Nickel	30
Silver	1.9[1]
Zinc	40

Note [1]: USEPA, Criteria Maximum Concentration (CMC) of the USEPA Water Quality Criteria (Saltwater)

Table 9.12c Assessment Criteria for Organic Micro-pollutants and other Parameters

Parameter	Maximum Concentration	Standard
Organic Micro-pollutants		
PCBs	0.3 μg/L (total)	EU Shellfish Waters Directive Note 1
PAHs	0.2 μg/L	The European Union Water Quality Standards
TBT	0.01 μg/L	USEPA Note 2

Notes: [1] Proposed Marine Water Quality Standards of EU Shellfish Waters Directive (79/923/EEC).
[2] Criterion Continuous Concentration (CCC) of the USEPA Water Quality Criteria (Saltwater).

9.6 Key Issues

9.6.1 Background

9.6.1.1 The key issues pertinent to the water pollution during the construction and operational phases are summarised below. As noted above, where assessment of these factors requires water quality modelling, the assessment has been based upon the combined HKBCF+HLKLR+TMCLKL projects.

9.6.2 Construction Phase

9.6.2.1 The principal water quality concern associated with these projects relate to the disturbance to the seabed during the construction period. There will be a need for dredging and filling for both the seawalls and reclamations for all three projects. These operations will inevitably result in the loss of sediments and backfilling materials into the water column where they will add to the suspended sediment load.

9.6.2.2 During dredging works, fine material will be displaced and may be carried downstream of the works area. The extent of the suspended sediment plume will depend on the rate of release and, thus, the working methods adopted, the particle size of the dredged material and its characteristic settling velocity, the prevailing currents and hydrodynamic conditions. Similar disturbance may be experienced during backfilling, although the backfill material will be very much coarser grained and heavier (sand fill and public fill).

9.6.2.3 Sediment laden plumes may directly affect marine organisms through abrasion and clogging of fish gills and other organs or possibly as a result of reduced light penetration.

9.6.2.4 From the review of sediment quality data above, it can be concluded that the dredging operations would be most unlikely to release significant levels of contaminants of potential ecotoxicological concern into the wider environment. In some situations dredging operations can give rise to concerns about possible release of nutrients or organically rich material which could result in water column oxygen depletion. However, there is very extensive experience of dredging operations for construction works similar to those intended for this project within the marine waters of Hong Kong. Nutrient enrichment or oxygen depletion has never been reported as a major concern for marine dredging works in Hong Kong previously and there is no reason to believe that these processes would be of concern in the well flushed North-western Waters.

9.6.2.5 Not Used.

9.6.2.6 In summary, the key construction phase issues will be as follows:

- Changes in the coastline configuration that may lead to short-term impacts on hydrodynamic and water quality conditions, and water sensitive receivers (WSRs) within the North Western waters and adjacent water bodies;

- Dredging and filling activities during the construction period which may release of suspended solids and generation of sediment plumes, and release of contaminants and nutrients into the water body;
- Changes in sediment deposition rate which may affect the adjacent WSRs and ecological sensitive receivers;
- Construction site runoff causing the increase in suspended solids levels and possibly oils due to erosion of exposed surfaces, stockpiles and material storage areas, fuel and oil storage and maintenance areas and dust suppression sprays;
- Wastewater and sewage generated from construction activities causing pollution of the surrounding water bodies;
- Disturbance to banks and stream beds during culverting and slope reinforcement or toll plaza works;
- Litter from packaging materials and waste construction materials; and
- Construction workforce sewage.

9.6.3 Operational Phase

9.6.3.1 The key operational phase issues are related to the effects that the proposed reclamations will have impact on the larger scale flows in the area and any subsequent deterioration in water quality. The key issues are as follows:

- significant reduction or acceleration of tidal flows resulting in siltation or erosion of seabed and scour hole formation;
- reduction in water quality;
- siltation and loss of water depth;
- poorly flushed embayments;
- accumulation of floating debris; and
- reduced dispersion of cooling water discharges and increase in seawater temperature.

9.6.3.2 There will be no routine discharge of wastewater or contaminated surface drainage to sea or surface watercourse in the operational phase but there will be some run-off from the road surfaces that could be marginally contaminated with pollution from vehicles fuel.

9.6.3.3 Not Used.

9.6.3.4 In summary, the key operational phase issues will be as follows:

- Changes in coastline configuration that may lead to long-term impacts on the hydrodynamic and water quality conditions, and WSRs within the North Western waters and adjacent water bodies;
- Changes in sedimentation and erosion patterns at San Tau SSSI, Tai Ho Bay and North Western waters;
- Surface runoff from the main reclamation of HKBCF, the coastal reclamation of HKLR and the northern and southern reclamation landings of the TMCLKL;
- Sewage generated from the HKBCF+HKLR+TMCLKL project.

9.7 Concurrent Projects

9.7.1.1 Notwithstanding the fact that HKBCF+HKLR+TMCLKL would be constructed and implemented together, it is necessary to take into account other projects that may be constructed or be in place during the operational phase of the three projects and which could result in cumulative impacts.

9.7.1.2 As such, it is important to ensure that all probable concurrent projects which could result in cumulative impacts during the construction and operation of the combined projects are assessed in the water quality model studies and, where detailed information is available, that the construction rates and programme data for each project are employed. If detailed information is not yet available on the construction programmes for possible concurrent projects, assumptions will be made to assess the worst case scenarios.

9.7.1.3 The major developments being planned for implementation in the North-western coastal waters, Victoria Harbour and Western Water are summarised in **Table 9.13** below with details presented in **Appendix 9D5**. In addition, the operation of the contaminated mud pits at East of Sha Chau and the construction and operation of the proposed new contaminated mud disposal facility at South of the Brothers would result in cumulative impacts on the marine environment during the construction of the HKBCF+HKLR+TMCLKL .

Table 9.13 Concurrent Projects

Proposed Development	Impacts to be Considered
For Inclusion	
Kwai Tsing Container Basin Dredging	Construction and Operation
Proposed Lantau Logistics Park (LLP) and Possible LLP Extension	Construction (72ha development) Operation (72ha and 40ha developments)
Tonggu Channel	Construction (annual maintenance dredging) and Operation
Hong Kong Zhuhai Macao Bridge (HZMB)	Construction and Operation
Hong Kong Zhuhai Macao Bridge (HZMB) – Hong Kong Link Road (HKLR)	Construction and Operation
HZMB Hong Kong Boundary Crossing Facilities (HKBCF) and Tuen Mun Chek Lap Kok Link (TMCLKL)	Construction and Operation
Road P1, Sham Shui Kok to Sunny Bay	Operation (based on assumed programme to be operational in 2026)
Remaining Development in Tung Chung (East and West)	Operation (construction to begin after completion of the TMCLKL+HKBCF)
Existing and Proposed Contaminated Mud Disposal Facility at East of Sha Chau and South of Brothers	Construction and Operation for Target Year of 2011-2013
Mud Disposal Facility at North Brothers	Operation (when disposal operations might begin is not known but it is possible this facility could be operational after 2009)
For Exclusion	
Airport Master Plan 2030 (3rd Runway)	Exclude due to lack of detail
CLP 2 x 132kV submarine cables	Exclude due to lack of data
Proposed submarine gas pipe across the Urmston Road	Exclude due to lack of data

Proposed Development	Impacts to be Considered
Permanent Aviation Fuel Facility (PAFF)	Exclude – project will be completed in 2009
SkyPier II	Exclude – no significant marine works
Organic Waste Treatment Facility	Exclude – no marine works
Container Terminal 10	Exclude – insufficient data on reclamation layout to include in hydraulic studies

Note 1: Only preliminary/indicative layout or layout options are available for the proposed HKIA 3rd runway and, further afield, CT10, which could be expected to have significant impacts on tidal flows and water quality in the Western Harbour. Therefore, it is considered that the designs for CT10/3rd Runway are too uncertain to be included in the current study.

9.7.1.4 Cumulative construction impacts of concern are principally those associated with elevations in suspended solids concentrations in the receiving waters during dredging and filling works. Details of the concurrent construction works to be assessed have been discussed in **Section 9.8.4** below and presented in **Appendix 9D5**. Operationally, all potential project that may be in place once the HKBCF+HKLR+TMCLKL have been completed, have been considered in the assessment.

9.8 Assessment Methodology

9.8.1 Background

9.8.1.1 The Delft3D suite of computer models of tidal flows has been set up, calibrated and validated under previous Agreements with the Government of Hong Kong and, since 1996, the models have been applied in a large number of marine environmental studies in Hong Kong's coastal waters. Under these studies, the models have been applied using a number of different model grids covering different areas of Hong Kong's coastal waters at different spatial resolutions depending on the requirements of each particular study.

9.8.1.2 For the current Investigation, it was important that the model included the coastal waters to the South of Lantau Island to ensure that, if the proposed development does have the potential to impact on tidal flows passing North Lantau Island, the applied boundary conditions do not artificially force a flow through the relatively narrow channel between North Lantau and the New Territories and that any tidal or residual circulation around Lantau Island can correctly respond to any effects from the proposed development.

9.8.1.3 The Western Harbour Model (WHM) (**Figure 9.8**), is considered suitable for application under the current Investigation with some minor refinements. For the current assessment, the model grid has been refined further in the study area to ensure that the reclamations and local flow channels are resolved adequately. The refined model grid in the vicinity of the proposed reclamations is shown in detail in **Figure 9.9**, which also shows an approximate layout for the HKBCF+HKLR+TMCLKL combined projects to illustrate the proposed resolution of the model grid in these areas (70m-100m). Other proposed concurrent project such as the LLP (72ha and 40ha reclamations) and the proposed remaining Tung Chung development are, also, included for reference.

9.8.1.4 The Government already hold the full documentation for the Delft3D models which they run on their in-house computers at present and the model satisfies the requirements of the EIA Study Briefs. The model, before the recent refinements, has also been applied in previous studies of construction impacts in the North-western coastal waters including the impacts from the dredging for the pipeline for the Permanent Aircraft Fuel Facility between Tuen Mun Area 38 and the current Aviation Fuel Receiving Facility (AFRF) at Sha Chau.

9.8.1.5 The model of tidal flows was used to simulate the same 15-day wet and dry season spring-neap tidal cycles for which it had been calibrated and a sufficient number of 15-day cycles were run in each season (spin-up) to allow any transient effects generated at the start of the simulation to dissipate.

9.8.1.6 The marine viaducts of HKLR and TMCLKL southern connection will be supported on piles where the individual piles will be of the order of 2m or less in diameter and cannot be resolved by the model grid. However, Delft Hydraulics have developed a method of representing the effects of individual piles and groups of piles on tidal flows which involves the calculation of additional loss coefficients to be included in each model cell containing one or more bridge piers. This method will be discussed further below.

9.8.2 Model Validation

9.8.2.1 The Delft3D hydrodynamic model was used to simulate tidal and seasonal flows for the Year 2010 which is considered a baseline year. This scenario was based on the coastline and bathymetry expected to be relevant prior to the start of construction in 2010 and was required to generate the baseline hydraulic conditions which were required in order to validate the refined model grid. Representative plots of discharges across major sections, time history of water level, salinity and current speed to demonstrate this are presented in **Appendix 9E1**.

9.8.2.2 The model validation baseline simulation for year 2010 has been completed using the new fine grid model and the results have been compared with the results from simulations of the same scenario using the original Western Harbour model grid. This comparison was required to ensure that the introduction of the fine grid areas in the vicinity of the proposed HKBCF+HKLR+TMCLKL reclamations had not altered the established calibration of the Western Harbour model and that the spin-up period was sufficiently long to allow the model to reach equilibrium. Representative plots of discharges across major sections, time history of water level, salinity and current speed to demonstrate this are presented in **Appendix 9E2**. Since the flow simulation of the 2011 scenario for Sequence B is based on the stabilised 2011 scenario of Sequence A, additional verification plots for Sequence B are presented in **Appendix 9E3**.

9.8.2.3 The simulations were carried out for wet and dry seasons over a 15-day spring-neap tidal cycle after allowing for a suitable spin-up period.

9.8.3 Operational Phase Methodology

9.8.3.1 Operational phase assessment comprised the modelling of both tidal and seasonal flows and, also, water quality. The methodologies applied are detailed in the sections below.

<u>Tidal Flow Simulations</u>

9.8.3.2 Having refined the model grid, the Delft3D hydrodynamic model was used to simulate various tidal and seasonal flows for assessment purposes and, in addition to the year 2010 scenario used for model validation as discussed above.

9.8.3.3 The tidal flow simulations have been chosen to represent the worst case scenarios during both the construction and operational phases of the project. As the project works will last over some years, several interim construction stages were considered. The anticipated project progress and construction programme were reviewed and the projected monthly maximum daily sediment loss into suspension derived based on the project progress, plant inventory and the types of marine construction activities involved.

9.8.3.4 Considering Sequence A of HKBCF reclamation, the details of derivation of worse case construction scenarios are presented in **Appendix 9D5.** The modelling scenarios are detailed in **Appendix 9D2** and are briefly summarised below.

(a) Year 2011, Construction Scenario 1: This Scenario was based on the coastline and bathymetry in February 2011 when the construction of the HKBCF and HKLR has begun and the potential sediment loss rates from dredging and filling were at their maximum (see **Appendix 9D5**);

(b) Year 2012, Construction Scenario 2: This Scenario was based on the coastline and bathymetry in April 2012 when the construction of the HKBCF, HKLR and TMCLKL would be well under way and would have had the potential to modify tidal currents. April 2012, also, coincided with a second peak in the potential loss rates (see **Appendix 9D5**);

(c) Year 2013, Construction Scenario 3: This Scenario was based on the coastline and bathymetry in April 2013 when the construction of the HKBCF, HKLR and TMCLKL would be nearing completion and would have had the potential to modify tidal currents. April 2013 is, also, the time after which potential sediment losses would decrease rapidly to zero (see **Appendix 9D5**);

(d) Year 2026: The Completed Scenario. As detailed in **Appendix 9D2**, this scenario includes the completed HKBCF+HKLR+TMCLKL reclamations and associated bridges, the HKLR and HZMB bridges and artificial islands, Road P1, the increased water depths in the Kwai Tsing Container Basin and associated fairways, the LLP completed reclamations (72ha and 40ha), the completed Tung Chung East and West Reclamations for the completion year of 2026 for all committed projects (**Figure 9.10**). It is anticipated that the HKBCF, HKLR and TMCLKL will be completed in 2016 but, in order to assess long term operational impacts, the target year of 2026 has been selected to allow for completion of all other expected reclamations (**Table 9.12**);

(e) As (d) above but without the HKBCF+HKLR+TMCLKL. This simulation was required to provide information on the future tidal hydraulic conditions if all other proposed works are completed but the HKBCF+HKLR+TMCLKL is not constructed.

For Sequence B of HKBCF reclamation, the modeling construction scenario will be discussed in **Section 9.8.4.16**.

9.8.3.5 All simulations were carried out for wet and dry seasons over a 15-day spring-neap tidal cycle after allowing for a suitable spin-up period.

9.8.3.6 As noted above, the bridge piers for the marine viaducts of HKLR and TMCLKL southern connection cannot be resolved by the model grid. In order to allow for the effects of the bridge piers on tidal flows, therefore, the Delft3D-Flow model allows for the addition of a quadratic friction term in the momentum equations which is applied in each model grid cell containing a bridge pier. The details of the bridge piers and the calculated loss coefficients applied in the modelling are presented in **Appendix 9D3**.

9.8.3.7 The tidal flows simulations (d) and (e) above were undertaken in order to obtain results for the future condition (2026) which would arise both if the HKBCF+HKLR+TMCLKL had been built and, also if they were not implemented. The results were required to provide the basic hydraulic input for the model of water quality and to identify any impacts on tidal flows resulting from the three projects. By comparing the results from these simulations, the possible impacts the HKBCF+HKLR+TMCLKL works might have on the future marine environmental condition when all other reclamations have been completed can be assessed.

9.8.3.8 Simulations for 2011, 2012 and 2013 ((a) to (c) above) have been undertaken to provide the tidal flow data required to assess construction impacts at intermediate stages of construction when potential sediment losses were at their greatest and to cover the range of changes in tidal flow patterns which might result as the construction works proceeded.

9.8.3.9 During the simulations, the model stored the results at regular intervals throughout the 15-day simulations at a large number of specific locations and in each of the 10 model layers over the whole area being modelled. The model results from all the simulations for the wet and dry season baseline and post HKBCF+HKLR+TMCLKL construction scenarios have been be presented in graphical and/or tabular form for the 2026 simulations ((d) and (e) above), include:

(i) Velocity vector plots at peak flood and ebb tidal flows covering the entire length of the TMCLKL and detailed near surface, mid-depth and near bed velocity vector plots covering the southern and northern landfalls where impacts from the HKBCF+HKLR+TMCLKL might be expected to be greatest;

(ii) Peak speed contour plots and time-history plots at stations in the Urmston Road to demonstrate any changes to large scale tidal flows are not affected or only affected slightly;

(iii) Time history plots of instantaneous and accumulated flows through major sections near the project area where impacts are likely (Ma Wan, Airport North and the Airport sea Channel) for the with and without scenarios;

(iv) Time history plots of water levels, water speeds, salinity at selected sensitive receivers (as shown in **Figure 9.5)** have been presented where the points have been selected to be located:

- in the channel between the Airport Island and Tai Mo To (WSR 49);
- in the San Tau SSSI at the Airport Sea Channel (WSR 27);
- in the Urmston Road offshore of the River Trade Terminal (WSR 9a);
- at the Ma Wan Fish Culture Zone (WSR 20);
- in the centre of East Tung Chung Bay (WSRs 26 and 43);
- in the Sha Chau and Lung Kwu Chau Marine Park (WSR 10);
- over the cooling water intakes Black Point Power stations (WSR 7);
- at the Cheung Sha Wan Fish Culture Zone (WSR 40).

(v) Time history plots of the instantaneous and cumulative tidal discharges and salt flux across a number of sections across the main flow channels in Hong Kong's coastal waters (Airport North, Ma Wan, Deep Bay, Victoria Harbour, East Lamma Channel, West Lamma Channel and Admasta Channel), and across the Airport Sea Channel (**Figure 9.11**); and

(vi) For the major sections around the project site described in (iii) above, tabulations of:

- the peak flood and ebb tide discharges through the sections on selected large and small amplitude tides within the 15-day period of each simulation; and
- the average (residual) discharge across the sections over the 15 day period and the cumulative discharge over the 15-day period for each simulation. The tabulations will include the differences in discharges between the baseline and scenario simulations. It should be noted, however, that the cumulative discharges over a 15 day period across the longer sections will be very large and any small impacts from the development may not be easily identified from these tabulations.

9.8.3.10 The modelled area included a large number of sensitive receivers and specific points **(Table 9.5 and Figure 9.5**) at which time-history plots and tabulations of numerical data could be presented. However, to avoid the presentation of excessive model output, results have only been presented at those output points and sensitive receivers where impacts have actually been detected.

Marine Water Quality

9.8.3.11 The assessment of any impacts on the dispersion of effluent and marine water quality as a result of the implementation of the projects needs to be undertaken. The Delft3D model of water quality has been applied using an overall effluent loading pattern representative of anticipated future condition following completion of the works.

9.8.3.12 The pollution loading inventory (PLI) is a compilation of all the waste water (mainly effluent of sewage treatment works, but also surface run-off/storm drains) discharges into the marine environment. The Western Harbour Model already has a PLI which has, also, been updated by projects utilising this model and, as such, has been updated to include the loadings for project up to 2016. For this study, the selected scenario year for operational assessment is 2026 and it is, therefore, further updated with due consideration of latest forecast of 2026 population obtained from Planning Department (PlanD, 2008) and, also, the ultimate design capacity of major sewage treatment works in Hong Kong.

9.8.3.13 With respect to this project, areas of potential water quality impacts during the operational phase will largely be related to the proposed on-site sewage treatment works, which is expected to employ secondary treatment technology before discharges. The indicative site location and discharge point are shown in **Figure 9.13.** The on-site STW will have an ultimate design capacity of 1,628 m^3/day and the proposed discharge standards are presented in **Table 9.14** below.

Table 9.14 Design Details of the Proposed On-site STW for HKBCF+TMCLKL

Flow	BOD_5	DO	SS	NH_4N	Ortho-P	Total P	Total N	Cu	*E. coli*
1,628	20	1.5	30	40	2	7	50	30	1,000
m^3/d	Mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ug/L	cfu /100ml

9.8.3.14 Apart from the on-site STW, surface run-off of the paved area containing suspended solids onto which other pollutants may be adhere/adsorbed. Potential adverse impacts from runoff from the paved road surfaces can result from storm water carrying dissolved and particulate material from degradation of the road surface and tyres and from normal operational fuel and oil loss from vehicles. Contaminants present in the normal operational runoff will, by their chemical nature, be strongly adsorbed onto particulates present.

9.8.3.15 Stormwater drainage systems will be provided to collect stormwater from the reclamation and carriageway surfaces. In respect of the roads on land, the stormwater will enter into gullies along the kerb lines and the gullies will be fitted with sumps to trap silt and grit prior to discharging the stormwater into the stormwater drainage systems. The drainage systems will eventually discharge the stormwater into the sea at discrete locations. A similar system will be provided along the marine viaduct, with sump traps being proposed to be built into the deck structure. The collected stormwater will discharge into the sea at the column locations. The major project related discharging points are illustrated in **Figures 9.12 and 9.13**.

9.8.3.16 The storm water pollution loading is estimated based using Hong Kong's long-term seasonal rainfall data and the EPD Pilot Study on Strom Pollution (cited in Maunsell, 2008). The assumed runoff concentrations are shown in **Table 9.15** below.

Table 9.15 Event Mean Concentrations for Stormwater Runoff

SS	BOD5	NH4N	Cu	Total P	Ortho-P	Silicate	Total Oxidised N	TKN
43.25	22.48	0.20	0.01	0.20	0.04	3.28	0.40	1.40

Note: All units in g/m^3.

9.8.3.17 The updated PLI is presented **Appendix 9D4**. The water quality model has been used to simulate the annual wet and dry season spring-neap tidal cycles, as was simulated by the flow model, with a sufficient number of repeating cycles being carried out to ensure dynamic equilibrium is reached. The model used the simulated flow fields for the year 2026, both with and without the HKBCF+HKLR+TMCLKL projects in order to provide a comparison of any possible water quality impacts.

9.8.3.18 The simulations have covered annual wet and dry season conditions and the results from the simulations will be presented as:

- Plan contour plots of key water quality parameters (suspended solids in term of percentage difference, dissolved oxygen, inorganic nitrogen, unionized ammonia and *E. coli*) over the whole of the area affected by the works in each season at selected times when tidal dispersal is minimum (i.e., during the high and low water level at both spring and neap tides);
- Time-history plots of the key water quality parameters at all relevant sensitive receivers as listed in **Section 9.8.3.9** above and also the beaches area to allow a direct assessment of the WQO and possible adverse impacts from the proposed development; and
- Tabulations of monthly average concentrations of the selected water quality parameters at the same stations selected for the time-history plots.

9.8.3.19 When assessing the results from any water quality modelling, where appropriate, comparisons will be made principally between the model results and the WQO for the relevant WCZ for each sensitive receiver and for the receiving waters in general.

9.8.4 Construction Phase Methodology

9.8.4.1 As discussed above, the principal water quality concerns in the construction period are those associated with dredging and backfilling for the reclamations and the marine viaducts of the HKBCF+HKLR+TMCLKL projects. Construction impacts on the marine environment will be related principally to sediment losses to suspension during construction. Sediment losses will increase suspended sediment concentrations in the receiving waters which could:

- result in exceedances of the Water Quality Objective (WQO) for the Water Control Zones (WCZs) which could be affected by the works;
- result in deposition rates which might adversely affect corals; and
- result in exceedances of specific water quality standards set for, for example, seawater intakes. Sediment losses could also introduce contaminants into the water column if the sediment to be removed is contaminated.

9.8.4.2 In this assessment, representative sediment plumes have been simulated using the Delft 3D tidal flow and water quality models. In order to ensure that the worst case conditions are simulated and while remaining consistent with the various construction and disposal programmes, the maximum rates of dredging and filling operations will be simulated at locations and time periods which will maximise the potential for sediment losses to be transported from the works areas and, individually and cumulatively, to impact on sensitive receivers.

Assessment Scenarios and Assumptions - HKBCF (Sequence A)+HKLR+ TMCLKL

9.8.4.3 Under Sequence A of HKBCF reclamation, the marine works will be on-going for about 42 months (about 3.5 years), it is not possible to model all conditions throughout this period. As such, based upon the overall construction programme for the HKBCF+HKLR+TMCLKL projects (see **Appendix 9D5**), the periods for the worst case of loss rate have been determined and, alsom other periods have been selected to represent situations where partial completion of the construction of the HKBCF, HKLR and TMCLKL would have had the potential to modify tidal currents. Hence, the following time periods have been selected for the assessment:

- February 2011 when the construction of the HKBCF and HKLR has begun and the potential sediment loss rates from dredging and filling are at their maximum. This scenario occurs at around 15% of the total duration of marine works since the commencement of the construction works.
- April 2012 when the construction of the HKBCF, TMCLKL and HKLR would be well under way and would have had the potential to modify tidal currents. April 2012, also, coincided with a second peak in the potential loss rates. This scenario occurs at around 50% of the total duration of marine works since the commencement of the construction works; and
- April 2013 when the construction of the HKBCF, TMCLKL and HKLR would be nearing completion and would have had the potential to modify tidal currents. April 2013 is, also, the time after which potential sediment losses would decrease rapidly to zero. This scenario occurs at around 75% of the total duration of marine works since the commencement of the construction works.

9.8.4.4 The envisaged programme of marine works with the estimated monthly potential sediment loss is presented in **Figure 9.2A**. The assumptions on dredging and filling rates, equipment and programme for HKBCF (Sequence A), HKLR & TMCLKL, together with the calculations for the overall unmitigated sediment loss rates are presented in full in **Appendix 9D5**. Since the anticipated potential sediment losses is calculated based on the tentative construction programmes for marine works that involve the dredging and filling works below high water mark (+2.5mPD), the assumed daily production rates and number of plants involved are presented in **Appendix 9D5.** A summary of the production rates of dredging and filling works at major construction stages are presented in **Table 9.15a** below.

Table 9.15a Summary of Production Rates and Plants at Major Events for Sequence A

Area	Activities	Production Rate (bulk volume m3/dav)	No. of Plant Trips / Day	Time & Remark
HKBCF	Max. Dredging	155,700	16 grab dredgers and 3 trips of TSHD	In end 2010 - early 2011, Portion A, B, C & FSD seawall dredging concurrent
	Max. Filling	330,000	330 Filling Barge Trips	In mid 2011, Portion A, B, C and FSD reclamation concurrent
TM-CLKL North	Max. Dredging	7,200	1 Grab Dredger	Throughout the works period
	Max. Filling	16,000	16 Filling Barge Trips	In 1st quarter 2012. Both seawall and reclamation filling. Leading seawall present for reclamation.

Area	Activities	Production Rate (bulk volume m3/dav)	No. of Plant Trips / Day	Time & Remark
TM-CLKL South	Max. Dredging	14,400	2 Grab Dredgers	Throughout the works period
	Max. Filling	16,000	16 Filling Barge Trips	In end 2012. Seawall filling of S-a are completed and reclamation filling for S-b just begin.
HKLR	Max. Dredging	21,600	3 Grab Dredgers	Throughout the works period
	Max. Filling	56,000	56 Filling Barge Trips	In 3rd quarter 2012, Reclamation filling for Portion Inearly completed, and filling activities for seawall and reclamation of Portion 2 just begin.

Notes:

[1] The filling rates and daily number of plant trips are only relevant for filling below +2.5mPD and does not include bored piling works for marine viaducts. Rock filing barge trips not included in the table.

[2] The production rates are bulk volume and a bulking factor of 1.3 assumed for filling, 1.2 for grab dredging and 1.5 for TSHD dredging.

[3] Portion A temporary seawall of HKBCF completed in 2nd quarter 2011.

[4] The target commencement of HKBCF and HKLR is assumed to be August 2010 and January 2011 respectively. If the actual commencement date is different to the above assumption, the timing/date in the above table shall be adjsuted accordingly.

9.8.4.5 The Delft3D water quality model has been applied to simulate the fate of all fine material expected to be lost to suspension from the simultaneous construction works for the HKBCF+HKLR+TMCLKL reclamations and bored piled viaduct piers at the times periods detailed above. The modelling simulated the same wet and dry season tidal conditions and stages of construction as simulated by the model of tidal flows. The modelling has, also, employed the same coefficients to describe the behaviour of fine sediment as have been used in previous studies of construction losses in Hong Kong.

9.8.4.6 The settling velocity of suspended cohesive sediment is concentration dependent. The simulations were carried out using a constant settling velocity of 0.5mm/s which is typical of low suspended solids concentrations. This represents a conservative assumption in that a higher sedimentation rate would actually be expected in the dense plume close to the drag head.

9.8.4.7 Erosion and deposition in the water quality model are defined in terms of a critical stress for deposition above which no deposition can take place and a critical stress for erosion above which erosion can take place. The critical stress for deposition was set at 0.2N/m^2 while the water depth of 0.2m was selected as the minimum depth in which deposition can take place. The critical stress for erosion was set at 0.3N/m^2 which is applicable to relatively soft new deposits with a density of around 200kg/m^3 (HWR, 1993) and typically applied in Hong Kong (e.g., ERM 1997, 2005; Meinhardt 2007; Mouchel 2002a, 2002b).

9.8.4.8 The results from the sediment plume simulations have been presented as below:

(a) Representative contour plots of surface, mid-depth and near bed suspended sediment concentrations during peak ebb and peak flood flows when the dispersion is expected to be maximum and provides an indication of the extend of the sediment plumes. Contours plots will also be presented at high and low water level on selected large (spring) and small amplitude (neap) tides during each of the15-day simulations. The tidal flow speed at high and low water levels are minimal and, hence, the sediment plumes are expected to built-up and these plots allow identification of hot-spots with predicted high localised suspended solids;

(b) Time history plots of suspended sediment concentrations near the surface, mid-depth and near the bed at key sensitive receivers and observation points (see **Figure 9.5** for their location) where the predicted elevations in suspended sediment concentrations due to the works are in excess of 0.5mg/L;

(c) Tabulations of maximum and depth averaged elevations in suspended sediment concentrations found at each sensitive receiver (surface, mid-depth, near bed and depth averaged) over each wet and dry season 15-day simulation where the maximum elevations are in excess of 0.5mg/L and the percentage of time when the WQO exceedances is predicted; and

(d) Contour plots of total deposition (g/m^2) over each of the wet and dry season simulation periods and contour plots of the daily average deposition rate ($g/m^2/day$).

9.8.4.9 Based upon the SI data, the elevations in contaminant levels have been calculated and compared to relevant water quality standards for the preservation of marine life.

9.8.4.10 The degree of oxygen depletion exerted by a sediment plume is a function of the sediment oxygen demand of the sediment, its concentration in the water column and the rate of oxygen replenishment. For the purposes of this assessment, the impact of the sediment oxygen demand on dissolved oxygen concentrations has been calculated based on the following equation (ERM, 1997):

$$DO_{Dep} = C * SOD * K * 0.001$$

where DO_{Dep} = Dissolved Oxygen depletion (mg/l)
C = Suspended Solids concentration (kg/m^3)
SOD = Sediment Oxygen Demand
K = Daily oxygen uptake factor (set at 1.0 for worse case estimate)

9.8.4.11 An SOD of 15,000 mg/kg has been taken with reference to EPD Marine Monitoring data as a suitably representative value for sediments in the North Western Waters region.

9.8.4.12 The analysis using the above equation does not allow for re-aeration which would tend to reduce any impact of the suspended sediment on the water column DO concentrations. The analysis, therefore, errs on the conservative side so as not to underestimate the extent of DO depletion. Further, it should be noted that, for sediment in suspension to exert any oxygen demand on the water column will take time and, in that time, the sediment will be transported and mixed/dispersed with oxygenated water. As a result, the oxygen demand and the impact on dissolved oxygen concentrations will diminish as the suspended sediment concentrations decrease.

9.8.4.13 Oxygen depletion is not instantaneous and thus previous workers have assumed that the impact of suspended sediment on dissolved oxygen will depend on tidally averaged suspended sediment concentrations (ERM, 1997). The previous studies (ERM, 1997) assumed that the oxygen demand would be satisfied at the same rate as the biological demand which equates to a K value of 0.23/day. However for the purposes of this demonstration the maximum increase in suspended sediment has been used as the basis for the calculation in order to identify the hypothetical worst case. As such, the daily uptake factor, K, in the equation above was set to be equal to 1.0 (Meinhart, 2007; Mouchel, 2002b) which indicates instantaneous oxidation of the sediment oxygen demand and represents a worst case to ensure oxidation rates are not underestimated. The resulting calculated dissolved oxygen deficit, therefore, is expected to be much larger than would be experienced in reality.

Assessment Scenarios and Assumptions – HKBCF (Sequence B)+HKLR+ TMCLKL

9.8.4.14 As discussed above, the modeling for HKBCF Sequence B is to demonstrate that HKBCF Sequence B would not result in higher water quality impact than Sequence A. For the comparison between Sequence A and Sequence B, the assumptions of model for Sequence B should be the same as those for Sequence A as mentioned in **Sections 9.8.4.1 to 9.8.4.13** above as far as practicable.

9.8.4.15 Under Sequence B of HKBCF reclamation, the marine works will be on-going for about 4 years which is slightly longer than Sequence A. The envisaged programme of marine works with the estimated monthly potential sediment losses are presented in **Figure 9.2B**. When compared between Sequence A and Sequence B (see **Figures 9B-1 and 9B-2** in **Appendix 9B**), the monthly sediment loss rates under Sequence B are much lower than Sequence A and the worse case scenario of maximum sediment loss rate under Sequence B is envisaged to occur around February/ March 2011. It should be noted that the worse case daily loss rate has drastically reduced from 4,394,000 kg/day associated with Sequence A at this time to about 1,778,000 kg/day under Sequence B. Since the identified worse case scenarios of Sequence A are fully modelled for assessment and the fact that potential sediment losses under Sequence B are much lower than Sequence A, it is not considered necessary to model all the scenarios under Sequence B for the purpose of impact assessment since the adoption of Sequence A in the modeling is more conservative than Sequence B in this case. Nevertheless, additional water quality modelling for the mitigated scenario for the first identified worse case timeframe (i.e, early 2011) under the Sequence B has been conducted to confirm that Sequence B will perform better than Sequence A from the water quality perspective.

9.8.4.16 In view of the above, the worse construction scenario (mitigated) of Sequence B has been modelled. As such the following representative time period, taking into account maximum sediment loss rates and layout of reclamation, has been selected for the assessment:

- February/ March 2011 when the temporary steel sheet pile wall has been installed near the northern edge of HKBCF reclamation which may have effect to the tidal current and the potential sediment loss rates from dredging and filling of HKBCF+HKLR+TMCLKL are at their maximum as shown in **Figures 9B-1 and 9B-2** in **Appendix 9B**.

The assumptions on dredging and filling rates, equipment and programme for HKBCF (Sequence B), HKLR and TMCLKL, together with the calculations for the overall mitigated sediment loss rates are presented in full in **Parts 9F1 and 9F2** of **Appendix 9F**. Similar to Sequence A, the anticipated potential sediment losses for Sequence B is calculated based on the tentative construction programmes for marine works that involve the dredging and filling works below high water mark (+2.5mPD), the assumed daily production rates and number of plants involved are presented in **Part 9F1** of **Appendix 9F**. A summary of production rates of dredging and filling works at major construction stages are presented in **Table 9.15b** below

Table 9.15b Summary of Production Rates and Plants at Major Events for Sequence B

Area	Activities	Production Rate (bulk volume m3/dav)	No. of Plant Trips / Day	Time & Remark
HKBCF	Max. Dredging	72,000	10 Grab Dredgers (9 at HKBCF island and 1 at FSD reclamation)	In 4th quarter 2010. Portion 1 seawall dredging and dredging for FSD concurrent.
	Max. Filling (1)	80,000	80 Filling Barge Trips	In early to mid 2011, Portion 1 seawall and FSD seawall
	Max. Filling (2)	190,000	190 Filling Barge Trips	In 1st quarter 2012, Seawall filling for Portion 3, reclamation filling for the main island and APM concurrent.
TMCLKL North	Max. Dredging	7,200	1 Grab Dredger	Throughout the works period.
	Max. Filling	16,000	16 Filling Barge Trips	In 1st quarter 2012. Both seawall and reclamation filling. Leading seawall present for reclamation.
TM-CLKL South	Max. Dredging	64,800	9 Grab Dredgers	In 1st quarter 2011. Seawall dredging.
	Max. Filling	24,000	24 Filling Barge Trips	In 3rd quarter 2011. Seawall filling of S-a nearly completed and reclamation filling for S-a, S-b and S-c just begin
HKLR	Max. Dredging	21,600	3 Grab Dredgers	Throughout the works period
	Max. Filling	56,000	56 Filling Barge Trips	In 3rd quarter 2012. Reclamation filling for Portion 1 nearly completed, and filling activities for seawall and reclamation of Portion 2 just begin.

Notes:

[1] The filling rates and daily number of plant trips are only relevant for filling below +2.5mPD and does not include bored piling works for marine viaducts. Rock filing barge trips not included in the table.

[2] The production rates are bulk volume and a bulking factor of 1.3 assumed for filling and 1.2 assumed for grab dredging.

[3] Portion 1 seawall of HKBCF completed in 3rd quarter 2012.

[4] The target commencement of HKBCF and HKLR is assumed to be August 2010 and January 2011 respectively. If the actual commencement date is different to the above assumption, the timing/date in the above table shall be adjsuted accordingly.

Integrated Protection Measures – HKBCF (Sequence A)+HKLR+TMCLKL

9.8.4.17 In determining the construction methods, equipment and sequencing for the reclamation works and pier construction, measures which would minimise the amount of sediment lost to suspension have been integrated as far as possible. Such measures include:

- minimsation of the overall footprint of the project sites and, also, combing the TMCLKL southern landing with the HKBCF island and, thus, further reducing the overall works area. For HKBCF, the width of the reclamation connecting HKBCF to the Airport Island has been reduced (however, for the purpose of worse case assessment, a wider footprint of this reclamation area is assumed in the assessment as given in **Appendix 9D5**);

- for the submarine tunnel of TMCLKL, the tunnel boring machine construction method has been adopted instead of the traditional immersed tube tunnel, thereby reducing the dredging and filling requirement;
- formation of seawalls prior to the reclamation dredging and filling. In order to achieve this, temporary seawall enclosing Portion A of HKBCF has been proposed (**Appendix 9D5**), notwithstanding a 100m of marine access. With this arrangement, the reclamation dredging and filling activities will be mostly enclosed within seawalls, reducing the potential sediment loss by about 80%. However, to be conservative, this factor has only been applied at the reclamation filling stage when the seawalls, other than the access gap, have been completed;
- advanced seawalls before reclamation dredging and filling as far as practicable. Where the reclamation dredging and filling activities cannot be deferred until the seawalls are completed due to programme constraints, the works will be scheduled to be at least 100-200m behind the formed seawalls. This is expected to reduce the potential sediment loss from the reclamation dredging and filling by at least 45%. This has generally been applied for the HKBCF, HKLR and TMCLKL (**Appendix 9D5**);
- Installation of temporary sheet pile wall next to the northern boundary of the HKBCF+TMCLKL (southern landfall) to enable the provision of mitigation measure of floating type silt curtains at the areas where the current is strong (see **Figures 25308/041/302 and 303** in **Appendix 9A1**);
- for the marine viaducts of TMCLKL and HKLR, the bored piling will be undertaken within a metal casing and, therefore, any dispersal of the sediment will be limited to the short time of sediment removal from the top;
- where public fill is proposed for filling below +2.5mPD, the fine content in the public fill will be controlled to 25% which is in line with the CEDD's General Specification; and
- for the majority of the filling works, 30% public fill (which has a higher fines content that sand) and 70% sandfill will be assumed to be used below +2.5mPD. Exception to this generation include the seawall filling for TMCLKL in which the filling material is about 50% of rockfill and 50% sandfill and the northern reclamation of TMCLKL in which the reclamation filling could be entirely public fill.

9.8.4.18 Details on the anticipated construction progress, works programme and construction sequences (based on HKBCF Sequence A) are presented in **Appendix 9D5**. Notwithstanding the integrated measures above, based upon the results of the unmitigated scenarios, the need for mitigation measures have been determined. As discussed in **Sections 9.10** and **9.11** below, impacts resulting from the construction activities have the potential to cause impacts to the WQOs and ecological sensitive receivers and the extensive use of silt curtains could be required. The assumed effectiveness of the cage type silt curtain for grab dredgers and the single layer of silt curtains proposed for Sequence A are presented in **Table 9.16a** below, together with the loss reductions that could be assumed for an additional layer of silt curtain if this is considered.

Table 9.16a Summary Table of Loss Reductions from Silt Curtain Configurations (based on Sequence A)

Silt Curtain Type	Loss Reduction Factor	Remark
Dredging Activities		
Cage type for Grab Dredger (1)	80%	Typical, also reviewed in LNG Terminal EIA
Floating Single Silt Curtain (2)	75%	Manufactures Brochure
Second layer Floating Silt Curtain (3)	50%	LNG Terminal EIA
Combined Reduction (1+2)	95%	For grab dredger only. Assumed for Option 1 in Table 9.16b
Combined Reduction (1+2+3)	97%	For grab dredger only Assumed for Option 2 in Table 9.16b
Combined Reduction (2+3)	87%	Assumed for Option 2 in Table 9.16b
Filling Activities		
Floating Single Silt Curtain (4)	45%	
Second layer Floating Silt Curtain (5)	30%	Proportional scaling following the reduction for dredging
Combined Reduction (4+5)	61%	Assumed for Option 2 in Table 9.16b

9.8.4.19 During the initial period of dredging and filling works for HKBCF and HKLR, the silt-removal efficiency of different combination of silt-curtain systems given in **Table 9.16a** above shall be verified by examining the results of water quality monitoring points under the EM&A works. The verified silt curtain effectiveness shall be used for future reference only. The need to implement additional mitigation measures shall be determined in accordance with the event/action plan in the EM&A Manual if there is any exceedance of the water quality identified in the monitoring results under the EM&A programme.

9.8.4.20 Based on the above integrated protection measures, the overall total daily sediment loss rate has been calculated for the selected scenario yea**rs (see Appendix 9D5**) and prese**nted in Table 9.16b below. Table 9.16b**, also, illustrates the possible further reduction in sediment loss if additional mitigation measures (silt curtains systems) are applied.

Table 9.16b Summary of Potential Daily Sediment Loss Rate (based on Sequence A)

Option	Silt Curtain	2011 (kg/day)	2012 (kg/day)	2013 (kg/day)	Remark
0	0	4,394,000	2,008,000	1,705,000	Base case with integrated protection measures.
1	1+1	1,220,000 (72% reduction compared to Option 0)	672,000 (67% reduction compared to Option 0)	577,000 (66% reduction compared to Option 0)	Single layer (1) of silt curtain systems around the peripheral of proposed reclamation site for the southern reclamation of HKBCF, HKLR and TMCLK. For grab dredgers, an extra layer of cage type silt curtain (+1) is assumed. However, for the TMCLKL northern reclamation, this is not assumed as the current could be too high for effective silt curtain application.
2	2+1	844,000 (31% reduction compared to	541,000 (19% reduction compared to	406,000 (30% reduction compared to	Double layers (2) of silt curtain systems around the peripheral of proposed reclamation site for the southern reclamation of HKBCF,

Option	Silt Curtain	2011 (kg/day)	2012 (kg/day)	2013 (kg/day)	Remark
		Option 1)	Option 1)	Option 1)	HKLR and TMCLKL. For TMCLKL, no silt curtain protection is assumed for northern reclamation except reclamation filling at stage (works item FN4 in **Appendix 9D5**).

Notes: Please refer to **Appendix 9D5** for construction sequences and works item code and **Appendix 9D6** for the deployment of silt curtain systems.

Integrated Protection Measures – HKBCF (Sequence B)+HKLR+TMCLKL

9.8.4.21 The integrated protection measures for Sequence B are similar to those for Sequence A. However, in view of the longer construction programme in Sequence B, it allows theses measures to be enhanced to further reduce the amount of sediment loss. The measures for Sequence B include:

- minimsation of the overall footprint of the project sites and, also, combing the TMCLKL southern landing with the HKBCF island and, thus, further reducing the overall works area;
- for the submarine tunnel of TMCLKL, the tunnel boring machine construction method has been adopted instead of the traditional immersed tube tunnel, thereby reducing the dredging and filling requirement;
- further minimisation of dredging/filling by adopting non-dredged reclamation method for a larger portion of the reclamation site in HKBCF. When compared to Sequence A, the dredging and filling amount are substantially reduced in Sequence B as shown in **Table 9.1** above;
- formation of peripheral seawalls prior to, except for the 100m gaps for marine access, the main reclamation dredging and filling as far as practicable. As there is a longer construction time in Sequence B, the main dredging and filling works at the reclamation areas of HKBCF and TMCLKL (southern landfall) within the seawall boundary shall only be carried out when the whole Portion 1 seawall (except the 100m gap for marine access) as shown in **Figure 9A2-1** in **Appendix 9A2** is completed above the high water mark. Dredging and filling for seawalls and the pits to receive dredged Mf sediment within the site are exception. During the reclamation dredging and filling process, additional mitigation measures such as adding temporary steel sheet pile wall or additional layer of silt curtain should be considered if the monitoring results under the EM&A programme have shown exceedance on the Action Limit Levels of the related parameters;
- for the reclamation works other than those mentioned above for HKBCF and TMCLKL (southern landfall), advanced seawalls are formed before reclamation dredging and filling. Where the reclamation dredging and filling activities cannot be deferred until the seawalls are completed due to programme constraints, the works will be scheduled to be at least 200m behind the formed seawalls;
- Similar to Sequence A, installation of temporary sheet pile wall next to the northern boundary of the HKBCF+TMCLKL (southern landfall) to enable the provision of mitigation measure of floating type silt curtains at the areas where the current is strong see **Figures 25308/041/301A and 302A** in **Appendix 9A2**). In view of the construction sequence in Sequence B, the following measures shall be applied:

  - before the completion of the sheet pile wall next to the northern boundary of the HKBCF+TM-CLKL (southern landfall), seawall dredging at the area north of the demarcation line of the Phase 1 and 2 of HKBCF will not be carried out; and
  - before the seawall within the area of Phase 2 of HKBCF is formed above the high water mark (except the 100m gap for marine access), sheet pile wall at the northern boundary of the HKBCF+TM-CLKL (southern landfall) will not be removed.

- for the marine viaducts of TMCLKL and HKLR, the bored piling will be undertaken within a metal casing and, therefore, any dispersal of the sediment will be limited to the short time of sediment removal from the top;
- where public fill is proposed for filling below +2.5mPD, the fine content in the public fill will be controlled to 25% which is in line with the CEDD's General Specification; and
- for the formation of HKBCF seawall, only sandfill will be used for the seawall trench filling. For other filling works, only 30% public fill (which has higher fines content that sand) and 70% sandfill will be assumed to be used below +2.5mPD in the water quality model. Exception to this generation include the seawall filling for TMCLKL Southern Landfall in which the filling material is about 50% of rockfill and 50% sandfill and the northern reclamation of TMCLKL in which the reclamation filling could be entirely public fill.

9.8.4.22 Under Sequence B, early implementation of the temporary sheet pile wall next to the northern boundary of the HKBCF+TMCLKL (southern landfall) is required to ensure that the floating type silt curtains can be effectively deployed in this area due to strong current. Similar to Sequence A, wet and dry season flow simulations have been conducted for the 2011 worse case scenario in Sequence B with a conservative assumption that completed seawalls at the eastern and western side of the main reclamation are not considered, although in reality a substantial portion of these seawalls should have been completed based on the construction programme. The flow simulation results show that the temporary sheet pile walls at the northern boundary of the HKBCF+TMCLKL (southern landfall) would be effective in reducing the current speed at the area behind the sheet pile wall to generally below 0.2m/s (vector plots presented in **Part 9F2** of **Appendix 9F**) and would, therefore, allow the effective application of silt curtains in this area. However, flow simulation results also show that the sheet pile wall could lead to localised increases in peak flows in the area further south of the sheet pile wall. The peak flow has been predicted to reach 0.5m/s at the eastern side of the main reclamation and over 0.5m/s at the western side. Under such condition, the effectiveness of silt curtain for sediment reduction is assumed to be reduced for conservatism.

9.8.4.23 In addition, the cage type silt curtain to be adopted for grab dredgers in Sequence B is different to that in Sequence A. In order to ensure the effectiveness of silt curtain under the localised increase in peak flows mentioned in **Section 9.8.4.22** above, the cage type silt curtain (with steel enclosure) is to be adopted by using the stronger material of steel plate instead of silt curtain to enclose the main portion of the cage. Details of the cage type silt curtain (with steel enclosure) are shown in **Figure 25308/041/308A** in **Appendix 9A2**.

9.8.4.24 For HKBCF and TMCLKL (southern landfall), the assumed effectiveness of the cage type silt curtain (with steel enclosure) for grab dredgers and the single layer of silt curtains proposed for Sequence B are presented in **Table 9.16c** below. For the reclamation works in HKLR, the assumed effectiveness of silt curtain systems shall be the same as those presented in **Table 9.16a** above. This is because the silt curtain systems to be deployed for HKLR are far away from HKBCF and they are not affected by the localised increase in peak flows.

Table 9.16c Summary Table of Loss Reductions from Silt Curtain Configurations for HKBCF + TMCLKL Southern Landfall (based on Sequence B)

Silt Curtain Type	Loss Reduction Factor	Remark
Seawall Dredging Activities		
Cage type (steel enclosure)for Grab Dredger (1)	80%	Reference is made to the similar cage silt curtain adopted in penny's bay reclamation
Floating Single Silt Curtain (2)	0%	Conservative assumption of no reduction under strong current
Combined Reduction (1+2)	80%	For grab dredger only. Assumed for Option 1 in Table 9.16d
Filling at the Easter Seawall		
Floating Single Silt Curtain (3)	23%	Conservative assumption of 50% reduction in efficiency of the silt curtain assumed in Sequence A (see Table 9.16a) in view of the increased flow at the eastern side.
Filling at the Western Seawall		
Floating Single Silt Curtain (4)	0%	Conservative assumption of no reduction in view of the increased flow at the western side.

Notes: For assumed silt curtain efficiency at other areas of reclamation, please refer to **Table 9.16a** above.

9.8.4.25 Based on the above integrated protection measures, the overall total daily sediment loss rate under Sequence B has been calculated for the selected scenario year (see **Appendix 9E**) and presented in **Table 9.16d** below.

Table 9.16d Summary of Potential Daily Sediment Loss Rate (based on Sequence B)

Option	Silt Curtain	2011 (kg/day)	Remark
0	0	1,778,000	Base case with integrated protection measures.
1	1+1	560,000 (69% reduction compared to Option 0)	Single layer (1) of silt curtain systems around the peripheral of proposed reclamation site for the southern reclamation of HKBCF, HKLR and TMCLKL. For grab dredgers, an extra layer of cage type silt curtain (+1) is assumed. However, for the TMCLKL northern reclamation, this is not assumed as the current could be too high for effective silt curtain application. For HKBCF+TM-CLKL (southern landfall), the effectiveness of the silt curtains system are assumed to be reduced when compared to other areas as presented in **Table96.16c** above.

9.8.4.26 Similar to Sequence A, the effectiveness of silt-curtain systems given in **Table 9.16c** above shall be verified during the initial period of dredging and filling works for HKBCF and HKLR as mentioned in **Section 9.8.4.19**. It should be noted that the verified silt curtain effectiveness shall be used for future reference only. The need to implement additional mitigation measures shall be determined in accordance with the event/action plan in the EM&A Manual if there is any exceedance of the water quality identified in the monitoring results under the EM&A programme.

Cumulative Impacts

9.8.4.27 In addition to the three projects, construction of other concurrent project may also occur in the same period and, as such it is necessary to assess any cumulative construction phase projects. As detailed in **Table 9.13,** the following projects have been assumed to have the potential to be under going construction at the same time as the HKBCF+HKLR+TMCLKL projects:

- Kwai Tsing Container Basin Dredging;
- Proposed Lantau Logistics Park (LLP) Phase I (72ha);
- Tonggu Channel annual maintenance dredging;
- Hong Kong Zhuhai Macao Bridge (HZMB); and
- Existing and Proposed Contaminated Mud Disposal Facility at East of Sha Chau and South of Brothers.

9.8.4.28 The anticipated rate of working of these concurrent projects (dredging, filling and mud disposal works at the contaminated mud pits and North of the Brothers) and the potential rate of loss of fine material (<63µm) to suspension have been calculated and are presented in **Appendix 9D5**. Based upon this, the simulations for the three worst case time periods (2011, 2012 and 2013) have been repeated, combining the mitigated loss rates from the HKBCF+HKLR+TMCLKL project simulations with those of the concurrent projects.

9.9 Operational Phase Assessment

9.9.1 Model Validation

9.9.1.1 The Delft3D Western Harbour model of tidal flows was used to simulate 15 day spring-neap tidal cycles in the wet and dry seasons for the 2010 Baseline scenario using both the original model grid (Western Harbour Model (WHM)) and the refined model grid (termed the WHM-RG), as detailed above (**Figure 9.9)**. The results from consecutive 15 day cycles were compared to confirm that the model spin-up period had been sufficiently long to allow the model to reach equilibrium. The results from the two model grid runs were, also, compared to confirm that the refinement of the model grid had not affected the calibration of the model.

9.9.1.2 Having refined the model grid, it was to be expected that the higher resolution in the vicinity of the proposed reclamations would result in an improved simulation and so some differences in the simulated tidal flows was to be expected in the area where the grid had been refined. However, the main tidal flows over the larger model area should not have been affected by the local grid refinement.

9.9.1.3 In general, the WHM-RG simulations of the instantaneous tidal water levels, salinity and water velocities agreed well with the original WHM except in the vicinity of the Airport Sea Channel where the model grid had been refined. It was to be expected that some changes in the tidal flows would be simulated and that the refined grid would result in an improved simulation compared to the WHM. In addition, when the accumulated flows from the WHM-RG were compared with those from the WHM, some differences were found especially in the dry season. Some differences in the accumulated flows were, also, found between successive 15-day simulations of the WHM-RG, again, mainly in the dry season in Victoria Harbour. Further details on the reasons for these differences are presented below. It should be noted that the accumulated flows are the result of integrating the simulated tidal discharges over the simulation period and are sensitive to the model being used and the scenarios being simulated as discussed below.

Comparison of the WHM and WHM-RG

9.9.1.4 The WHM-RG was based upon the refined grid prepared under the Lantau Logistics Park project and it was subsequently found that the resolution of the model grid in Victoria Harbour had been reduced in the model. Therefore, it would be expected that the accumulated flows simulated by the WHM and WHM-RG in this area would differ.

9.9.1.5 The WHM-RG, also, differed from the WHM in the simulation of thermal discharges from the main power stations, with the WHM thermal simulations being for the wet season only. Thus, the simulation of water temperatures in the WHM-RG in the dry season, is considered may, also, contribute to the differences in the results between the two models.

Comparison of Successive 15-day Simulations in the WHM-RG

9.9.1.6 When the results from successive 15-day simulations using the WHM-RG were compared, it was found that the instantaneous tidal water levels and water speeds agreed well and it appeared that the model had reached equilibrium. However, some differences between successive simulations in the accumulated flows were noted which were larger in the dry season than in the wet season. It has been concluded that the main reason for the differences in the results for the accumulated flows from the WHM-RG for successive 15-day simulations in the dry season was the salinity specified as the initial condition. However, these differences in salinity are considered to be small.

Summary

9.9.1.7 Based on the assessment of the model results as detailed above, it is concluded that the WHM and WHM-RG model results are in agreement with each other while taking into account the salinity effects and areas with a coarse schematisation. With respect to the calibration of the WHM-RG, these differences do not suggest that, in the study area, the calibration of the model has been affected by the grid refinement.

9.9.1.8 In addition, taking into account the small differences in salinity between successive 15-day simulations which were predicted in the validation simulations, it is considered that any impacts the initial condition for salinity will have on the sediment plume and water quality simulations will be equally small. In assessing the construction impacts associated with the HKBCF+HKLR+TMCLKL projects, relatively short term direct tidal impacts are of greatest concern and the changes in dry season residual flows over the simulation periods due to the changes in the salinity distribution are not expected to be significant with respect to the results of the modelling.

9.9.1.9 With respect to the annual simulations of water quality to be carried out for the scenarios with the completed works in 2026 and without the works in 2026, both simulations will begin with the same salinity initial conditions, specified separately in the WAQ and therefore, relatively independent of the FLOW simulation, and the relative impacts of the completed works in 2026 can still, therefore, be assessed and it is considered that the residual flows which are being generated as the salinity distribution adjusts are relatively small and unlikely to have a significant impact on the outcome of the study. The results of the verification have been detailed in a standalone working document and selected representative plots are included in **Appendix 9E** for reference.

9.9.2 Tidal Flows and Velocities

9.9.2.1 The tidal flows simulations (d) and (e) as described in **Section 9.8.3.4** above have been undertaken in order to obtain results for the future condition (2026) which would arise both if the HKBCF+HKLR+TMCLKL had been built and, also if they were not implemented (base scenario). By comparing the results from these simulations, the possible impacts the HKBCF+HKLR+TMCLKL works might have on the future marine environmental condition when all other reclamations have been completed can be assessed. The modelling results are presented in **Appendix 9D7** and are discussed below.

9.9.2.2 Tidal discharges have been obtained from the computed velocities across selected cross-sections in main channels and used to assess the changes in the tidal circulation in the large or regional scale. Flow velocities at selected locations are also assessed to reflect the local effects or changes due to the proposed developments.

9.9.2.3 In terms of flow velocities, at WSR41 located north of the HKBCF reclamation, the average speed decreases by 11% (from 43 cm/s to 39 cm/s) in wet season and 3% (from 37 cm/s to 36 cm/s) in dry season, but at WSR49 located to the north-east of the HKBCF, the speed increases by about 3% (from 40 cm/s to 41 cm/s) in the wet season and by 13% (from 32 cm/s 36 cm/s) in the dry season. In the Airport Sea Channel (WSR28), it is found that the average speed decreases by about 10% (from about 10 cm/s to 9 cm/s) in the wet season, but increases slightly by about 3% (from about 8.9 cm/s to 9.2 cm/s). At the eastern entrance to the channel, the average speed increases from around 4.8 cm/s to 6 cm/s in dry season and from 6.4 cm/s to 6.7 cm/s in wet season. In general, the induced change incurrent speed around the proposed development is at most up to 10 – 20% or a few cm/s and no extensive stagnant area is observed. As mentioned above, the induced changes in the tidal speeds are only up to a few cm/s and, therefore, it is not expected that such changes will cause significant differences in the deposition and erosion of sediments from the case without the new developments.

9.9.2.4 A summary of the tidal discharges and percentages of change at key areas are presented in **Table 9.17** below for residual, peak flood, peak ebb for both the wet and dry seasons.

Table 9.17 Wet and Dry Season Tidal Discharges (m^3/s)

Section	Season	Dry		Wet	
	Flow direction	Base Scenario 2026 Other Project	2026 TMCLKL/HKBCF and HKLR Projects Only	Base Scenario 2026 Other Project	2026 TMCLKL/HKBCF and HKLR Projects Only
North of Airport Island	Flood	43291	42328	42492	41498
	% change	-	-2.2%	-	-2.3%
	Ebb	46384	45607	46658	45927
	% change	-	-1.7%	-	-1.6%
	Residual (+ve flood)	1601	1530	1423	1359
	% Change	-	-4.4%	-	-4.5%
Ma Wan	Flood	51883	50777	51509	50413
	% change	-	-2.1%	-	-2.1%
	Ebb	56906	55915	58496	57487
	% change	-	-1.7%	-	-1.7%
	Residual (+ve flood)	1640	1582	1402	1353
	% Change	-	-3.6%	-	-3.5%
Airport Sea Channel	Flood	158	251	214	187
	% change	-	59.3%	-	-12.5%

Section	Season	Dry		Wet	
	Flow direction	Base Scenario 2026 Other Project	2026 TMCLKL/HKBCF and HKLR Projects Only	Base Scenario 2026 Other Project	2026 TMCLKL/HKBCF and HKLR Projects Only
	Ebb	203	214	280	275
	% change	-	5.6%	-	-1.9%
	Residual (+ve flood)	24	36	-36	-21
	% Change	-	50.2%	-	-41.3%
Victoria Harbour	Flood	7443	7405	7805	7811
	% change	-	-0.5%	-	0.1%
	Ebb	5847	5770	4687	4636
	% change	-	-1.3%	-	-1.1%
	Residual (+ve flood)	1438	1440	2872	2880
	% Change	-	0.2%	-	0.3%
East Lamma Channel	Flood	33634	33367	35412	35144
	% change	-	-0.8%	-	-0.8%
	Ebb	39197	38708	35817	35423
	% change	-	-1.3%	-	-1.1%
	Residual (+ve flood)	1070	1047	2086	2105
	% Change	-	-2.2%	-	0.9%
West Lamma Channel	Flood	26332	25824	25327	24836
	% change	-	-1.9%	-	-1.9%
	Ebb	33100	32733	42038	41512
	% change	-	-1.1%	-	-1.3%
	Residual (+ve ebb)	747	740	4131	4197
	% Change	-	-0.9%	-	1.6%

9.9.2.5 Based upon **Table 9.17**, it can be seen that the changes in tidal discharges, including both increases and decreases, are relatively small after implementation of the projects as compared to base scenario. From the model results, it has been found that the proposed development has very minimal impact upon the flow regime of Hong Kong Waters.

9.9.2.6 To the north of the Airport Island, in comparing the scenarios, it was found that, in both wet and dry seasons, the peak flood and ebb flow in the north of the Airport Island are found to reduce by about 2.3% and 1.7% respectively, while the residual flows are reduced by about 4.5%. For both wet and dry season, peak flood and ebb flow across Ma Wan are found to reduce by about 2.1% and 1.7% respectively, while the residual flow is reduced by about 3.6%. The reduction in residual flows may indicate the reduction in flushing and assimilative capacity of a water body. However, with the support of the water quality model results, the minor reductions in the tidal discharges do not have significant adverse impacts upon project area.

9.9.2.7 However, more significantly changes are found for the flow through the Airport Channel. In wet season, the residual, peak flood and ebb flow are shown to reduce by 41.3%, 12.5% and 1.9% respectively, while in dry season, the residual, peak flood and ebb flow increase by 50.2%, 59.3% and 5.6% respectively. Implementation of the projects, therefore, are predicted to result in increased flows in the sea channel in both directions in the dry season and in general, the proposed developments would cause a more westward flow through the Airport Channel, both of which could improve the flushing of East Tung Chung Bay but with reduced flows in the wet season. The predicted increased tidal flows in the sea channel following construction of the HKBCF+HKLR+TMCLKL project could have some impact on the stability of the seabed in the sea channel with some erosion of any soft marine deposits present. However, it is considered that any erosion would be relatively small and would take many years to develop and as further discussed in the sedimentation section below, the predicted changes are small and insignificant.

9.9.2.8 In East Tung Chung Bay, water quality in this area at present is maintained by the offshore tidal flows and the flows through the Airport Sea Channel. The area is generally shallow and tidal current speeds are low and below 0.5m/s. However, in the absence of any local effluent discharges, the tidal currents in the bay and flows from the sea channel do generate sufficient mixing with the offshore waters to maintain water quality at existing levels.

9.9.2.9 Following construction of the projects, as compared to the base scenario, the modelling has predicted that, in the dry season, the peak tidal water speeds would increase in some areas of the bay but remain very similar to the existing water speeds in other areas. Similar results were obtained for the wet season except that there could be some reduction in the tidal flow speeds in the northwest corner of the embayed area at some occasions during the tidal cycle. However, as noted that the above existing tidal current speeds are already low in this area and provided that the tidal currents remain sufficiently strong to maintain the same level of exchange with the offshore waters, there should be no adverse water quality impact following construction of the projects.

9.9.2.10 Areas of increased water speeds within the embayed area and in the sea channel have been observed. It should be noted, however, that while peak water speeds are expected to increase in many areas following construction of the project reclamations compared to the base scenario, the water speeds are not expected to be higher than those locations further east along the North Lantau Island shoreline. It should, also, be noted that the peak water speeds only persist for a short time during the tidal cycle and, for most of the tidal cycle, water speeds remain well within the range of speeds which would be expected in the base scenario.

9.9.2.11 Tai Ho Bay is a particularly sensitive area and it is important that any developments do not adversely affect the tidal flows and water quality within the bay. The tidal flows which enter and leave the bay are driven by the tidal water levels outside the bay and controlled by the width of the entrance to the bay. Considering the relatively small area to be reclaimed for the projects compared to the total water area north of Lantau Island, no impact on tidal water levels are anticipated for the HKBCF+HKLR+TMCLKL reclamations. The model studies have, also, confirmed that tidal water levels would not be affected by the project. As a result, the daily tidal flows into and out of Tai Ho Bay would also remain unaffected as compared to the future 2026 other project baseline.

9.9.2.12 From the assessment of the results of the simulations of the 2026 HKBCF+HKLR+TMCLKL projects and 2026 other projects on tidal flows, it has been found that both options could have some impacts on tidal flows in the Airport Sea Channel which could impact on the flushing of East Tung Chung Bay. Overall, however, the HKBCF+HKLR+TMCLKL projects are not expected to have a greater potential to result in adverse impacts on tidal flows in East Tung Chung Bay. The HKBCF+HKLR+TMCLKL will result in changes to existing tidal flow patterns with increased water speeds at times during the tidal cycle. Any increases in water speeds, however, will remain within the range of water speeds to be encountered should the project not go ahead and no unacceptable changes to tidal flows are expected. Similarly, while the HKBCF+HKLR+TMCLKL reclamations would modify the existing tidal flow patterns, at least locally, the project are not expected to adversely affect the exchange of water between the embayed area, the Airport Sea Channel and the offshore waters.

9.9.2.13 As discussed above, with respect to the peak discharges, the differences between the residual discharges for the HKBCF+HKLR+TMCLKL reclamations and the base scenario are generally very small. It is fair to conclude, therefore, that the proposed development would not result in any significant change to the residual flow patterns in the wet and dry seasons.

9.9.3 Water Quality

9.9.3.1 The water quality in the water control zones of interest in the current study is determined by effluent sources, water quality in the neighbouring water control zones and the tidal and residual flows. The proposed HKBCF, HKLR and TMCLKL projects will result in only minor discharges from the reclamation pavement runoff and also the discharge from the on-site sewage treatment works, as described in **Section 9.8.3**. However, these discharges together with the existing and future ones, have been included in the pollution load inventory which have been used in the simulation of water quality impacts for the 2026 HKBCF+HKLR+TMCLKL projects and the base scenario.

9.9.3.2 The results of the tidal flow simulations have concluded that there should be no significant effects on the large scale tidal or residual flows as a result of the proposed development and areas where there are some decreases or increases in flows are not expected to affect the overall water quality.

9.9.3.3 The following water quality parameters have been assessed for the future based and 2026 HKBCF+HKLR+TMCLKL scenarios:

- Water temperature;
- Salinity;
- Dissolved Oxygen;
- Suspended Solids;
- Total Inorganic Nitrogen;
- Biological Oxygen Demand (BOD5);
- Ammonia;
- *E. coli;*
- Sedimentation.

9.9.3.4 In assessing the impacts on water quality, key representative sensitive areas have been selected for analysis both in the immediate vicinity and further afield from the projects:

(i) WSR 07 - Black Point Cooling Water Intake;

(ii) WSR 09a - Urmston Road (Main Channel);

(iii) WSR 10 - Sha Chau and Lung Kwu Chau Marine Park;

(iv) WSR 20 - Ma Wan Fish Culture Zone;

(v) WSR 23 – Future seawater intake for LLP;

(vi) WSR 24 – Future seawater intake for Tung Chung;

(vii) WSR 25 - Cooling water intake at HK International Airport;

(viii) WSR 26 - HKBCF South;

(ix) WSR 27 - San Tau Beach SSSI;

(x) WSR 28 - Cooling water intake at HK International Airport;

(xi) WSR 40 - Cheung Sha Wan Fish Culture Zone (Far field);

(xii) WSR 41 - Artificial Reef at NE Airport;

(xiii) WSR 43 - Future seawater intake for Tung Chung;

(xiv) WSR 44 - Future HKBCF Intake; and

(xv) WSR 49 - Tai Mo To (Dolphin Habitat).

9.9.3.5 The results from the water quality modelling have shown that, following construction of the 2026 reclamations for the HKBCF and associated projects, the water quality at the sensitive receivers listed changes only marginally compared to the base. The changes (small increases or decreases) differ from season to season but most changes are minor. Moreover, due to the change in flow pattern in some areas, there some beneficial increases in DO and reductions in *E. coli* concentrations.

9.9.3.6 The monthly averaged levels at surface, mid-layer and bottom layer, as well as the depth averages results of water quality modelling parameters for the key representative sensitive receivers are presented in summary tables and contour plots in **Parts 9D7b and 9D7c** of **Appendix 9D7**. A description of the results for each parameter is presented below.

Salinity

9.9.3.7 **Appendix 9D7 (Figures 209 – 310 in Part 9D7a)** compares the salinity between the base scenario and 2026 scenario with HKBCF+HKLR+TMCLKL projects. The Salinity at key sensitive receivers is shown in **Tables 13 – 15** in **Part 9D7c** of **Appendix 9D7**. For most ecological sensitive receivers, the changes in monthly depth averaged salinity are within 2%. The highest change in monthly salinity of 9% occurs at mid-depth of WSR 44 (Future HKBCF intake), which is within the WQO criteria. Hence, adverse water quality impact is not anticipated.

9.9.3.8 It is noted that, as indicated in the wet season hourly salinity plots presented in **Appendix 9D7**, there could be larger differences in the hourly salinity levels in the Airport Channel (WSR 27) and area south of the main reclamation (WSR 43), than the monthly average. The plots indicate that the differences are mainly predicted in the wet season and at the bottom level and this phenomenon was further investigated. **Table 9.17a** summarises the wet season salinity differences at WSR 27 and WSR 43. As indicated in **Table 9.17a**, the average differences at the surface level are only between -0.1 to -0.2 ppt (reduction) with a maximum difference of -2.1 ppt. At the bottom level, the average differences are between -1.4 to -1.9 ppt although the maximum difference can reach about -3.1ppt at WSR27 and -5.0 ppt at WSR 43. Closer analysis inspection of the plots, however, reveals that the vertical difference (between surface and bottom) in salinity levels are predicted to be reduced with the implementation of the project. Without the project, the average vertical differences are between -2.3 ppt to -3.4ppt (the bottom level is more saline) but can reach a maximum of -7.8 ppt. With the implementation of the project, the average vertical differences are reduced to only about -1.0ppt to -1.7ppt and the maximum difference also reduced to -7.1ppt only. In order to facilitate the visualisation of the pattern, the predicted salinity level and surface and bottom level as well as the vertical differences are depicted in **Part 9D7a (Figure 260) of Appendix 9D7**. Overall, the changes are relatively small and extreme differences are only predicted for a small fraction of the time. However, as the vertical mixing is improved, it could be expected that this could potentially be beneficial to the ecology of the area since wet season bottom level hypoxia are often developed when the water column is stratified and the reduced vertical difference can help avoid the development of stratification. It should also be noted that the minimum salinity in the North Western Waters at any time in the wet season is heavily dependent on the freshwater discharge from the Pearl River Estuary while, in the dry season, the salinity should be close to oceanic values in excess of 34ppt. As a result, the established marine ecology in this area will already tolerate large variations in salinity and the impact of the project on salinity levels is not expected to have any adverse impact on the marine ecology.

Table 9.17a Summary of Predicted Changes in Hourly Salinity Difference at Airport Channel and Tung Chung (Wet Season)

	Difference at Surface Level	Difference at Bottom Level	Vertical Difference Without Project	Vertical Difference With Project
WSR27	-0.1 (-2.1 – 1.6)	-1.4 (-3.1 – -0.1)	-2.3 (-6.2 – -0.4)	-1.0 (-4.8 – 0.0)
WSR43	-0.2 (-1.7 – 1.8)	-1.9 (-5.0 – -0.1)	-3.4 (-7.8 – -0.5)	-1.7 (-7.1 – 0.0)

Note:
Values are presented as average (min – max) pair wise differences (ppt).
Difference at level are calculated as 2026 (project – baseline).
Vertical difference are (surface – bottom).

Dissolved Oxygen (DO)

9.9.3.9 **Appendix 9D7 (Figures 028 – 054, Figures 217 – 243** in **Part 9D7b)** compares the DO between the base scenario and 2026 scenario with HKBCF+HKLR+TMCLKL projects. It shows that levels of Dissolved oxygen (DO) do not change significantly as a result of the implementation of the project, particularly in the dry season. The DO levels are lower in the wet season, as a result of seasonal variations The DO at key sensitive receivers is shown in **Tables 4 – 6** in **Part 9D7c** of **Appendix 9D7**. However, some localised decreases are predicted in the wet season, typically of less than 3%, when comparing with the base scenario. Notwithstanding, all results for both cases show that the DO levels will comply with the DO criteria (depth average >=4 mg/L, bottom level >=2 mg/L). As a result, it can be concluded that the implementation of the project will not significantly affect DO levels and no ecological sensitive receivers, including the CWD, corals and fisheries, will be affected by the implementation of the project.

Suspended Solids (SS)

9.9.3.10 **Appendix 9D7 (Figures 136 – 159, Figures 298 – 333** in **Part 9D7b)** compares the SS between the base scenario and 2026 scenario with HKBCF+HKLR+TMCLKL projects. In majority of the study area, there are relatively small changes in SS levels (less than 5%) as a result of the implementation of the project. Notwithstanding, in certain areas changes do occur, notably at Pillar Point on the east side of the TMCLKL northern landfall and, also, around the HKBCF/TMCLKL island east of the airport. These are probably due to the change in flow due to the reclamation and artificial island. With the proposed reclamation in Tuen Mun and the creation of the HKBCF and TMCLKL southern landfall, the flow during the ebb tide will be diverted towards the Airport and HKBCF, so higher concentrations would result. The elevated SS at key sensitive receivers is shown in **Table 16** in **Part 9D7c of Appendix 9D7**. For WSR44 (HKBCF seawater intake), the elevation in SS is around 4% in dry season but can be up to about 15% in the lower layers of the water column during wet season. Notwithstanding, the results show that the implementation of the project would not cause any increases in SS to above 30% (i.e WQO criteria) of the base scenario.

For the WSR seawater intakes (WSR 23, 24 and 43), as a conservative scenario, they are assumed to locate near the seabed. The closest EPD water quality monitoring stations to these receivers are NM3 and NM6. According to EPD monitoring data from Yr 1998 to Yr 2007, the average SS in dry and wet seasons near the seabed were 15.7mg/L and 13.1mg/L, which have exceeded the WSD criteria of 10mg/L. Hence, for the future seawater intake, silt screen should be installed to alleviate the high SS level. The operation of this project will further cause an elevation in SS at these sensitive receivers by around 5 -10 mg/L above the baseline level. The predicted elevated SS at the sensitive receivers are summarized in the following Table. With the silt screen, it can provide a further

60% reduction in the SS level. Hence, the predicted maximum SS in dry season at WSR23, WSR24 and WSR43 will be reduced to 8.3 mg/L. The predicted maximum SS in wet season at WSR23, WSR24 and WSR43 will be reduced to 9.2 mg/L, 9.2mg/L and 7.2 mg/L respectively. With the silt screen in place, the maximum SS in both dry and wet seasons would comply with the WQO.

WSR	Existing Baseline		Maximum Elevation		Unmitigated		Mitigated	
	Dry mg/L	Wet mg/L	Dry mg/L	Wet mg/L	Dry (Total) mg/L	Wet (Total) mg/L	Dry (Total) mg/L	Wet (Total) Mg/L
WSR 23	15.7	13.1	< 5	< 10	< 20.7	< 23.1	< 8.3	< 9.2
WSR 24	15.7	13.1	< 5	< 10	< 20.7	< 23.1	< 8.3	< 9.2
WSR 43	15.7	13.1	< 5	< 5	< 20.7	< 18.1	< 8.3	< 7.2

Dissolved Inorganic Nitrogen (DIN)

9.9.3.11 **Appendix 9D7 (Figures 001 – 024, Figures 190 – 216** in **Part 9D7b)** compares the DIN between the base scenario and 2026 scenario with HKBCF+HKLR+TMCLKL projects. The DIN at key sensitive receivers is shown in **Tables 1 – 3** in **Part 9D7c** of **Appendix 9D7.** For the WSRs in close vicinity to the works, namely WSRs 26, 27, 28 and 43 and to a lesser extent, WSRs 44 and 49, the dissolved inorganic nitrogen (DIN) levels are higher during the dry season but lower during the wet season. However, all the increases are less than 3%. The following table tabulates the annual DIN values with and without the project. With the projects, the predicted TIN levels at most sensitive receivers (except WSR 07) comply with the WQO nutrient criteria of 0.5mg/L. For WSR 07, the predicted TIN level has exceeded the WQO nutrient criteria of 0.3mg/L (Castle Peak Subzone). Nevertheless, on comparing with the base scenario, the change in TIN level is insignificant, suggesting that the project would not cause adverse water quality impact.

WSR	Description	DIN (with Project) mg/L	DIN (Without Project) mg/L	Criteria (mg/L)
WSR 07	Black Point Cooling Water Intake	0.38	0.38	0.3
WSR 09a	Urmston Road (Main Channel)	0.30	0.30	0.5
WSR 10	Sha Chau and Lung Kwu Chau Marine Park	0.32	0.32	0.5
WSR 20	Ma Wan Fish Culture Zone	0.23	0.22	0.5
WSR 25	Airport Cooling Water Intake (NE)	---	---	0.5
WSR 26	HKBCF South	0.22	0.23	0.5
WSR 27	San Tau SSSI	0.22	0.22	0.5
WSR 28	Cooling Water intake at HKIA	0.22	0.22	0.5
WSR 40	Cheung Sha Wan FCZ	0.09	0.09	0.5
WSR 41	Artificial Reef at NE Airport	0.28	0.28	0.5
WSR 43	Future seawater intake for Tung Chung	0.22	0.22	0.5
WSR 44	Future HKBCF Intake	0.28	0.25	0.5
WSR 49	Tai Mo To (Dolphin Habitat)	0.27	0.25	0.5

Unionised Ammonia (NH_3-N)

9.9.3.12 **Appendix 9D7 (Figures 082 – 105, Figures 271 – 297** in **Part 9D7b**) compares the NH_3-N between the base scenario and 2026 scenario with HKBCF+HKLR+TMCLKL projects. The unionized ammonia at key sensitive receivers is shown in **Tables 10 – 12** in **Part 9D7c** of **Appendix 9D7.** The levels of NH_3 in the study area are very low and in the majority of cases below the WQO criteria of 0.021 mg/L.

BOD_5

9.9.3.13 **Appendix 9D7 (Figures 111 – 134** in **Part 9D7b)** compares the BOD_5 between the base scenario and 2026 scenario with HKBCF+HKLR+TMCLKL projects. The BOD_5 at key sensitive receivers is shown in **Tables 21 – 23** in **Part 9D7c** of **Appendix 9D7**. It can be seen that the predicted results are similar for the two scenarios. During the dry season, the BOD_5 levels increase marginally (approximately 0.1-0.2mg/L or 1 – 3%) as a result of the project. During wet season, the increase in BOD_5 can be up to about 9% at mid-depth at WSR44 (HKBCF water intake). This increase is not a critical factor for the sensitive use in this location. Reductions are, also, observed at majority WSRs, in particular WSR26, WSR28, WSR40, WSR41 and WSR49, in the wet season.

E. coli

9.9.3.14 **Appendix 9D7 (Figures 055 – 078, Figures 244 – 270** in **Part 9D7b)** compares the *E. Coli* between the base scenario and 2026 scenario with HKBCF+HKLR+TMCLKL projects. The *E.Coli* at key sensitive receivers is shown in **Tables 7 – 9** in **Part 9D7c** of **Appendix 9D7.** It shows that the predicted results are similar for the two scenarios. The *E. Coli* levels vary throughout the study area, with the highest levels predicted near Tai Mo To as a result of the Siu Ho Wan STW outfall. However, all the levels are well within the criteria of 610 cfu / 100ml, although this is specifically for beaches and not strictly relevant for the open waters. For most sensitive receivers, the *E. Coli* levels are higher in the dry season but lower in the wet season.

Sedimentation

9.9.3.15 **Appendix 9D7 (Figures 163 – 165** in **Part 9D7b)** compares the annual sedimentation between the base scenario and 2026 scenario with HKBCF+HKLR+TMCLKL projects. The annual sedimentation at key sensitive receivers is shown in **Table 17** in **Part 9D7c** of **Appendix 9D7c** and is extracted in the following Table.

WSR	Description	Sedimentation (with Project)		Sedimentation (Without Project)	
		$g/m^2/day$	mm/year	$g/m^2/day$	mm/year
WSR 09a	Urmston Road (Main Channel)	1.09	0.53	1.08	0.53
WSR 12	Butterfly Beach	2.88	1.40	2.50	1.21
WSR 22b	Tai Ho Wan / Near Tai Ho Stream SSSI	3.92	1.91	4.06	1.98
WSR 22c	Tai Ho Wan Outlet (outside)	3.68	1.79	3.82	1.86
WSR 24	Tung Chung Fairway	3.91	1.90	3.93	1.91
WSR 27	San Tau SSSI	4.40	2.14	4.45	2.17
WSR 28	Airport Channel	3.21	1.56	3.41	1.66

WSR	Description	Sedimentation (with Project)		Sedimentation (Without Project)	
		g/m²/day	mm/year	g/m²/day	mm/year
WSR 41	Artificial Reef at NE Airport	1.42	0.69	1.21	0.59
WSR 47a	River Trade Terminal	2.99	1.46	0.80	0.39
WSR 47b	River Trade Terminal	2.92	1.42	2.62	1.27
WSR 29	Hau Hok Wan (Horseshoe Crab Hanitat)	4.59	2.23	4.69	2.28
WSR 30	Sha Lo Wan (Horseshoe Crab Hanitat)	4.65	2.26	4.63	2.25
WSR 31	Sham Wat Wan (Mangrove and Horseshoe Crab Habitat)	4.85	2.36	4.82	2.35
WSR 32	Tai (Mangrove Habitat)	4.23	2.06	4.22	2.05
WSR 33	Tai O Bay	2.21	1.07	2.16	1.05
WSR 34	Yi O (Mangrove and Horseshoe Crab Hanitat)	4.22	2.05	4.22	2.05
WSR 50	HKBCF Embayment Area / Sky Pier	3.22	1.57	1.64	0.8

9.9.3.16 The annual sedimentation rates at major eco-sensitive receivers with the project is ranging from 1.42g/m^2/day (WSR 41) to 4.85g/m^2/day (WSR 31), which are far below the assessment criterion of 0.2 kg/m^2/day. The annual sedimentation rate inside the airport sea channel (WSR 28) with the project decreases from 1.66mm/yr to 1.56mm/yr. The change is 0.1mm/yr or 1mm/10 year. Hence, the impact of project on the sedimentation inside the airport sea channel is minor.

Summary

9.9.3.17 In summary, only slight increases or decreases of the water quality parameters would occur as a result of the implementation of the project comparing to the base scenario. In addition, all parameters are expected to comply with the relevant criteria. Significant water quality impacts as a result of the implementation of the project are not anticipated.

9.9.4 Accidental Spillage

9.9.4.1 Under normal operating circumstances, significant impacts on water quality are not anticipated. In the event that a major spill occurs on the marine viaduct of HKLR and TMCLKL, a defined response plan is required in order to, not only be able to reopen the road as soon as possible to minimise disruption to traffic, but also to minimise effects on the marine ecological resources and water quality. All methods of spill clearance should be environmentally acceptable and should not lead to pollution of the marine environment. The following sections detail the procedures that would be applicable in this situation.

Chemical Spillages

9.9.4.2 For chemical spillages that do not pose fire, explosion or life risks, the spills should be contained, recovered and soaked-up for disposal as chemical waste. Under no circumstances should chemical spillages be washed into the natural streams, or any other natural or man-made water bodies or carrying systems.

Oil Spillages

9.9.4.3 In case of oil spillage, the use of chemical dispersants to break up the oil is not recommended as their use could impact on the surrounding environment and compound the pollution situation. In addition, the oil spill should be contained in the location of the spill wherever possible.

9.9.4.4 For all spillages, the acceptable method of control is by "absorption" and then removal of the absorbed waste for disposal by special contractors. Absorption of the oil should be achieved by the use of sawdust or other suitable material. Advice on how to clean-up a chemical spillage if required can be sought from EPD. Contact should be made with EPD's Chemical Waste Treatment Centre for assistance in disposing of the contaminated sawdust. Source of sawdust for use in case of emergencies can be obtained from Transport Department.

9.9.4.5 The management and maintenance authority for the venue/roads/parts would be responsible for clearing up a spillage in their responsible area.

9.9.4.6 The emergency call-out procedure in case oil/chemical spillage on roads in this area:

(a) Police

- to access the impact of incident and then immediately inform:
  - FSD in case of fire hazard; and
  - TD in case of road closure:
- to set up a Mobile Command Post to co-ordinate the road closure and clearing up operations. All parties concerned might then liaise with the Command Post for updated information; and
- to inform EPD, FEHD and other departments to render assistance if necessary after the immediate traffic and rescue operations completed.

(b) Transport Department

- to inform HyD's Emergency Co-ordination Centre;
- to liaise with the bus companies, MTRCL, relevant ferry operators on emergency public transport arrangements;
- to disseminate information of emergency public transport arrangements through GIS.

9.9.4.7 Not Used.

9.9.4.8 The above measures will reduce the magnitude of any impacts. Notwithstanding it is possible for some of the spilled material to be discharged into the marine environment via the viaduct drainage system. While oil interceptors are not feasible on the marine viaduct, the spill will decay through a variety of means including evaporation, adsorption onto suspended materials and emulsification. Adsorption of oils can be effective means for breaking up the spill. However, the natural process of the spill spreading reduces its thickness and allows the process of wind and wave action in breaking up the spill to increase as well as evaporation and dissolution. Dispersion of any spill will occur more rapidly in higher water flows which occur along the majority of the viaduct length but in lower water flows inside the bays, dispersion could take longer. Notwithstanding, it is likely that a spill would disperse in region of 3-4 days without any long term effects on water quality (ERM 1995).

9.9.4.9 Based upon this, the emergency response plan would be considered to be sufficient to reduce any impacts to acceptable levels.

9.10 Construction Phase Assessment

9.10.1 Suspended Solids - Year 2011 Scenario (HKBCF Sequence A + HKLR + TMCLKL)

Unmitigated Sediment Plumes

9.10.1.1 The selected worse case scenario occurs in early (February) 2011 and the construction activities at that time are restricted to the construction of HKBCF and HKLR. The anticipated work fronts are mainly in seawalls constructions at the HKBCF site, though the works for re-provisioning of FSD berth at the NE tip of the Airport Island is also on-going. The seawalls for HKLR construction just begin. Apart from the temporary seawalls along the northern edge of the HKBCF Portions A and C, the coastline is largely the same as the pre-construction condition.

9.10.1.2 The predicted elevated sediment plumes contours (**Figures 001 – 036 in Part 9D8a** of **Appendix 9D8**) for selected time frames (peak ebb and flood tides, high and low water levels during spring and neap tides in both dry and wet seasons, time history plots of the elevated SS over the entire modelling timeframe **(Part 9D8d of Appendix 9D8**), and the total and daily sediment deposition are presented in **Figures 037 – 040** in **Part 9D8a** of **Appendix 9D8.**

9.10.1.3 As the project site is located in the relatively shallow East Tung Chung Bay area, the sediment plumes are largely retained within the vicinity of the site. During the slack periods (i.e. in high and low waters), the suspended solids (SS) at the work fronts could elevate to around 300 mg/l on the surface. However, during peak ebb and flood tides, the plumes could travel further east (during ebb tide) or west (during flood tide) depending on the tidal state, though the surface SS rapidly drops to around 50 mg/L in a distance of about 2km. In general, the plumes travel a longer distance during the ebb tide and could approach the Ta Pang Po (WSR 21) in north Lantau, at low concentration (<10 mg/L). However, this situation only occurs occasionally.

9.10.1.4 The western extent of the surface plumes (~50 mg/L) occur at about the NE tip of the Airport, close to the artificial reef deployment site (WSR 41), but not reaching the airport intake (WSR 25). Lower concentration surface plumes (<10 mg/L) could, however, reach to a distance of about half the airport run-way. Under no circumstances do the plumes cross the Urmston Road. The sediment plumes generally extend to the East Tung Chung Bay near the project site, though during the flood tide of the spring cycle. The plumes from HKLR could pass the Tung Chung Channel (underneath the North Lantau Highway) and reach Ma Wan Chung at low concentrations (<10 mg/L), but not reaching the San Tau SSSI (WSR 27). This situation again occurs occasionally and the plumes only last for around 2 hours.

9.10.1.5 The predicted maximum elevated SS for selected observation points around the site are compared with the Water Quality Objectives (WQO) or Water Quality Criteria (WQC). The results are summarized in **Table 9.19** below. As indicated in **Table 9.19**, exceedances in elevated SS are limited to locations around the project site. While the plumes can reach Ta Pang Po (WSR 21), the predicted maximum depth average concentrations in dry and wet season are 7.2 mg/L and 1.7mg/L respectively. Exceedances in WQO are only predicted to occur in 3% of the time at surface or mid-depth levels during the dry season. For key marine ecology sensitive receivers around the project area, no exceedances in WQO are predicted for Sha Chau and Lung Kwu Chau Marine Park (WSR 10), Tai Ho Wan (WSR 22a-c), San Tau SSSI (WSR 27), Hau Hok Wan (WSR29) and Sha Law Wan (WSR30).

9.10.1.6 The predicted maximum depth average SS elevations, at south of Tai Mo To (WSR49) would exceed the WQO in dry season for about 4% of the time. Exceedances in WQO are also predicted at surface and mid-depth level in dry season. The predicted maximum depth average SS elevations at Sham Shui Kok (WSR 45c) would exceed the wet season WQO for about 2% of the time. Exceedances in WQO are also predicted at the mid-depth and bottom level. The predicted maximum depth average SS elevations, at the Artificial Reef at NE Airport (WSR 41) would exceed of the WQO in wet season and dry season for about 39% and 35% of the time respectively. Exceedances in WQO are also predicted at the surface, mid-depth and bottom level. The predicted maximum depth average SS elevations at the NE Airport Intake (WSR 25) would, also, exceed the wet season and dry season WQO for about 33% and 36% of the time respectively. Exceedances in WQO are also predicted at the surface, mid-depth and bottom level.

9.10.1.7 The total elevated sediment deposition over the entire simulation period and daily averaged elevated sediment deposition rates are, also, presented in **Figures 037 – 040** in **Part 9D8a** of **Appendix 9D8**. As the proposed site is located in a shallow sheltered bay area, the suspended solids plumes generally stay around the project site. The highest deposition is observed in the project area and reaches ~10,000 g/m^2/day around the site boundary. However, outside the site boundary, it rapidly reduces to less than 200 g/m^2/day in about 1km.

Mitigated Sediment Plumes ((1+1) Silt Curtain System)

9.10.1.8 Under the early (February) 2011 unmitigated scenario, the predicted maximum SS elevations could exceed the WQO for a few sensitive receivers around the project site as discussed above. As such, specific mitigation measures would be required to reduce the suspended solids dispersion. The use of a layer of floating type silt curtains surrounding each reclamation site (while taking into account the need for marine access), together with a cage-type silt curtain around each grab dredger to be used (referred as the (1+1) silt curtain system), has been recommended and modelled. This (1+1) silt curtain system is expected to reduce the overall potential sediment loss to the surrounding water columns by 72% in the 2011 scenario (**Table 9.16**). The applicability and effectiveness of the use silt curtains are limited by the current speed of the site. The technical feasibility of the recommended silt curtain system has been evaluated based upon the results of the flow simulations and concluded to be acceptable given the low currents in this area. Further details, together with an indication of the silt curtain layout, are presented in **Appendix 9D6**.

9.10.1.9 The predicted elevated sediment plumes contours (**Figures 001 – 036** in **Part 9D8b** of **Appendix 9D8**) for the selected time frames (peak ebb and flood tides, high and low water level during spring and neap tides), time history plots of the elevated SS over the entire modelling timeframe (**Part 9D8d** of **Appendix 9D8**)and, also, the total and daily sediment deposition assuming the (1+1) silt curtain system is implemented are shown in **Figures 037 – 040** in **Part 9D8b** of **Appendix 9D8**.

9.10.1.10 With these specific mitigation measures, the predicted sediment plumes size and maximum SS elevations are much reduced. In general, surface plumes above 30 mg/L are predicted to be confined to within about 500m of the project site. The dynamic pattern of the plumes is similar to the unmitigated case, but the concentrations are much reduced. The eastward bound extent of the sediment plumes are, only, expected to reach Sham Shui Kok (WSR 45c), which is about 1.5km west of Ta Pang Po, and only low surface concentrations of around 3 mg/L would occur. Again, this situation is predicted to happen occasionally.

9.10.1.11 The western extent of the surface plume around the NE tip of the airport is, also, much reduced to only around 15 mg/L. With the mitigation, the plumes from HKLR will be confined to within only a few hundred meters from the site at low concentrations of less than 10 mg/L, and are not predicted to cross the Tung Chung Channel, nor would it reach the San Tau Beach SSSI.

9.10.1.12 The predicted maximum elevation in SS for selected observation points around the site are compared with the Water Quality Objectives (WQO) or Water Quality Criteria (WQC). The results are summarized in **Table 9.20** below. As indicated in **Table 9.20**, exceedances in SS are observed to few areas in the vicinity of the site. For key marine ecology sensitive area around the project area, no WQO exceedances are predicted for Sha Chau and Lung Kwu Chau Marine Park (WSR 10), Tai Ho Wan (WSR 22a-c), San Tau SSSI (WSR 27), Hau Hok Wan (WSR29), Sha Law Wan (WSR30) and Sham Shui Kok (WSR 42c).

9.10.1.13 With the mitigation measures, exceedances in WQO are still observed at Tai Mo To (WSR 46 and WSR 49) where dolphin habitats are identified. However the predicted maximum percentage of time to exceed respective WQO is within 1% (bottom layer in wet season). Given the short transient time of exceedance, adverse impact on this sensitive receiver is not anticipated. The predicted maximum SS elevations, at the Artificial Reef at NE Airport (WSR 41) would occasionally exceed the wet season WQO and dry season WQO for about 12% (Mid Depth) and 4% (Mid Depth) of the time respectively. The predicted maximum depth average SS elevations at the NE Airport Intake (WSR 25) would, also occasionally exceed the wet season WQO and dry season WQO for about 2% and 2% of the time respectively. Hence, mitigation measures for WSR 41 and WSR 25 are required. Details are discussed in **Section 9.12**.

9.10.1.14 The total elevated sediment deposition over the simulation period and daily averaged sediment deposition rate are also presented in **Figures 037 – 040** in **Part 9D8b** of **Appendix 9D8**. With the mitigation measures, the sediment deposition is much confined to the project site. Outside the site boundary, the elevated sedimentation rapidly reduced to less than 200 $g/m^2/day$ in about 500m. The following table summarizes the maximum elevated sedimentation rate with and without the mitigation measures at key sensitive receivers. With the mitigation measures, the maximum elevated sedimentation rate at key sensitive receivers can be reduced far below the criteria of $200g/m^2/day$.

WSR	Description	Elevated Sedimentation rate without mitigation measures ($g/m^2/day$)		Elevated Sedimentation rate with mitigation measures ($g/m^2/day$)	
		Dry	Wet	Dry	Wet
WSR 22c	Tai Ho Wan Outlet	5.2	2.1	1.9	0.7
WSR 27	San Tau SSSI	6.8	8.0	0.3	0.4
WSR 28	Airport Channel / Airport Cooling Water Intake (S)	0.3	0.1	0.0	0.0
WSR 41	Artificial Reef at NE Airport	265.7	189.7	69.3	50.1
WSR 46	Tai Mo To (near coral / CWD habitat range)	43.8	49.4	19.0	17.0
WSR 49	Tai Mo To (Deep Channel / CWD habitat range)	52	109.1	22.7	42.4

9.10.1.15 In summary, the proposed (1+1) silt curtain system is considered necessary to reduce impacts from suspended solids to within acceptable levels. Although some marginal and transient exceedances remain in very close proximity to the works site, significant residual impacts are not anticipated.

9.10.1.16 Notwithstanding the above, double layers of peripheral silt curtains and cage type silt curtains around the grab dredgers (referred as the (2+1) silt curtain system), could further reduce the potential sediment losses by an extra reduction of about 31%. As such, this (2+1) double silt curtain system could be applied if the construction phase EM&A on-site showed the need for further mitigation. This (2+1) silt curtain system has been modelled and the predicted elevation in the sediment plumes (contours) for the selected time frames (peak ebb and flood tides, high and low water level during spring and neap tides), time history plots of the elevation over the entire modelling timeframe and, also, the total and daily sediment deposition are shown in **Part 9D11a** of **Appendix 9D11** for reference. In addition, if specific sensitive receivers require further protection, silt curtains around sensitive receivers could be considered.

Table 9.19 Predicted Maximum SS (mg/L) Elevations at Observation Points for the Scenario Year 2011 (Unmitigated)

Observation Points	Point SR	Name	Associated EPD Station	Maximum SS (mg/L)								Frequency of Exceedances (% Time)								WQO/WQC							
				Dry Season				Wet Season				Dry Season				Wet Season				Dry Season				Wet Season			
				S	M	B	DA	S	M	B	DA	S	M	B	DA	S	M	B	DA	S	M	B	DA	S	M	B	DA
WSR 08	Yes	Lung Kwu Sheung Tan (non-gazetted beach)	NM5,6,8	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 09a	No	Urmston Road (Main Channel)	NM5,6,8	0.4	0.7	0.7	0.6	0.1	0.6	1.5	0.7	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 10	Yes	Sha Chau and Lung Kwu Chau Marine Park	NM5,6,8	0.1	0.1	0.2	0.1	0.0	0.1	0.4	0.1	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 11	Yes	Castle Peak Power Station Cooling Water Intake (Note 1)	-	0.1	0.1	0.2	0.1	0.0	0.1	0.3	0.1	0%	0%	0%	0%	0%	0%	0%	0%	764	764	764	764	764	764	764	764
WSR 12	Yes	Butterfly Beach (gazetted beach)	NM1,2,3	0.0	0.1	0.2	0.1	0.0	0.1	0.1	0.0	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 13	Yes	WSD Seawater Intake at Tuen Mun	NM1,2,3	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.0	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 15	Yes	Gazetted Beaches at Tuen Mun	NM1,2,3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 18	Yes	Gazetted Beaches along Castle Peak Road	NM1,2,3	0.2	0.5	0.3	0.3	0.1	0.1	0.3	0.2	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 19	Yes	Gazetted Beaches at Ma Wan	WM4	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0%	0%	0%	0%	0%	0%	0%	0%	3.9	6.0	9.0	6.1	1.7	2.8	6.0	3.4
WSR 20	Yes	Ma Wan Fish Culture Zone (Note 2)	-	0.7	0.9	0.9	0.8	0.4	0.4	0.4	0.4	0%	0%	0%	0%	0%	0%	0%	0%	39.1	39.1	39.1	39.1	43.0	43.0	43.0	43.0
WSR 21	Yes	Ta Pang Po (near Sunny Bay Mangrove)	NM1,2,3	6.4	7.1	8.0	7.2	1.5	1.7	1.8	1.7	4%	3%	0%	3%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 22a	No	Tai Ho Wan Outlet (inside)	NM1,2,3	0.2	0.2	0.3	0.2	0.1	0.1	0.2	0.1	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 22b	Yes	Tai Ho Wan (inner), Near Tai Ho Stream SSSI	NM1,2,3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 22c	Yes	Tai Ho Wan Outlet (outside) / Near coral site	NM1,2,3	0.4	0.5	0.6	0.5	0.1	0.3	0.4	0.2	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 25	Yes	Airport Cooling Water Intake (NE)	NM1,2,3	18.4	26.9	30.7	23.7	8.2	23.3	30.6	17.6	24%	38%	37%	36%	5%	35%	33%	33%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 27	Yes	San Tau Beach SSSI	NM5,6,8	0.7	0.9	1.0	0.9	0.1	0.6	1.4	0.6	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 28	Yes	Airport Channel / Airport Cooling Water Intake (S)	NM1,2,3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 29	Yes	Hau Hok Wan (Horseshoe Crab Habitat)	NM5,6,8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 30	Yes	Sha Lo Wan (Horseshoe Crab Habitat)	NM5,6,8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 31	Yes	Sham Wat Wan (Mangrove and Horseshoe Crab Habitat)	NM5,6,8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 32	Yes	Tai O (Mangrove Habitat)	NM5,6,8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 34	Yes	Yi O (Mangrove and Horseshoe Crab Habitat)	NM5,6,8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 41	Yes	Artificial Reef at NE Airport	NM1,2,3	14.7	26.0	65.4	29.9	16.8	38.1	70.8	24.4	20%	40%	22%	39%	18%	38%	26%	35%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 42	Yes	Artificial Reef at Sha Chau	NM5,6,8	0.1	0.1	0.1	0.1	0.0	0.0	0.1	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 45c	No	Sham Shui Kok (CWD habitat range)	NM1,2,3	7.9	9.0	10.2	9.0	1.7	2.0	2.3	2.0	5%	5%	2%	4%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 46	No	Tai Mo To (near coral / CWD habitat range)	NM1,2,3	3.2	6.6	7.8	4.2	4.7	4.4	12.9	4.4	0%	1%	0%	0%	2%	1%	1%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 47a	No	River Trade Terminal	NM1,2,3	0.1	0.4	0.6	0.4	0.1	0.2	0.3	0.2	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 47b	Yes	River Trade Terminal (near coral site)	NM1,2,3	0.1	0.1	0.2	0.1	0.0	0.1	0.2	0.1	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 48	No	Airport Channel western end	NM5,6,8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 49	No	Tai Mo To (Deep Channel / CWD habitat range)	NM1,2,3	2.6	6.4	7.2	4.3	1.3	3.1	18.4	6.2	0%	1%	0%	0%	0%	0%	5%	2%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7

Notes:

- WQO = Water Quality Objective; WQC = Water Quality Criteria; S=Surface level; M=Mid-depth; B=Bottom level; DA=Depth-averaged.
- Grey cell = Values with WQO/WQC Exceedances

1 There is a specific requirement for the Castle Peak Power Station intake and the SS should be maintained at below 150 mg/L (ERM, 2005)
2 General water quality protection guideline for FCZ (CityU, 2001)
3 The "Point SR" column indicate if the site is considered as specific stationary sensitive receiver by the nature of its use (e.g., beaches, existing intakes, SSSI or habitats for less mobile species).

Table 9.20 Predicted Maximum SS (mg/L) Elevations at Observation Points for the Scenario Year 2011 (Mitigated)

Observation Points	Point SR	Name	Associated EPD Station	Maximum SS (mg/L)								Frequency of Exceedances (% Time)								WQO/WQC							
				Dry Season				Wet Season				Dry Season				Wet Season				Dry Season				Wet Season			
				S	M	B	DA	S	M	B	DA	S	M	B	DA	S	M	B	DA	S	M	B	DA	S	M	B	DA
WSR 08	Yes	Lung Kwu Sheung Tan (non-gazetted beach)	NM5,6,8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 09a	No	Urmston Road (Main Channel)	NM5,6,8	0.1	0.2	0.2	0.2	0.0	0.2	0.3	0.2	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 10	Yes	Sha Chau and Lung Kwu Chau Marine Park	NM5,6,8	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 11	Yes	Castle Peak Power Station Cooling Water Intake (Note 1)	-	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0%	0%	0%	0%	0%	0%	0%	0%	764	764	764	764	764	764	764	764
WSR 12	Yes	Butterfly Beach (gazetted beach)	NM1,2,3	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 13	Yes	WSD Seawater Intake at Tuen Mun	NM1,2,3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 15	Yes	Gazetted Beaches at Tuen Mun	NM1,2,3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 18	Yes	Gazetted Beaches along Castle Peak Road	NM1,2,3	0.1	0.2	0.1	0.1	0.0	0.0	0.1	0.1	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 19	Yes	Gazetted Beaches at Ma Wan	WM4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	3.9	6.0	9.0	6.1	1.7	2.8	6.0	3.4
WSR 20	Yes	Ma Wan Fish Culture Zone (Note 2)	-	0.3	0.3	0.3	0.3	0.1	0.1	0.1	0.1	0%	0%	0%	0%	0%	0%	0%	0%	39.1	39.1	39.1	39.1	43.0	43.0	43.0	43.0
WSR 21	Yes	Ta Pang Po (near Sunny Bay Mangrove)	NM1,2,3	2.4	2.6	2.9	2.6	0.6	0.7	0.7	0.7	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 22a	No	Tai Ho Wan Outlet (inside)	NM1,2,3	0.1	0.1	0.1	0.1	0.0	0.0	0.1	0.0	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 22b	Yes	Tai Ho Wan (inner), Near Tai Ho Stream SSSI	NM1,2,3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 22c	Yes	Tai Ho Wan Outlet (outside) / Near coral site	NM1,2,3	0.1	0.2	0.2	0.2	0.0	0.1	0.1	0.1	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 25	Yes	Airport Cooling Water Intake (NE)	NM1,2,3	5.6	7.2	8.2	6.7	2.3	6.4	8.3	4.7	4%	9%	1%	2%	0%	13%	2%	2%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 27	Yes	San Tau Beach SSSI	NM5,6,8	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 28	Yes	Airport Channel / Airport Cooling Water Intake (S)	NM1,2,3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 29	Yes	Hau Hok Wan (Horseshoe Crab Habitat)	NM5,6,8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 30	Yes	Sha Lo Wan (Horseshoe Crab Habitat)	NM5,6,8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 31	Yes	Sham Wat Wan (Mangrove and Horseshoe Crab Habitat)	NM5,6,8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 32	Yes	Tai O (Mangrove Habitat)	NM5,6,8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 34	Yes	Yi O (Mangrove and Horseshoe Crab Habitat)	NM5,6,8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 41	Yes	Artificial Reef at NE Airport	NM1,2,3	4.3	4.7	13.1	5.1	3.6	10.8	18.0	6.1	1%	0%	4%	0%	3%	12%	7%	4%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 42	Yes	Artificial Reef at Sha Chau	NM5,6,8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 45c	No	Sham Shui Kok (CWD habitat range)	NM1,2,3	2.9	3.3	3.8	3.3	0.6	0.7	0.9	0.7	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 46	No	Tai Mo To (near coral / CWD habitat range)	NM1,2,3	1.0	2.0	3.9	1.4	2.4	1.8	6.6	2.3	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 47a	No	River Trade Terminal	NM1,2,3	0.0	0.2	0.2	0.1	0.0	0.1	0.1	0.1	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 47b	Yes	River Trade Terminal (near coral site)	NM1,2,3	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 48	No	Airport Channel western end	NM5,6,8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 49	No	Tai Mo To (Deep Channel / CWD habitat range)	NM1,2,3	0.9	2.0	2.6	1.4	0.5	1.3	6.9	2.3	0%	0%	0%	0%	0%	0%	1%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7

Notes:

- WQO = Water Quality Objective; WQC = Water Quality Criteria; S=Surface level; M=Mid-depth; B=Bottom level; DA=Depth-averaged.
- Grey cell = Values with WQO/WQC Exceedances

1 There is a specific requirement for the Castle Peak Power Station intake and the SS should be maintained at below 150 mg/L (ERM, 2005)

2 General water quality protection guideline for FCZ (CityU, 2001)

3 The "Point SR" column indicate if the site is considered as specific stationary sensitive receiver by the nature of its use (e.g., beaches, existing intakes, SSSI or habitats for less mobile species).

9.10.2 Suspended Solids - Year 2012 Scenario (HKBCF Sequence A + HKLR + TMCLKL)

Unmitigated Sediment Plumes

9.10.2.1 The second selected worse case scenario occurs in early (April) 2012 and the construction activities for HKBCF, HKLR and TMCLKL are all actively progressing at this time. The seawalls for the Phase 1 of HKBCF are mostly completed and seawalls for the Phase 2 HKBCF are partially completed, which would cause some localised changes to the flow patterns. The presence of the HKBCF seawalls will slightly increase the current speed at the gap between the Airport Island and the partially formed HKBCF, especially during the peak ebb and peak flood tides (from generally <0.2m/s to about <0.6 m/s but reaching around <0.8m/s during peak flood). The local flows at this area will be mainly in the north-south direction. The current at the south of the HKBCF will, also, slightly increase from around <0.2 m/s to about <0.4 m/s during peak ebb/flood, although the average speed stays around <0.2m/s. These changes could have some localised effect on the plume dispersion and dilution power. However, the seawall for Portion 1 of the HKLR is nearly completed at this time and would, thus, restrict the sediment loss from this part of the works area.

9.10.2.2 The anticipated work fronts are scattered around the multiple work sites. At the HKBCF island, works are mainly around the northern part of the Phase 1 site and, also, the construction of the southern landfall nib for the TMCLKL is actively in progress. In addition, the dredging / filling works for the APM tunnel between the airport and HKBCF islands is also on-going at this time. Construction works at the TMCLKL northern reclamation will be on-going, with works are mainly confined to around the partially formed Portion N-C. There are, also, predicted to be smaller losses from the construction of the bridge viaduct piers for both the TMCLKL and HKLR.

9.10.2.3 The predicted elevated sediment plumes contours (**Figures 001 – 036** in **Part 9D9a** of **Appendix 9D9**) for the selected time frames (peak ebb and flood tides, high and low water level during spring and neap tides), time history plots of the elevated SS over the entire modelling timeframe (**Part 9D9d** in **Appendix 9D9**) and, also, the total and daily sediment deposition are shown in **Figures 037 – 040** in **Part 9D9a** of **Appendix 9D9.**

9.10.2.4 The total daily unmitigated sediment losses have reduced from around 4.4M kg/day in early 2011 to about 2.0 M kg/day at this time and as such the sediment plumes can be expected to be smaller than those of the 2011 scenario. During the slack periods (high and low waters), the suspended solids (SS) at the work fronts only elevate to around 30 - 50 mg/L at the surface. Surface plumes leaving the site during the slack periods are generally at low concentrations of less than 10 mg/L and do not travel far from the site. During peak ebb and flood tides, the main direction of plumes are still along the east (ebb tide) or west (flood tide), with directions depending on the tidal state and some components of north-south flowing plumes are predicted to travel along the gap between the Airport Island and the HKBCF. Overall speaking, the surface SS rapidly drops to around less than 10 mg/L at a distance of about 1km. The plumes may travel a longer distance during the peak ebb tide and pass over the Ta Pang Po at concentrations of less than 3 mg/L but this situation only occurs occasionally.

9.10.2.5 The western extent of the surface plumes (~15 mg/L contour line) occur at about the NE tip of the Airport, close to the artificial reef deployment site (WSR 41), but not reaching the airport intake (WSR 25). Similar to the 2011 scenario, low concentration surface plumes (<5 mg/L) could, however, reach to a distance about half of the airport run-way. Under no circumstances do the plumes cross the Urmston Road. The sediment plumes generally remain around the East Tung Chung Bay near the project site, although during the flooding time of the spring cycle, the plumes from HKLR could pass the North Lantau Highway and reach Ma Wan Chung at low concentrations (<3 mg/L), but not reaching the San Tau SSSI (WSR 27). This situation is, again, very rare and the plumes only last for around 2 hours, if it does occur.

9.10.2.6 The plumes form the northern reclamation of TMCLKL will be rapidly dispersed by the high flow of Urmston Road. Smaller plumes are observed during the slack tide periods and the plumes are rapidly diluted within about 100m.

9.10.2.7 The predicted maximum elevations in SS for selected observation points around the site are compared with the Water Quality Objectives (WQO) or Water Quality Criteria (WQC). The results are summarized in **Table 9.21** below. As indicated in **Table 9.21**, SS elevations exceeding the relevant WQO are limited to locations around the project site. No exceedances are predicted at Ta Pang Po (WSR 21). For key marine ecology sensitive receivers around the project area, no WQO exceedances are predicted for Sha Chau and Lung Kwu Chau Marine Park (WSR 10), Tai Ho Wan (WSR 22a-c), and San Tau SSSI (WSR 27), Hau Hok Wan (WSR29) and Sha Law Wan (WSR30) inside Airport Channel.

9.10.2.8 The predicted maximum plumes at the identified dolphin habitat closer to the project site, such as Tai Mo To (WSR49), may still marginally exceed the WQO (less than 5% of time), but at areas further away like Sham Shui Kok (WSR 45c), no exceedances are predicted. The plumes are expected to reach Ma Wan FCZ (WSR 20) at very low level (less than 1 mg/L) and no WQC /WQO exceedances are predicted. At the Tuen Mun side, the maximum predicted elevations in SS at Butterfly Beach (WSR 12) and WSD intake (WSR 13) will be less than 2 mg/L, which are well below the WQO/WQC. Occasional exceedances are, only, predicted to occur around the River Trade Terminal (WSR 47a), adjacent to the work area of TMCLKL.

9.10.2.9 The predicted maximum depth average SS elevations, at the Artificial Reef at NE Airport (WSR 41) would exceed of the wet season WQO of 3.7 mg/L and dry season WQO of 5.5 mg/L for about 24% and 25% of the time respectively. The predicted surface maximum SS elevations at the NE Airport Intake (WSR 25) would exceed the wet season WQO and dry season WQO for about 19% and 19% of the time respectively. Exceedances in WQO are also predicted at the surface, mid-depth and bottom level of the above receivers.

9.10.2.10 The total elevated sediment deposition over the entire simulation period and daily averaged sediment deposition rates are presented in **Figures 037 – 040** in **Part 9D9a** of **Appendix 9D9**. As majority of the proposed works are located in a shallow sheltered bay area, the suspended solids plumes, generally, remain around the project site and the deposition is the highest inside the project area, reaching ~10,000 g/m^2/day around the site boundary. However, outside the site boundary, the elevated sediment deposition rapidly reduces to less than 200 g/m^2/day in about 500m. For the northern reclamation of the TMCLKL, the deposition rate would be less than 50 g/m^2/day outside the work site.

Table 9.21 Predicted Maximum SS (mg/L) Elevations at Observation Points for the Scenario Year 2012 (Unmitigated)

Observation Points	Point SR	Name	Associated EPD Station	Maximum SS (mg/L)								Frequency of Exceedances (% Time)								WQO/WQC							
				Dry Season				Wet Season				Dry Season				Wet Season				Dry Season				Wet Season			
				S	M	B	DA	S	M	B	DA	S	M	B	DA	S	M	B	DA	S	M	B	DA	S	M	B	DA
WSR 08	Yes	Lung Kwu Sheung Tan (non-gazetted beach)	NM5,6,8	0.0	0.4	0.5	0.3	0.0	0.0	0.1	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 09a	No	Urmston Road (Main Channel)	NM5,6,8	0.3	0.4	0.6	0.3	0.3	0.4	0.7	0.3	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 10	Yes	Sha Chau and Lung Kwu Chau Marine Park	NM5,6,8	0.0	0.1	0.1	0.1	0.0	0.1	0.2	0.1	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 11	Yes	Castle Peak Power Station Cooling Water Intake (Note 1)	-	0.3	0.9	1.2	0.8	0.0	0.2	2.1	0.7	0%	0%	0%	0%	0%	0%	0%	0%	764	764	764	764	764	764	764	764
WSR 12	Yes	Butterfly Beach (gazetted beach)	NM1,2,3	0.4	1.2	1.4	0.9	0.6	1.1	1.4	0.9	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 13	Yes	WSD Seawater Intake at Tuen Mun	NM1,2,3	0.7	0.9	1.1	0.9	0.5	0.8	1.2	0.7	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 15	Yes	Gazetted Beaches at Tuen Mun	NM1,2,3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 18	Yes	Gazetted Beaches along Castle Peak Road	NM1,2,3	0.2	0.5	0.5	0.4	0.1	0.2	0.3	0.2	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 19	Yes	Gazetted Beaches at Ma Wan	WM4	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0%	0%	0%	0%	0%	0%	0%	0%	3.9	6.0	9.0	6.1	1.7	2.8	6.0	3.4
WSR 20	Yes	Ma Wan Fish Culture Zone (Note 2)	-	0.6	0.7	0.8	0.7	0.2	0.4	0.4	0.4	0%	0%	0%	0%	0%	0%	0%	0%	39.1	39.1	39.1	39.1	43.0	43.0	43.0	43.0
WSR 21	Yes	Ta Pang Po (near Sunny Bay Mangrove)	NM1,2,3	2.4	2.6	2.9	2.6	0.8	0.9	1.1	0.9	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 22a	No	Tai Ho Wan Outlet (inside)	NM1,2,3	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 22b	Yes	Tai Ho Wan (inner), Near Tai Ho Stream SSSI	NM1,2,3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 22c	Yes	Tai Ho Wan Outlet (outside) / Near coral site	NM1,2,3	0.2	0.2	0.2	0.2	0.0	0.1	0.1	0.1	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 25	Yes	Airport Cooling Water Intake (NE)	NM1,2,3	9.3	13.5	18.1	10.7	5.8	13.7	16.9	10.1	9%	24%	17%	19%	4%	26%	18%	19%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 27	Yes	San Tau Beach SSSI	NM5,6,8	0.1	0.2	0.2	0.1	0.0	0.0	0.1	0.1	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 28	Yes	Airport Channel / Airport Cooling Water Intake (S)	NM1,2,3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 29	Yes	Hau Hok Wan (Horseshoe Crab Habitat)	NM5,6,8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 30	Yes	Sha Lo Wan (Horseshoe Crab Habitat)	NM5,6,8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 31	Yes	Sham Wat Wan (Mangrove and Horseshoe Crab Habitat)	NM5,6,8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 32	Yes	Tai O (Mangrove Habitat)	NM5,6,8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 34	Yes	Yi O (Mangrove and Horseshoe Crab Habitat)	NM5,6,8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 41	Yes	Artificial Reef at NE Airport	NM1,2,3	8.2	12.2	23.3	12.3	7.8	13.7	21.2	10.0	19%	29%	21%	25%	12%	31%	12%	24%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 42	Yes	Artificial Reef at Sha Chau	NM5,6,8	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 45c	No	Sham Shui Kok (CWD habitat range)	NM1,2,3	2.2	2.6	3.0	2.6	0.7	1.0	1.4	0.8	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 46	No	Tai Mo To (near coral / CWD habitat range)	NM1,2,3	5.2	8.8	27.4	11.2	8.4	14.1	22.2	7.9	1%	5%	4%	1%	14%	7%	5%	3%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 47a	No	River Trade Terminal	NM1,2,3	6.0	8.4	14.6	5.5	4.2	9.7	11.0	4.9	2%	1%	1%	0%	4%	6%	1%	3%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 47b	Yes	River Trade Terminal (near coral site)	NM1,2,3	0.6	0.7	2.3	1.0	0.7	1.7	1.7	0.8	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 48	No	Airport Channel western end	NM5,6,8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 49	No	Tai Mo To (Deep Channel / CWD habitat range)	NM1,2,3	2.6	6.9	6.6	4.7	4.5	6.0	10.1	3.7	0%	3%	0%	0%	1%	5%	4%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7

Notes:

- WQO = Water Quality Objective; WQC = Water Quality Criteria; S=Surface level; M=Mid-depth; B=Bottom level; DA=Depth-averaged.
- Grey cell = Values with WQO/WQC Exceedances

1 There is a specific requirement for the Castle Peak Power Station intake and the SS should be maintained at below 150 mg/L (ERM, 2005)
2 General water quality protection guideline for FCZ (CityU, 2001)
3 The "Point SR" column indicate if the site is considered as specific stationary sensitive receiver by the nature of its use (e.g., beaches, existing intakes, SSSI or habitats for less mobile species).

Table 9.22 Predicted Maximum SS (mg/l) Elevations at Observation Points for the Scenario Year 2012 (Mitigated)

Observation Points	Point SR	Name	Associated EPD Station	Maximum SS (mg/L)								Frequency of Exceedances (% Time)								WQO/WQC							
				Dry Season				Wet Season				Dry Season				Wet Season				Dry Season				Wet Season			
				S	M	B	DA	S	M	B	DA	S	M	B	DA	S	M	B	DA	S	M	B	DA	S	M	B	DA
WSR 08	Yes	Lung Kwu Sheung Tan (non-gazetted beach)	NM5,6,8	0.0	0.3	0.5	0.3	0.0	0.0	0.1	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 09a	No	Urmston Road (Main Channel)	NM5,6,8	0.1	0.2	0.6	0.3	0.1	0.3	0.6	0.2	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 10	Yes	Sha Chau and Lung Kwu Chau Marine Park	NM5,6,8	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 11	Yes	Castle Peak Power Station Cooling Water Intake (Note 1)	-	0.3	0.9	1.2	0.8	0.0	0.2	2.1	0.7	0%	0%	0%	0%	0%	0%	0%	0%	764	764	764	764	764	764	764	764
WSR 12	Yes	Butterfly Beach (gazetted beach)	NM1,2,3	0.4	1.1	1.4	0.9	0.6	1.1	1.4	0.9	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 13	Yes	WSD Seawater Intake at Tuen Mun	NM1,2,3	0.7	0.9	1.1	0.9	0.5	0.8	1.1	0.7	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 15	Yes	Gazetted Beaches at Tuen Mun	NM1,2,3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 18	Yes	Gazetted Beaches along Castle Peak Road	NM1,2,3	0.2	0.2	0.3	0.2	0.0	0.1	0.1	0.1	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 19	Yes	Gazetted Beaches at Ma Wan	WM4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	3.9	6.0	9.0	6.1	1.7	2.8	6.0	3.4
WSR 20	Yes	Ma Wan Fish Culture Zone (Note 2)	-	0.2	0.2	0.2	0.2	0.1	0.1	0.2	0.1	0%	0%	0%	0%	0%	0%	0%	0%	39.1	39.1	39.1	39.1	43.0	43.0	43.0	43.0
WSR 21	Yes	Ta Pang Po (near Sunny Bay Mangrove)	NM1,2,3	0.6	0.7	0.8	0.7	0.2	0.3	0.3	0.3	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 22a	No	Tai Ho Wan Outlet (inside)	NM1,2,3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 22b	Yes	Tai Ho Wan (inner), Near Tai Ho Stream SSSI	NM1,2,3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 22c	Yes	Tai Ho Wan Outlet (outside) / Near coral site	NM1,2,3	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 25	Yes	Airport Cooling Water Intake (NE)	NM1,2,3	2.6	3.6	5.0	3.0	1.6	3.7	4.6	2.7	0%	0%	0%	0%	0%	1%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 27	Yes	San Tau Beach SSSI	NM5,6,8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 28	Yes	Airport Channel / Airport Cooling Water Intake (S)	NM1,2,3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 29	Yes	Hau Hok Wan (Horseshoe Crab Habitat)	NM5,6,8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 30	Yes	Sha Lo Wan (Horseshoe Crab Habitat)	NM5,6,8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 31	Yes	Sham Wat Wan (Mangrove and Horseshoe Crab Habitat)	NM5,6,8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 32	Yes	Tai O (Mangrove Habitat)	NM5,6,8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 34	Yes	Yi O (Mangrove and Horseshoe Crab Habitat)	NM5,6,8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 41	Yes	Artificial Reef at NE Airport	NM1,2,3	3.1	4.0	7.5	4.0	2.7	4.0	6.5	3.1	0%	0%	0%	0%	0%	3%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 42	Yes	Artificial Reef at Sha Chau	NM5,6,8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 45c	No	Sham Shui Kok (CWD habitat range)	NM1,2,3	0.6	0.7	0.8	0.7	0.2	0.3	0.4	0.2	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 46	No	Tai Mo To (near coral / CWD habitat range)	NM1,2,3	1.4	2.6	7.7	3.3	3.3	4.0	6.6	2.4	0%	0%	0%	0%	1%	1%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 47a	No	River Trade Terminal	NM1,2,3	6.0	8.4	14.6	5.5	4.2	9.7	10.9	4.9	2%	1%	1%	0%	4%	6%	1%	3%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 47b	Yes	River Trade Terminal (near coral site)	NM1,2,3	0.6	0.7	2.3	1.0	0.7	1.7	1.7	0.8	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 48	No	Airport Channel western end	NM5,6,8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 49	No	Tai Mo To (Deep Channel / CWD habitat range)	NM1,2,3	0.8	1.8	2.0	1.3	1.2	1.6	3.0	1.1	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7

Notes:

- WQO = Water Quality Objective; WQC = Water Quality Criteria; S=Surface level; M=Mid-depth; B=Bottom level; DA=Depth-averaged.
- Grey cell = Values with WQO/WQC Exceedances

1 There is a specific requirement for the Castle Peak Power Station intake and the SS should be maintained at below 150 mg/L (ERM, 2005)
2 General water quality protection guideline for FCZ (CityU, 2001)
3 The "Point SR" column indicate if the site is considered as specific stationary sensitive receiver by the nature of its use (e.g., beaches, existing intakes, SSSI or habitats for less mobile species).

Mitigated Sediment Plumes ((1+1) Silt Curtain System)

9.10.2.11 Under the early (April) 2012 unmitigated scenario, the predicted maximum SS elevations could exceed the WQO for a very few sensitive receivers around the project site as discussed above. As such, specific mitigation measures would be required to reduce the suspended solids dispersion. The use of (1+1) silt curtain systems has been recommended and modelled. This (1+1) silt curtain system is expected to reduce the overall potential sediment loss to the surrounding water columns by 67% in the 2012 scenario year (**Table 9.16b**). The applicability and effectiveness of the use silt curtains are limited by the current speed of the site and the technical feasibility of the recommended silt curtain system has been evaluated based upon the results of the flow simulations and concluded to be acceptable given the low currents in this area. As noted in **Table 9.16b**, however, no silt curtain system protection is assumed at this stage for the TMCLKL northern reclamation in which the flow is high. Further details, together with an indication of the silt curtain layout, are presented in **Appendix 9D6**.

9.10.2.12 The predicted elevated sediment plumes contours (**Figures 001 – 036** of **Part 9D9b** of **Appendix 9D9**) for the selected time frames (peak ebb and flood tides, high and low water level during spring and neap tides), time history plots of the elevated SS over the entire modelling timeframe (**Part 9D9d** of **Appendix 9D9**)and, also, the total and daily sediment deposition assuming the (1+1) silt curtain system is implemented are shown in **Figures 037 – 040** in **Part 9D9b** of **Appendix 9D9.**

9.10.2.13 With these specific mitigation measures, the predicted sediment plumes size and maximum SS elevations are much reduced. In general, surface SS plumes above 15 mg/L are predicted to be confined to within about 500m of the project site. The dynamic pattern of the plumes is similar to the unmitigated case, but the concentrations are much reduced. The eastward bound extent of the sediment plumes are not expected to reach Sham Shui Kok (WSR 45c) as the predicted SS elevation is less than 1mg/L. The western extent of the surface plume around the NE tip of the airport is, also, much reduced.

9.10.2.14 With the mitigation, the predicted plumes from the HKLR are confined to within only a few hundred metres from the site. The concentration contour of 10 mg/L is predicted not to cross the North Lantau Highway, nor would they reach the San Tau Beach SSSI.

9.10.2.15 Exceedances in WQO are also observed at Tai Mo To (WSR46) where coral and chinese white dolphins habitats are identified. However the predicted maximum percentage of time to exceed respective WQO is within 1% (surface and mid layer in wet season). Given the short transient time of exceedance, adverse impacts on this sensitive receiver are not anticipated.

9.10.2.16 The predicted maximum elevation in SS for selected observation points around the site are compared with the Water Quality Objectives (WQO) or Water Quality Criteria (WQC). The results are summarized in **Table 9.22** below. As indicated in **Table 9.22**, SS exceedances of the relevant WQOs are limited to few areas in close vicinity to the site. For key marine ecology sensitive receivers around the project area, no WQO exceedances are predicted for Sha Chau and Lung Kwu Chau Marine Park (WSR 10), Tai Ho Wan (WSR 22a-c), Sham Shui Kok (WSR 45c), Tai Mo To (WSR49) and San Tau SSSI (WSR 27), Hau Hok Wan (WSR29) and Sha Law Wan (WSR30) inside Airport Channel. No observable plumes at Ma Wan FCZ (WSR 20) are expected as the predicted elevation is less than 1 mg/L and not exceeding the WQC /WQOs.

9.10.2.17 Exceedances in SS at Artificial Reef at NE Airport (WSR 41) are predicted in surface, mid depth and bottom layer in wet season. The predicted percentage of time exceedances is less than 3%. Exceedance in SS at Airport cooling water intake (WSR 25) is predicted in mid depth layer in wet season. The predicted percentage of time exceedances is less than 1%. Hence, mitigation measures for WSR 41 and WSR 25 are required. Details are discussed in Section 9.12.

9.10.2.18 The total elevated sediment deposition over the simulation period and daily averaged sediment deposition rate is also presented in **Figures 037 – 040** in **Part 9D9b** of **Appendix 9D9**. With the mitigation measures, the sediment deposition is much confined to the project site. Outside the site boundary, it rapidly reduces to less than 200 g/m^2/day in about 500m. The following table summarizes the maximum elevated sedimentation rate with and without the mitigation measures at key sensitive receivers. With the mitigation measures, the maximum elevated sedimentation rate at key sensitive receivers can be reduced far below the criteria of 200g/m^2/day.

WSR	Description	Elevated Sedimentation rate without mitigation measures (g/m^2/day)		Elevated Sedimentation rate with mitigation measures (g/m^2/day)	
		Dry	Wet	Dry	Wet
WSR 22c	Tai Ho Wan Outlet	2.4	1.1	0.7	0.4
WSR 27	San Tau SSSI	1.1	0.5	0.1	0.1
WSR 28	Airport Channel / Airport Cooling Water Intake (S)	0.1	0.1	0.1	0.1
WSR 41	Artificial Reef at NE Airport	119.3	122.7	33.5	37.5
WSR 46	Tai Mo To (near coral / CWD habitat range)	59	65.8	18.3	18.7
WSR 49	Tai Mo To (Deep Channel / CWD habitat range)	60	96.8	16.8	25.2

9.10.2.19 In summary, the proposed (1+1) silt curtain system is able to reduce the impact of SS to within acceptable levels. Although marginal and transient exceedances remain in very close proximity to the works site, residual impacts are not anticipated.

9.10.2.20 Notwithstanding, double layers of peripheral silt curtains and cage type silt curtains around the grab dredgers (referred as the (2+1) silt curtain system), could further reduce the potential sediment losses by an extra reduction of about 19%. As such, this (2+1) double silt curtain system could be applied if the construction phase EM&A on-site showed the need for further mitigation. This (2+1) silt curtain system has been modelled and the predicted elevation in the sediment plumes (contours) for the selected time frames (peak ebb and flood tides, high and low water level during spring and neap tides), time history plots of the elevation over the entire modelling timeframe and the total and daily sediment deposition are shown in **Part 9D11b** of **Appendix 9D11** for reference. In addition, if specific sensitive receivers require further protection, silt curtains around sensitive receivers could be considered.

9.10.3 Suspended Solids - Year 2013 Scenario (HKBCF Sequence A + HKLR + TMCLKL)

<u>Unmitigated Sediment Plumes</u>

9.10.3.1 The last selected worse case scenario is in early (April) 2013 when construction activities for both the HKBCF and TMCLKL are still actively progressing. The reclamation works of the HKLR are expected to be completed by this time and the only HKLR marine works left would comprise piling for the viaduct piers. The seawalls for the Phase 2 of HKBCF would be largely completed, while Portion D of the HKBCF, connecting the Airport Island and the HKBCF, would, also, be partially formed. The narrowing of the channel by Portion D of HKBCF would further change the local north-south flows along Portion A of the HKBCF seawalls from peak ebb of <0.4m/s to around <0.8m/s, but the peak flood flows stay around <0.8m/s. Significant localised changes in flow around the south of the HKBCF are not anticipated. For the northern reclamation of TMCLKL, the seawalls would be almost completed and, thus, shielding works being undertaken near the shore.

9.10.3.2 The anticipated work fronts are scattered around the multiple work sites. At the HKBCF, works will comprise mainly Phase 2reclamation filling. Works at the TMCLKL southern reclamation would be on-going and progressing southwards along the edge of the HKBCF island. As noted above, seawalls for the TMCLKL northern reclamation would be almost completed and the main works would comprise reclamation filling. Marine works for HKLR would be completed except for the viaduct pier piling. Piling for the TMCLKL southern marine viaduct pilling would be completed.

9.10.3.3 The predicted elevated sediment plumes contours (**Figures 001 – 036** of **Part 9D10a** of **Appendix 9D10**) for the selected time frames (peak ebb and flood tides, high and low water level during spring and neap tides), time history plots of the elevated SS over the entire modelling timeframe (**Part 9D10d** of **Appendix 9D10**) and, also, the total and daily sediment deposition are shown in **Figures 037 – 040** in **Part 9D10a** of **Appendix 9D10.**

9.10.3.4 As the works are near completion, the total daily unmitigated sediment losses has reduced from around 2.0M kg/day in early 2012 to about 1.7 M kg/day and as such the sediment plumes can be expected to be similar to 2012 scenario, though the newly formed Phase 1 HKBCF land mass and the location of the works fronts would affect the dynamics of the sediment plumes.

9.10.3.5 During the slack periods (high and low waters), the suspended solids (SS) at the work fronts could elevate to around 300 mg/L at the surface. This is mainly localised around the Portion D of the works, in which seawalls filling and reclamation dredging rates are higher than 2012. As a consequence, the surface plumes leaving the site during the slack periods could elevate to around 100 mg/L within 1km of the site and only drop to <30 mg/L at a distance of 2km. This is mainly predicted during the low water level in which the ebb tide carried the plumes from Portion D towards East Tung Chung Bay where flow and dilution is relatively week and the plumes can built up rapidly. Plumes heading north towards the artificial reef near the NE tip of the airport would be rapidly diluted by the high flow of the main channel and as such the plumes would be small and in low elevation (<30 mg/L). Under no circumstances do the plumes cross the Urmston Road.

9.10.3.6 During peak ebb, the main direction of plumes from Portion D are southward and than turn eastward inside the East Tung Chung Bay. The surface plumes 30mg/L contour line can reach the proposed South Brothers CMP Pit B. During ebbing, the plumes are predicted to be larger and of higher concentration during the dry season. However, it could be closer to the Tung Chung coastline during the wet season. During the peak flood, plumes from Portion D of the works travel northward and than westward. The surface plumes at the gap between the Airport Island and HKBCF would reach around 100 mg/L but rapidly diluted to <30mg/L in around 500m after leaving the gap heading west. The plumes form the Phase 2 of the HKBCF would be mainly confined by the surrounding seawalls and no surface plumes outside this working area are expected.

9.10.3.7 The surface plumes leaving the TMCLKL southern reclamation are, generally, of low concentrations (<15 mg/L) outside the works area and, typically, they travel westward along the southern edge of the HKBCF during flood tide and travel eastward during the ebb tide. At the TMCLKL northern reclamation, the plumes are highly localised to the east side of the reclamation where the marine access gap is located. The localised surface plumes at Tuen Mun, however, could become more prominent as flows are blocked by the seawalls. Notwithstanding, the local surface plumes outside the site are predicted to drop to <10mg/L in 500m and would not affect the sensitive receivers along the coastline.

9.10.3.8 The predicted maximum elevations in SS for selected observation points around the site are compared with the Water Quality Objectives (WQO) or Water Quality

Criteria (WQC). The results are summarized in **Table 9.23** below. As indicated in **Table 9.23**, SS elevations exceeding the relevant WQO are limited to locations around the project site. For plumes occasionally reaching Ta Pang Po (WSR 21), the maximum depth average concentrations are only 1.5 mg/L, which are well below the WQOs.

9.10.3.9 For key marine ecology sensitive area around the project area, no WQO exceedances are predicted for Sha Chau and Lung Kwu Chau Marine Park (WSR 10), Tai Ho Wan (WSR 22a-c), Sham Shui Kok (WSR 45c) and San Tau SSSI (WSR 27), Hau Hok Wan (WSR29) and Sha Law Wan (WSR30) inside Airport Channel. No observable plume at Ma Wan FCZ (WSR 20) is observed as the predicted maximum elevation in SS is below 0.5 mg/L, which is well within the WQC /WQOs. At the Tuen Mun side, the maximum predicted elevations in SS at Butterfly Beach (WSR 12) and WSD intake (WSR 13) are less than 2 mg/L, which is well below the WQO/WQC.

9.10.3.10 Exceedance in SS (less than 3% of time) is predicted at mid-depth at the identified dolphin habitat near Tai Mo To (WSR49) in dry season. The predicted maximum depth average SS elevations, at River Trade Terminal (WSR 47b) adjacent to the works would exceed the WQO of 3.7 mg/L (wet season) and 5.5 mg/L (dry season) for about 11% and 9% of the time respectively.

9.10.3.11 The predicted maximum depth average SS elevations, at the Artificial Reef at NE Airport (WSR 41) would exceed of the calculated WQO of 3.7 mg/L (wet season) and 5.5 mg/L (dry season) for about 11% and 9% of the time respectively. The predicted surface maximum SS elevations at the NE Airport Intake (WSR 25) would, also, exceed the wet season and dry season WQO for about 32% and 6% of the time respectively. Exceedances in WQO are also predicted at the surface, mid-depth and bottom level for the above receivers.

9.10.3.12 The total sediment deposition over the entire simulation period and daily averaged sediment deposition rates are, also, presented in **Figures 037 – 040** in **Part 9D10a** of **Appendix 9D10**. As the proposed site is located in a shallow sheltered bay area, the SS plumes generally stay around the project site and the deposition is also the highest inside the project area. The sedimentation can reach ~10,000 g/m^2/day around the site boundary. However, outside the site boundary, it rapidly reduces to less than 200 g/m^2/day in about 500m. For Portion D of the HKBCF, however, an area of relatively high deposition rate (~1,000 g/m^2/day) would extend to about 1km southward. For the northern reclamation of the TMCLKL, the deposition rate would be reduced to less than 200 g/m^2/day in about 500m from the work site. The following table summarizes the maximum elevated sedimentation rate with and without the mitigation measures at key sensitive receivers. With the mitigation measures, the maximum elevated sedimentation rate at key sensitive receivers can be reduced far below the criteria of 200g/m^2/day.

WSR	Description	Elevated Sedimentation rate without mitigation measures (g/m^2/day)		Elevated Sedimentation rate with mitigation measures (g/m^2/day)	
		Dry	Wet	Dry	Wet
WSR 22c	Tai Ho Wan Outlet	3.6	2.0	1.1	0.6
WSR 27	San Tau SSSI	1.1	0.4	0.4	0.2
WSR 28	Airport Channel / Airport Cooling Water Intake (S)	0.1	0.0	0.0	0.0
WSR 41	Artificial Reef at NE Airport	79.3	15.1	25.5	5.4
WSR 46	Tai Mo To (near coral / CWD habitat range)	11.8	15.7	4.0	5.2
WSR 49	Tai Mo To (Deep Channel / CWD habitat range)	26.4	31	8.6	11.2

Mitigated Sediment Plumes ((1+1) Silt Curtain System)

9.10.3.13 Under the early (April) 2013 unmitigated scenario, the predicted maximum SS elevations could exceed the WQO for only a very few sensitive receivers around the project site as discussed above. As such, specific mitigation measures would be required to reduce the suspended solids dispersion. The use of (1+1) silt curtain systems has been recommended and modelled. This (1+1) silt curtain system is expected to reduce the overall potential sediment loss to the surrounding water columns by 66% in the 2013 scenario year (**Table 9.16b**). The applicability and effectiveness of the use of silt curtains are limited by the current speed of the site. The technical feasibility of the recommended silt curtain system has been evaluated based upon the results of the flow simulations and concluded to be acceptable given the low currents in this area. For TMCLKL northern reclamation, the work front is close to the shoreline and the seawall would, also, provide certain degree of protection against high flows. As such, silt curtains can be applied in this location at this stage. Further details, together with an indication of the silt curtain layout, are presented in **Appendix 9D6**.

9.10.3.14 The predicted elevated sediment plumes contours (**Figures 001 – 036** in **Part 9D10b** of **Appendix 9D10**) for the selected time frames (peak ebb and flood tides, high and low water level during spring and neap tides), time history plots of the elevated SS over the entire modelling timeframe (**Part 9D10d** of **Appendix 9D10**)and, also, the total and daily sediment deposition assuming the (1+1) silt curtain system is implemented are shown in **Figures 037 – 040** in **Part 9D10b** of **Appendix 9D10.**

9.10.3.15 With these specific mitigation measures, the predicted sediment plumes size and maximum SS elevations are much reduced. In general, surface plumes above 50 mg/L are predicted to be confined to within about 500m of the project site. The dynamic pattern of the plumes is similar to the unmitigated case, but the concentrations are much reduced. The eastward extent of the sediment plume is not expected to reach Sham Shui Kok (WSR 45c), where the predicted elevated SS is less than 1mg/L.

9.10.3.16 The western extent of the surface plume around the NE tip of the airport is much reduced to around 10 mg/L. With the mitigation, the south-east surface plumes from Portion D of the HKBCF work, during ebbing, are predicted to reduce to around 30 mg/L within 1km. Similarly, the plumes from the TMCLKL at Tuen Mun are predicted to be much reduced.

9.10.3.17 The predicted maximum elevations in SS for selected observation points around the site are compared with the Water Quality Objectives (WQO) or Water Quality Criteria (WQC). The results are summarized in **Table 9.24** below. As indicated in **Table 9.24**, SS exceedances of the relevant WQOs are limited to few areas in close vicinity to the site. No WQO exceedances are predicted for key ecology sensitive areas around the project area, such as Sha Chan and Lung Kwu Chau Marine Park (WSR 10), Tai Ho Wan (WSR 22a-c) or Airport Channel (including WSR 27, 29 and 30). The predicted maximum plumes at the recently identified dolphin habitat like Tai Mo To (WSR49) and Sham Shui Kok (WSR 45c) would not exceed the WQO. No observable plumes at Ma Wan FCZ (WSR 20) are expected as the predicted elevation is <0.5 mg/L and not exceeding the WQC /WQO exceedances. For corals near the River Trade Terminal (WSR 47b), low level of exceedances are still predicted at 11% of the wet season time but not during the dry season. As corals colonies near the River Trade terminal are recommended to be translocated prior to the works, no direct impacts are anticipated.

9.10.3.18 The maximum SS elevations at the Artificial Reef at the airport Exclusion Zone (WSR 41) are predicted to exceed the WQO. Exceedances (2% of the time) are predicted at surface and mid depth in dry season. Moreover, exceedances at surface (11% of the time) and exceedance at mid depth (2% of time) are predicted in the wet season. The predicted maximum depth averaged SS at the NE Airport Intake (WSR 25) is below the WQO at all times, although occasional exceedances (2% of the time) are still predicted at the surface and mid-depth. Given the short transient time of exceedance, adverse impacts on these sensitive receivers are not anticipated.

9.10.3.19 The total sediment deposition over the simulation period and daily averaged sediment deposition rate is also presented in **Figures 037 – 040** in **Part 9D10b** of **Appendix 9D10**. With the mitigation measures, the sediment deposition are much confined to the project site and outside the site boundary, they rapidly reduce to less than 100 $g/m^2/day$ in about 500m. For Portion D of HKBCF, however, such low levels of deposition are predicted at an area 1km away from the site.

9.10.3.20 In summary, the (1+1) silt curtain system proposed is considered to reduce impacts from suspended solids to within acceptable levels and while some marginal and transient exceedances remain in very close proximity to the works site, as these do not predicted to affect any ecological sensitive receivers, including key dolphin habitat at Tai Mo To, significant residual impacts are not expected.

9.10.3.21 However, the sediment plumes from Portion D of HKBCF are predicted to be close to the Tung Chung coastline even with the (1+1) silt curtain systems in place for the 2013 scenario compared to the other scenario years, as a result of the narrowing of the channel and associated increase in flow when the construction of Portion D begins. In the original worse case construction programme (Sequence A), it is assumed that the northern and southern seawalls for Portion D will be constructed in parallel with the reclamation dredging and filling. Under this scenario, the potential sediment loss from this work front is high as minimal integrated design measures such as a leading seawall can be implemented. With the implementation of the (1+1) silt curtain system, WQO exceedances and high SS plumes can be mitigated to some extent. However, the localised high flows could represent a challenge for effective deployment of the (1+1) silt curtain system and the effectiveness of the silt curtain systems may not be guaranteed unless the silt curtain system are specially built (as per the manufacturer specification) or some other engineering measures such as steel sheet piles (proposed on the northern part of HKBCF) is considered. A more viable alternative would be the formation of either the northern or southern seawalls for the Portion D which, once completed, would be expected to reduce the local flow speed (box culverts, however, will be provided at the operation phase to restore the flows in the embayment area) and, thus, reducing the size of the sediment plumes size. This, however, would be subject to other constrains such as marine access although it is recommended to consider this programme change should a higher level of protection to the Tung Chung coastline (southern seawall first) or to the artificial reef at the NE of airport (northern seawall first).

9.10.3.22 Notwithstanding, double layers of peripheral silt curtains and cage type silt curtains around the grab dredgers (referred as the (2+1) silt curtain system), could further reduce the potential sediment losses by an extra reduction of about 30%. As such, this (2+1) double silt curtain system could be applied if the construction phase EM&A on-site showed the need for further mitigation. This (2+1) silt curtain system has been modelled and the predicted elevation in the sediment plumes (contours) for the selected time frames (peak ebb and flood tides, high and low water level during spring and neap tides), time history plots of the elevation over the entire modelling timeframe and the total and daily sediment deposition are shown in **Part 9D11c** of **Appendix 9D11** for reference. In addition, if specific sensitive receivers require further protection, silt curtains around sensitive receivers could be considered.

Table 9.23 Predicted Maximum SS (mg/L) Elevations at Observation Points for the Scenario Year 2013 (Unmitigated)

Observation Points	Point SR	Name	Associated EPD Station	Maximum SS (mg/L)								Frequency of Exceedances (% Time)								WQO/WQC							
				Dry Season				Wet Season				Dry Season				Wet Season				Dry Season				Wet Season			
				S	M	B	DA	S	M	B	DA	S	M	B	DA	S	M	B	DA	S	M	B	DA	S	M	B	DA
WSR 08	Yes	Lung Kwu Sheung Tan (non-gazetted beach)	NM5,6,8	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 09a	No	Urmston Road (Main Channel)	NM5,6,8	0.2	0.3	0.3	0.2	0.1	0.5	0.4	0.3	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 10	Yes	Sha Chau and Lung Kwu Chau Marine Park	NM5,6,8	0.0	0.0	0.1	0.0	0.0	0.1	0.2	0.1	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 11	Yes	Castle Peak Power Station Cooling Water Intake (Note 1)	-	0.1	0.2	0.2	0.2	0.0	0.1	0.3	0.1	0%	0%	0%	0%	0%	0%	0%	0%	764	764	764	764	764	764	764	764
WSR 12	Yes	Butterfly Beach (gazetted beach)	NM1,2,3	0.3	0.8	0.6	0.5	0.6	1.5	1.8	0.9	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 13	Yes	WSD Seawater Intake at Tuen Mun	NM1,2,3	0.1	0.1	0.1	0.1	0.3	0.3	0.3	0.2	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 15	Yes	Gazetted Beaches at Tuen Mun	NM1,2,3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 18	Yes	Gazetted Beaches along Castle Peak Road	NM1,2,3	0.1	0.3	0.2	0.2	0.1	0.1	0.2	0.1	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 19	Yes	Gazetted Beaches at Ma Wan	WM4	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0%	0%	0%	0%	0%	0%	0%	0%	3.9	6.0	9.0	6.1	1.7	2.8	6.0	3.4
WSR 20	Yes	Ma Wan Fish Culture Zone (Note 2)	-	0.3	0.5	0.5	0.4	0.1	0.2	0.2	0.2	0%	0%	0%	0%	0%	0%	0%	0%	39.1	39.1	39.1	39.1	43.0	43.0	43.0	43.0
WSR 21	Yes	Ta Pang Po (near Sunny Bay Mangrove)	NM1,2,3	1.3	1.5	1.6	1.5	0.2	0.3	0.4	0.3	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 22a	No	Tai Ho Wan Outlet (inside)	NM1,2,3	0.1	0.2	0.2	0.2	0.0	0.1	0.1	0.1	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 22b	Yes	Tai Ho Wan (inner), Near Tai Ho Stream SSSI	NM1,2,3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 22c	Yes	Tai Ho Wan Outlet (outside) / Near coral site	NM1,2,3	0.3	0.4	0.4	0.4	0.1	0.2	0.2	0.1	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 25	Yes	Airport Cooling Water Intake (NE)	NM1,2,3	14.5	18.6	21.2	16.5	3.0	15.2	8.8	8.7	10%	26%	21%	21%	2%	14%	1%	4%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 27	Yes	San Tau Beach SSSI	NM5,6,8	0.1	0.2	0.2	0.2	0.0	0.1	0.1	0.1	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 28	Yes	Airport Channel / Airport Cooling Water Intake (S)	NM1,2,3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 29	Yes	Hau Hok Wan (Horseshoe Crab Habitat)	NM5,6,8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 30	Yes	Sha Lo Wan (Horseshoe Crab Habitat)	NM5,6,8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 31	Yes	Sham Wat Wan (Mangrove and Horseshoe Crab Habitat)	NM5,6,8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 32	Yes	Tai O (Mangrove Habitat)	NM5,6,8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 34	Yes	Yi O (Mangrove and Horseshoe Crab Habitat)	NM5,6,8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 41	Yes	Artificial Reef at NE Airport	NM1,2,3	14.5	19.8	24.3	16.2	21.5	16.6	3.2	10.7	11%	17%	6%	11%	18%	10%	0%	9%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 42	Yes	Artificial Reef at Sha Chau	NM5,6,8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 45c	No	Sham Shui Kok (CWD habitat range)	NM1,2,3	1.7	2.2	2.0	2.0	0.4	0.5	0.5	0.4	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 46	No	Tai Mo To (near coral / CWD habitat range)	NM1,2,3	4.4	7.9	3.9	3.5	4.0	3.9	5.3	1.9	1%	3%	0%	0%	1%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 47a	No	River Trade Terminal	NM1,2,3	0.1	0.3	0.4	0.3	0.0	0.2	0.4	0.2	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 47b	Yes	River Trade Terminal (near coral site)	NM1,2,3	4.6	10.7	19.1	9.4	7.2	16.1	21.0	10.7	1%	10%	9%	6%	20%	42%	23%	32%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 48	No	Airport Channel western end	NM5,6,8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 49	No	Tai Mo To (Deep Channel / CWD habitat range)	NM1,2,3	3.3	7.1	6.0	4.8	1.5	2.6	4.2	2.4	0%	3%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7

Notes:

- WQO = Water Quality Objective; WQC = Water Quality Criteria; S=Surface level; M=Mid-depth; B=Bottom level; DA=Depth-averaged.
- Grey cell = Values with WQO/WQC Exceedances

1 There is a specific requirement for the Castle Peak Power Station intake and the SS should be maintained at below 150 mg/L (ERM, 2005)
2 General water quality protection guideline for FCZ (CityU, 2001)
3 The "Point SR" column indicate if the site is considered as specific stationary sensitive receiver by the nature of its use (e.g., beaches, existing intakes, SSSI or habitats for less mobile species).

Table 9.24 Predicted Maximum SS (mg/l) Elevations at Observation Points for the Scenario Year 2013 (Mitigated)

Observation Points	Point SR	Name	Associated EPD Station	Maximum SS (mg/L)								Frequency of Exceedances (% Time)								WQO/WQC							
				Dry Season				Wet Season				Dry Season				Wet Season				Dry Season				Wet Season			
				S	M	B	DA	S	M	B	DA	S	M	B	DA	S	M	B	DA	S	M	B	DA	S	M	B	DA
WSR 08	Yes	Lung Kwu Sheung Tan (non-gazetted beach)	NM5,6,8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 09a	No	Urmston Road (Main Channel)	NM5,6,8	0.1	0.1	0.1	0.1	0.0	0.2	0.1	0.1	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 10	Yes	Sha Chau and Lung Kwu Chau Marine Park	NM5,6,8	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 11	Yes	Castle Peak Power Station Cooling Water Intake (Note 1)	-	0.0	0.1	0.1	0.1	0.0	0.0	0.2	0.1	0%	0%	0%	0%	0%	0%	0%	0%	764	764	764	764	764	764	764	764
WSR 12	Yes	Butterfly Beach (gazetted beach)	NM1,2,3	0.2	0.4	0.3	0.3	0.3	0.8	1.0	0.5	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 13	Yes	WSD Seawater Intake at Tuen Mun	NM1,2,3	0.0	0.0	0.0	0.0	0.1	0.2	0.2	0.1	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 15	Yes	Gazetted Beaches at Tuen Mun	NM1,2,3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 18	Yes	Gazetted Beaches along Castle Peak Road	NM1,2,3	0.0	0.1	0.1	0.1	0.0	0.0	0.1	0.0	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 19	Yes	Gazetted Beaches at Ma Wan	WM4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	3.9	6.0	9.0	6.1	1.7	2.8	6.0	3.4
WSR 20	Yes	Ma Wan Fish Culture Zone (Note 2)	-	0.1	0.2	0.2	0.1	0.0	0.1	0.1	0.1	0%	0%	0%	0%	0%	0%	0%	0%	39.1	39.1	39.1	39.1	43.0	43.0	43.0	43.0
WSR 21	Yes	Ta Pang Po (near Sunny Bay Mangrove)	NM1,2,3	0.4	0.5	0.5	0.5	0.1	0.1	0.1	0.1	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 22a	No	Tai Ho Wan Outlet (inside)	NM1,2,3	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 22b	Yes	Tai Ho Wan (inner), Near Tai Ho Stream SSSI	NM1,2,3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 22c	Yes	Tai Ho Wan Outlet (outside) / Near coral site	NM1,2,3	0.1	0.1	0.1	0.1	0.0	0.0	0.1	0.0	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 25	Yes	Airport Cooling Water Intake (NE)	NM1,2,3	4.8	6.0	6.8	5.5	1.0	5.2	3.0	3.0	2%	2%	0%	0%	0%	1%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 27	Yes	San Tau Beach SSSI	NM5,6,8	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 28	Yes	Airport Channel / Airport Cooling Water Intake (S)	NM1,2,3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 29	Yes	Hau Hok Wan (Horseshoe Crab Habitat)	NM5,6,8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 30	Yes	Sha Lo Wan (Horseshoe Crab Habitat)	NM5,6,8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 31	Yes	Sham Wat Wan (Mangrove and Horseshoe Crab Habitat)	NM5,6,8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 32	Yes	Tai O (Mangrove Habitat)	NM5,6,8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 34	Yes	Yi O (Mangrove and Horseshoe Crab Habitat)	NM5,6,8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 41	Yes	Artificial Reef at NE Airport	NM1,2,3	4.5	6.2	7.8	5.1	7.1	5.3	1.2	3.4	2%	2%	0%	0%	11%	2%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 42	Yes	Artificial Reef at Sha Chau	NM5,6,8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 45c	No	Sham Shui Kok (CWD habitat range)	NM1,2,3	0.5	0.7	0.6	0.6	0.1	0.2	0.2	0.1	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 46	No	Tai Mo To (near coral / CWD habitat range)	NM1,2,3	1.4	2.5	1.2	1.1	1.3	1.3	1.9	0.7	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 47a	No	River Trade Terminal	NM1,2,3	0.1	0.1	0.2	0.1	0.0	0.1	0.2	0.1	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 47b	Yes	River Trade Terminal (near coral site)	NM1,2,3	2.5	5.9	10.5	5.2	4.0	8.9	11.6	5.9	0%	1%	1%	0%	6%	18%	9%	11%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 48	No	Airport Channel western end	NM5,6,8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	0%	0%	0%	0%	0%	0%	0%	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 49	No	Tai Mo To (Deep Channel / CWD habitat range)	NM1,2,3	1.1	2.3	1.9	1.5	0.5	0.8	1.3	0.8	0%	0%	0%	0%	0%	0%	0%	0%	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7

Notes:
- WQO = Water Quality Objective; WQC = Water Quality Criteria; S=Surface level; M=Mid-depth; B=Bottom level; DA=Depth-averaged.
- Grey cell = Values with WQO/WQC Exceedances

1 There is a specific requirement for the Castle Peak Power Station intake and the SS should be maintained at below 150 mg/L (ERM, 2005)
2 General water quality protection guideline for FCZ (CityU, 2001)
3 The "Point SR" column indicate if the site is considered as specific stationary sensitive receiver by the nature of its use (e.g., beaches, existing intakes, SSSI or habitats for less mobile species).

9.10.4 Suspended Solids - Year 2011 Scenario (HKBCF Sequence B + HKLR + TMCLKL)

Mitigated Sediment Plumes ((1+1) Silt Curtain System)

9.10.4.1 As elaborated in **Section 9.2**, it is environmentally more advantageous to adopt Sequence B as it could minimise the potential water quality impacts due to reduced amount of dredging and filling works. As the potential sediment loss of the unmitigated scenario of Sequence B is substantially lower than that of Sequence A (see **Figures 9B-1 and 9B-2** in **Appendix 9B)**, only the mitigated worst construction scenario of Sequence B has been modelled in order to demonstrate the Sequence B will perform better than Sequence A from the water quality perspective and the adoption of Sequence A in the full modelling represents a worse scenario for the water quality assessment in this Chapter.

9.10.4.2 As a conservative assumption for the flow simulations of Sequence B, it is assumed that only the temporary sheet pile wall near the northern side of the HKBCF reclamation is present while the completed seawalls at the eastern and western sides of the main HKBCF+TMCLKL (southern landfall) are not considered. The sheet pile wall is predicted to reduce the flows in the area immediately south to <0.1 m/s while the high east-west flow north of the sheet pile wall (Urmston Road) would not be affected by the sheet pile wall. The sheet pile wall, however, is predicted to cause some localised change in the flows at the area between Airport Island and HKBCF and also in the area further south, including the main reclamation site. At the area between the Airport Island and HKBCF, the north-south flow will increase to a peak of around 1.0 m/s, although it is generally below 0.5 m/s for the majority of the time. At area south of the main reclamation, the east-west flows become more obvious during the peak ebb/flood tides with flows generally reaching around <0.3 m/s to <0.4 m/s, although localised flows reaching 0.7 m/s are also predicted at the perimeter of the site.

9.10.4.3 As Sequence A has demonstrated that mitigation in the form of (1+1) silt curtain system is required to reduce the suspended solids dispersal, this is also assumed in Sequence B. The applicability and effectiveness of silt curtains are limited by the current speed at the site and the technical feasibility of the recommended silt curtain system has been evaluated based upon the results of the flow simulations. As the integrated sheet pile wall measure is predicted to increase localised flows to over 0.5m/s at times, which is the generally condition accepted for the fully efficient silt curtains, the effectiveness of silt curtains at the main HKBCF+TMCLKL (southern landfall) reclamation site is assumed to be reduced as presented in **Table 9.16c**. Further details, including the vector plots during peak ebb and flood tides together with an indication of the silt curtain layout, are presented in **Part 9F2** of **Appendix 9F**. Under this setting, the (1+1) silt curtain system is expected to reduce the overall potential sediment loss to the surrounding water columns by 69% in the 2011 scenario year from 1,778,000 kg/day to 560,000 kg/day (see **Table 9.16d**).

9.10.4.4 The works assumed in the modelled scenario for Sequence B are mainly the seawall dredging and filling for the main reclamation of HKBCF+TMCLKL (southern landfall) although there are also works at FSD berth and also reclamation of HKLR. The major works are at the western seawall of the main HKBCF+TMCLKL(southern landfall) reclamation where relative intensive seawall dredging and filling activities are on going. There are also 3 work fronts of seawall filling at the eastern seawall of the main HKBCF+TMCLKL (southern landfall) at low intensity.

9.10.4.5 The predicted elevation in the sediment plumes (contours) for the selected time frames (peak ebb and flood tides, high and low water level during spring and neap tides), time history plots of the elevation over the entire modelling timeframe and, also, the total and daily sediment deposition assuming the (1+1) silt curtain system is implemented are shown in **Part 9F3** in **Appendix 9F** and tabulated values presented in **Part 9F4 (Table 2)** in **Appendix 9F**.

9.10.4.6 With these specific mitigation measures, the predicted sediment plume sizes and maximum SS elevations are much reduced compared to the mitigated scenario of Sequence A. Generally, the plumes are highly localised and constrained within the works areas. Because of the higher working rate at the western seawall and higher fine content of soft public fill is used at the FSD reclamation, plumes are mainly found around these two works areas. During the slack periods (high and low waters), the suspended solids (SS) at the work fronts would only elevate to around 30 - 50 mg/L at the surface. However, for the FSD reclamation site, surface plumes reaching 100 - 200 mg/L is predicted although this is mostly contained within the site. Surface plumes leaving the site are of low concentrations (<15 mg/L) and do not travel far from the site.

9.10.4.7 During peak ebb and flood tides, the main directions of initial plumes are north (flood tide) or south (ebb tide). The north moving plumes (during flooding) often are captured by the sheet piled wall and the newly formed FSD seawall. For those that pass through the area between the Airport Island and HKBCF, they are rapidly deflected westward towards the airport intake at low concentrations (<10 mg/L) and completely dispersed at around 1km. The south moving plumes (during ebbing) are generally dispersed to around <10 mg/L at the southern boundary of the site. The remaining plumes that have not completely dispersed at the southern boundary of the site are then deflected eastward along the southern boundary. If this remaining eastward plume merged with the filling plumes at reclamation portion S-c of the TMCLKL, the eastward plume could further travel for about 1km, but the concentrations leaving the eastern boundary are generally low at around <6mg/L.

9.10.4.8 The dynamic pattern of plumes from HKLR are similar to the 2011 mitigated scenario for Sequence A and are confined to stay within only a few hundred meters from the site at low concentrations (<10 mg/L) and are not predicted to cross the Tung Chung Channel, nor would it reach the San Tau Beach SSSI.

9.10.4.9 The predicted maximum elevations in SS for selected observation points around the site and comparison with the Water Quality Objectives (WQO) or Water Quality Criteria (WQC), for selected specific sites, for the mitigated scenario are summarised in **Table 9.24a** below. As indicated in **Table 9.24a**, SS exceedances of the relevant WQOs are limited to few areas in close vicinity to the site. **Table 9.24a** also includes the results of Sequence A 2011 mitigated scenario and it is clear that the predicted SS elevations at sensitive receivers from Sequence B are generally lower than those in Sequence A.

Table 9.24a Predicted Maximum SS (mg/L) Elevations at Observation Points for Worse Case Scenario (Year 2011) (Mitigated) (Sequence B) and Comparison with Sequence A of Similar Scenario Time

Observation Points	Point SR	Name	Associated EPD Station	Maximum SS (mg/L)								Percentage of Time Exceedances Predicted								WQO / WQC							
				Dry Season				Wet Season				Dry Season				Wet Season				Dry Season				Wet Season			
				S	M	B	DA	S	M	B	DA	S	M	B	DA	S	M	B	DA	S	M	B	DA	S	M	B	DA
WSR 09a	No	Urmston Road (Main Channel)	NM5,6,8	0.1 (0.1)	0.1 (0.2)	0.1 (0.2)	0.1 (0.2)	0.0 (0.0)	0.1 (0.2)	0.1 (0.3)	0.1 (0.2)	0% (0%)	0% (0%)	0% (0%)	0% (0%)	0% (0%)	0% (0%)	0% (0%)	0% (0%)	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 20	Yes	Ma Wan Fish Culture Zone (Note 2)	-	0.1 (0.3)	0.1 (0.3)	0.2 (0.3)	0.1 (0.3)	0.0 (0.1)	0.1 (0.1)	0.1 (0.1)	0.0 (0.1)	0% (0%)	0% (0%)	0% (0%)	0% (0%)	0% (0%)	0% (0%)	0% (0%)	0% (0%)	39.1	39.1	39.1	39.1	43.0	43.0	43.0	43.0
WSR 22c	Yes	Tai Ho Wan Outlet (outside) / Near coral site	NM1,2,3	0.1 (0.1)	0.1 (0.2)	0.1 (0.2)	0.1 (0.2)	0.0 (0.0)	0.0 (0.1)	0.0 (0.1)	0.0 (0.1)	0% (0%)	0% (0%)	0% (0%)	0% (0%)	0% (0%)	0% (0%)	0% (0%)	0% (0%)	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 24	No	Tung Chung Fairway	NM1,2,3	0.3 (0.2)	0.4 (0.2)	0.5 (0.2)	0.4 (0.2)	1.5 (0.1)	1.9 (0.3)	2.1 (2.9)	1.5 (1.1)	0% (0%)	0% (0%)	0% (0%)	0% (0%)	0% (0%)	0% (0%)	0% (0%)	0% (0%)	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 25	Yes	Airport Cooling Water Intake (NE)	NM1,2,3	4.8 (5.6)	6.3 (7.2)	7.3 (8.2)	5.5 (6.7)	1.1 (2.3)	6.7 (6.4)	6.0 (8.3)	4.2 (4.7)	0% (4%)	2% (9%)	0% (1%)	0% (2%)	0% (0%)	7% (13%)	0% (2%)	1% (2%)	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 27	Yes	San Tau Beach SSSI	NM5,6,8	0.0 (0.0)	0.0 (0.0)	0.0 (0.1)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.1 (0.1)	0.0 (0.0)	0% (0%)	0% (0%)	0% (0%)	0% (0%)	0% (0%)	0% (0%)	0% (0%)	0% (0%)	5.7	7.7	11.8	8.3	3.0	3.6	10.3	5.6
WSR 41	Yes	Artificial Reef at NE Airport	NM1,2,3	6.7 (4.3)	11.0 (4.7)	10.1 (13.1)	5.7 (5.1)	4.5 (3.6)	10.5 (10.8)	3.3 (18.0)	3.8 (6.1)	4% (1%)	5% (0%)	1% (4%)	0% (0%)	2% (3%)	12% (12%)	0% (7%)	0% (4%)	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 45c	No	Sham Shui Kok (CWD habitat range)	NM1,2,3	0.5 (2.9)	0.7 (3.3)	0.6 (3.8)	0.5 (3.3)	0.1 (0.6)	0.2 (0.7)	0.1 (0.9)	0.1 (0.7)	0% (0%)	0% (0%)	0% (0%)	0% (0%)	0% (0%)	0% (0%)	0% (0%)	0% (0%)	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 46	No	Tai Mo To (near coral / CWD habitat range)	NM1,2,3	1.5 (1.0)	3.5 (2.0)	2.2 (3.9)	1.5 (1.4)	0.9 (2.4)	1.2 (1.8)	1.7 (6.6)	0.6 (2.3)	0% (0%)	0% (0%)	0% (0%)	0% (0%)	0% (0%)	0% (0%)	0% (0%)	0% (0%)	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 49	No	Tai Mo To (Deep Channel / CWD habitat range)	NM1,2,3	1.0 (0.9)	2.2 (2.0)	2.5 (2.6)	1.7 (1.4)	0.6 (0.5)	0.6 (1.3)	1.1 (6.9)	0.5 (2.3)	0% (0%)	0% (0%)	0% (0%)	0% (0%)	0% (0%)	0% (0%)	0% (1%)	0% (0%)	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7

Notes:
- WQO = Water Quality Objective; WQC = Water Quality Criteria; S=Surface level; M=Mid-depth; B=Bottom level; DA=Depth-averaged.
- Grey cell = Values with WQO/WQC Exceedances

1 The values in brackets are prediction of the Sequence A2011 mitigated scenario (see **Table 9.20** for full)
2 General water quality protection guideline for FCZ (CityU, 2001)
3 The "Point SR" column indicate if the site is considered as specific stationary sensitive receiver by the nature of its use (e.g., beaches, existing intakes, SSSI or habitats for less mobile species).

9.10.4.10 No WQO exceedances are predicted for key ecology sensitive areas around the project area, such as Sha Chau and Lung Kwu Chau Marine Park (WSR 10), Tai Ho Wan (WSR 22a-c) or Airport Channel (including WSR 27, 28, 29, 30 and 48). The predicted maximum plumes at known coral sites near Tai Mo To (WSR 46), Tai Ho Wan seawall (WSR 22c) and west of the Airport Channel (WSR 48) were all below the WQO. The predicted maximum plumes at south of Tai Mo To (WSR 49) or Sham Shui Kok (WSR 45c) around the recently identified dolphin habitat would also be controlled below the WQO and no impacts are anticipated with the mitigation. No observable plumes at Ma Wan FCZ (WSR 20) are expected as the predicted elevation is <0.5 mg/L and does not exceed the WQC or WQOs.

9.10.4.11 The predicted surface maximum SS elevations at the Artificial Reef (AR) at NE Airport (WSR 41), which is very close to (about 300m from the HKBCF and about 1km from the TMCLKL) and downstream (during the flood tide) of the project site, however, are still predicted to exceed the calculated WQO of 3.7 mg/L (wet season) and 5.5 mg/L (dry season) for less than 1% of the time. Compared to the mitigated Sequence A 2011 scenario in which exceedances are predicted for 4% of the wet season but none during the dry season, the Sequence B overall have reduced the potential impacts to the AR. Nonetheless, as the AR site has been proposed to be re-provided and, therefore, the marginal exceedances would not be a major concern. For the NE Airport Intake (WSR 25), marginal exceedances are also predicted under the mitigated Sequence B for about 1% of the wet season time (max. SS elevation is 4.2 mg/L compared to 3.7 mg/L of the calculated WQO) but none during the dry season. This again is an improvement over the Sequence A in which exceedances are predicted for about 2% o the wet and dry season time (max. SS elevation is about 4.7 – 6.7 mg/L). While only very low frequencies of low level exceedances are predicted, an additional silt screen at around this water intake to ensure full compliance with SS WQO is recommended.

9.10.4.12 The total elevated sediment deposition over the simulation period and daily averaged sediment deposition rates are also presented in **Part 9F3 (Figures 37-40)** of **Appendix 9F**. Tabulations of running averages of the accumulated sediment over every 24 hours period are also presented in **Part 9F4 (Tables 6 and 7)** of **Appendix 9F**. With the mitigation measures, the deposition of suspended sediment is mainly confined to the project site. Outside the site boundary, deposition is mainly predicted at the area between the Airport Island and HKBCF and area immediate south of the main reclamation. The averaged deposition rate higher than 100 g/m^2/day is not predicted outside the site except in the gap between the Airport Island and the HKBCF. The predicted maximum daily sedimentation rates at major ecological sensitive receivers are summarised in **Table 6.24b** together with a comparison of the predicted rate for Sequence A under similar time frame. At all sensitive receivers, it is clear that the sedimentation is controlled within the project site and the predicted rate outside the project site are much lower compared to Sequence A. The maximum rates ranged between 0.0 g/m^2/day to 7.6 g/m^2/ day which are well below the tolerable rate for corals although corals were only identified in some of these sites. Under Sequence A, the maximum rate of 69.3 g/m^2/day has been predicted at the artificial reef (AR) at the NE of airport and the maximum rate is much reduced to 28.8 g/m^2/day under Sequence B.

Table 6.24b Comparison of Predicted Maximum Daily Elevated Sedimentation Rate at Representative Marine Ecology and Fisheries Sensitive Receivers (Sequence B)

WSR	Nature	Sequence A	Sequence A	Sequence B
		2011 Unmitigated	2011 Mitigated	2011 Mitigated
WSR 10	Sha Chau and Lung Kwu Chau Marine Park	2.6	0.7	0.2
WSR 20	Ma Wan Fish Culture Zone	4.8	1.8	1.0
WSR 22b	Tai Ho Wan (inner), Near Tai Ho Stream SSSI	0.0	0.0	0.0
WSR 22c	Tai Ho Wan Outlet (outside) / Near coral site	5.3	1.9	0.9
WSR 27	San Tau Beach SSSI	8.8	0.4	0.3
WSR 28	Airport Channel	0.3	0.0	0.0
WSR 41	Artificial Reef at NE Airport (Note 1)	267.4	69.3	28.8
WSR 46	Tai Mo To (near coral / CWD habitat range)	49.4	19.0	7.6
WSR 47b	River Trade Terminal (near coral site) (Note 2)	2.9	1.0	0.4
WSR 48	Airport Channel western end	0.0	0.0	0.0

Notes: Unit = $g/m^2/day$;
1. The AR at NE Airport is proposed to be re-provided.
2. Coral colonies near River Trade Terminal are proposed to be trans-located before project works.
3. Mitigated refer to the (1+1) silt curtain system.

9.10.4.13 In summary, Sequence B with the (1+1) silt curtain system proposed is considered to reduce impacts from suspended solids to within acceptable levels and while some marginal and transient exceedances remain in very close proximity to the works site, these were not predicted to affect major ecological sensitive receivers, including marine park, coral sites and key dolphin habitat at Tai Mo To, as well as the Ma Wan FCZ, and so significant residual impacts are not expected.

9.10.4.14 As Sequence B has a much reduced potential sediment loss by design and construction programme, double layers of peripheral silt curtains and cage type silt curtains around the grab dredgers (referred as the (2+1) silt curtain system) considered under Sequence A is considered not necessary and not evaluated.

9.10.4.15 In view of the above, the results of additional modelling for Sequence B has demonstrated that Sequence B will perform better than Sequence A from the water quality perspective and the adoption of Sequence A in the full modelling represents a worse scenario for the water quality assessment in this Chapter.

9.10.5 Reuse of dredged Mf material in reclamation

<u>Reuse of dredged Mf sediment within HKBCF</u>

9.10.5.1 **Figure 9.14** shows the approximate area where the dredging of Mf materials will be encountered in HKBCF (i.e. seawall at the northern edge of HKBCF site).

9.10.5.2 Based on the SI results available to-date, the Mf materials in HKBCF are of about $0.35Mm^3$ in volume (bulk) at a depth of about -14mPD to -15mPD.

9.10.5.3 To accommodate the Mf materials, consideration is given to the two vehicle queuing areas as shown in **Figure 9.14**. The settlement issues due to consolidation of the redeposited of Mf sediments are considered to be lesser at the above two areas, as only pavement with no structure is to be constructed at these areas. (Nevertheless, the reclamation will still be treated with band-drains and surcharge). According to the layout of HKBCF, the land use of the area above Mf sediment in HKBCF will be used for vehicle queuing areas. As only pavement with no deep foundation of structure will be involved at the above areas, there is no need to dig-up the Mf material again.

9.10.5.4 As the seawall is to be constructed first, it is anticipated that the Mf materials would be encountered during Month 6 to Month 8 approximately (counting from contract start).

9.10.5.5 Before re-deposition the Mf materials, temporary steel sheet pile wall should be formed in advance around the above two areas to receive the Mf materials. As the further measures, silt curtain would also be installed outside the sheet pile wall as shown in **Figure 9.15**.

9.10.5.6 The area within temporary steel sheet pile wall should be dredged to form a pit to contain the Mf sediment being redeposited. The size of these two pits is 5.1 ha and 3.3 ha with the depth of about 6m. Considering the redepositing of Mf materials from HKBCF into the above two pits up to the existing seabed level, the capacity of the pits is about 0.5 Mm^3 which is more than 0.35 Mm^3 of Mf sediment to be redeposited. Should the actual Mf quantity exceed the pit size, the Mf sediment will be handled in accordance with the procedure already established under ETWB TC(W) No. 34/2002.

9.10.5.7 SI result available to-date does not indicate any presence of Mf material in the aforesaid areas to receive the Mf sediment. Hence dredging for forming a pit (as described above) will not itself create another batch of Mf materials. Based on Sequence B of HKBCF reclamation, the envisaged programme of the above activities for forming the pits to receive the Mf sediment is given below.

Period (Counting from contract start)	Activities
Month 2 to 3 (Sept 2010 to Oct 2010)	Installation of temporary sheet piles and silt curtain around pits to receive Mf sediment
Month 4 to 5 (Nov 2010 to Dec 2010)	Dredging to form the pits (total dredging volume = 0.5Mm^3)
Month 6 to 8 (Jan 2011 to Mar 2011)	Deposition of dredged Mf sediment to the pits (total volume = 0.35Mm^3 and it could be up to 0.5Mm^3 if more Mf sediment is found on site)

The dredged Mf sediment from other locations of HKBCF reclamation site will be delivered and deposited at the pits enclosed by the sheet pile wall and silt curtain. This dumping activity will be monitored by the system of Real Time Tracking & Monitoring of Vessel (RTTMV) similar to those activities controlled under the Dumping At Sea ordinance (DASO). All the dumping vessels responsible for the handling of the Mf sediment will be required to install the Front End Mobile Unit (FEMU) system on board in order to receive, record and transmit the recorded date to the EPD Control Centre. The details procedure should follow the guidance notes to be issued by EPD.

9.10.5.8 Before the re-deposition of Mf sediment, a layer of geotextile should be placed at the bottom of the pits to avoid the direct contract of the Mf sediment and the bottom sediment. After redeposition of Mf materials, the aforesaid area will be reclaimed by the reclamation fill. After 2m thick sandfill has been placed to protect and cover the Mf sediment after redeposition, the access opening of the confined area will be closed by sheet pile. Then the sheet pile would be cut and removed for the reclamation to proceed. The activities of filling within the pits, closing of assess opening, cutting and removal of sheet piles will be carried out in pace with the reclamation of HKBCF.

Reuse of dredged Mf sediment within HKLR

9.10.5.9 **Figure 9.16** shows the approximate area where the dredging of Mf materials will be encountered in HKLR.

9.10.5.10 Based on the SI results available to-date, the Mf materials from HKLR piling works is about 0.07 Mm^3 (bulk volume) and HKLR reclamation is about 0.26 Mm^3 (bulk volume) at a depth of about -10mPD to -13mPD. The total estimated quantity of Mf from HKLR is about 0.33 Mm^3 (bulk volume).

9.10.5.11 To accommodate the Mf materials, consideration is given to the reclamation area between the Airport east coast and the portion of HKLR south of the Dragonair HQ Building, as shown in the attached **Figure 9.16**. The area is approx. 40,000 m^2 in size on plan, with marine deposit down to approx. -10 to -15 mPD (based level of marine deposit).

9.10.5.12 Considering the depth of the pit is about 12.5m below the seabed level of -2mPD, the space available is approx. 0.5 Mm^3 which is more than the 0.33 Mm^3 of Mf sediment to be redeposited. Should the actual Mf quantity exceed the pit size, the mf sediment will be handled in accordance with the procedure already established under ETWB TC(W) No. 34/2002.

9.10.5.13 According to the proposed amendment to the OZP Plan (approved by the Town Planning Board on 5 June 2009 and the amended OZP is to be gazetted in June 2009) , the land use of the area above Mf sediment in HKLR will be used for the Highways Maintenance Area and the height restriction of the development at this area is restricted to 2 storeys. Therefore, no deep foundation is involved at this area and there is no need to dig-up the Mf material again.

9.10.5.14 Disposal methodology and protection measures for Mf sediment in HKLR is similar to those in HKBCF as shown in **Figure 9.17**. The envisaged programme of the above activities for forming the pits in HKLR to receive the Mf sediment is given below.

Period (Counting from contract start)	Activities
Month 2 to 3 (Feb 2011 to Mar 2011)	Installation of temporary sheet piles and silt curtain around pits to receive Mf sediment
Month 4 to 5 (Apr 2011 to May 2011)	Dredging to form the pits (total dredging volume = $0.5Mm^3$)
Month 6 to 7 & 20 to 21 (Jun 2011 to July 2011 & Aug 2012 to Sept 2012)	Deposition of dredged Mf sediment to the pits (total volume = $0.33Mm^3$ and it could be up to $0.5Mm^3$ if more Mf sediment is found on site)

The dumping activity will be monitored by RTTMV as mentioned in **Section 9.10.5.7** above. The activities of filling within the pits, closing of assess opening, cutting and removal of sheet piles will be carried out in pace with the reclamation of HKLR.

Prediction on effect on water sensitive receivers (WSRs)

9.10.5.15 As the reclamation operation re-using the Mf materials will be in a pre-formed pit enclosed by sheet piling, with further enclosure by silt-curtain, any leakage of Mf material to the waters outside this double-enclosures arrangement ought to be minimal.

9.10.5.16 Moreover, the result of elutriate test on the Mf material is as follows:

		Chemical (μg/L)								
		Cd	Cr	Cu	Hg	Ni	Pb	Ag	Zn	As
Result (i)	HKBCF	0.37	< 1	< 1	< 0.1	6.5	< 1	< 1	8.5	< 2
	HKLR	<0.2	< 1	< 1	< 0.1	< 1	< 1	< 1	< 4	4.9
Criterion (ii)		2.5	15	5	0.3	30	25	1.9	40	25

Note (i) This row is the result of elutriate test on samples of the Mf material taken during the site investigation works in 2004 for HKLR and 2009 for HKBCF. For HKBCF, reference is made to the result of sample obtained from Vibroocre BCF/VC-A01 at depth 9.9m to 10.8m where Mf is found. For HKLR, reference is made to the sample obtained from grab sample D3 and this is the only elutriate test result available near the areas of Mf. The locations of these samples are shown on Figures 9.14 and 9.16.

(ii) This row shows the limits stipulated by European Union Environmental Quality Standard Values (EUEQSV) to Protect Marine Life on each chemical except Silver (Ag) in which the limit is not available in EUEQSV. The limit of Silver (Ag) stipulated by the U.S. Environmental Protection Agency (USEPA) is adopted in this case.

9.10.5.17 From the above, it can be seen that even at the reclamation filling location itself, the criterion on the various categories of chemicals are already met. Obviously, the concentration at the WSRs will be even smaller, after dispersion.

9.10.5.18 As regards suspended solids, a quantitative prediction is shown below on the effect in the event that a 2.75% leakage rate occurs. (Note: This is very conservative, as the chance of leakage through the aforesaid double-enclosures will be minimal.)

9.10.5.19 Main points of the quantitative prediction:

(a) Formula: $C(x) = q/DX\omega\sqrt{\pi}$

Where : C(x) = concentration at distance x from the source
q = sediment loss rate
D = water depth
X = distance from source
ω= diffusion velocity. The value for diffusion velocity is taken to be 0.01 m/s, which is the same as that which was used in the previous study for the near field assessment of sediment plumes from the installation of Hong Kong Electric's 132kV cable in Deep Water Bay and from the reclamations associated with the developments at Penny's Bay.

(b) Filling rate: From SI results so far, the volume of Mf for HKBCF and HKLR will be 0.35 Mm^3 and 0.33 Mm^3 respectively. For prudence sake, it is assumed that the both volume may become 0.5 Mm^3 (in case further SI reveals more Mf). The 0.5 Mm^3 Mf under HKBCF is anticipated to be deposited during January to March in 2011, whereas the 0.5 Mm^3 Mf under HKLR is anticipated to be deposited during April to mid June in 2012. The filling rate is therefore approximately 0.17 Mm^3/month i.e. 5,600 m^3/day or 0.097 m^3/s (assuming 16 working hours per day) in HKBCF and approximately 0.14 Mm^3/month i.e. 4,800 m^3/day or 0.083 m^3/s (assuming 16 working hours per day) in HKLR.

(c) The loss rate to suspension due to bottom dumping from the barge is 3%. As mentioned in **9.10.5.18** above, a very conservative assumption is made to the leakage rate by assuming that the loss rate due to the sheet pile wall enclosing the Mf pits is 5% and the loss after sediment reduction by further enclosure of silt curtain is 55%. Therefore, the leakage rate is 2.75% (i.e. 5% x 55% = 2.75%).

9.10.5.20 In HKBCF, the nearest WSR to the pits receiving Mf is WSR 46 (i.e. Tai Mo To deep water channel). The distance between WSR 46 and the pits receiving Mf in HKBCF is about 900m and the average water depth is about 5m. Applying the dispersal formula above, the calculated concentration of depth average SS at the sensitive receiver WSR 46 is 0.76 mg/L (see the calculation in Note (i) of the table in Section 9.10.5.22 below).

9.10.5.21 In HKLR, the nearest WSR to the pit receiving Mf is WSR 27 (i.e. San Tau SSSI). The distance between WSR 27 and the pit to receiving Mf in HKLR is about 1,800m and the average water depth is about 2m. Applying the dispersal formula above, the calculated concentration of depth average SS at the sensitive receiver WSR 27 is 0.81 mg/L (see the calculation in Note (i) of the table in Section 9.10.5.22 below).

9.10.5.22 The redeposition of Mf materials in HKBCF and HKLR is anticipated to be carried out in different period. However, these activities would be carried out concurrently with the reclamation works of HKBCF, HKLR and TMCLKL. As shown in the following tables, the cumulative effect has been considered and no exceedance of WQO is found.

HKBCF:

	SS due to redeposition of Mf (Note 1), A	**SS due to other reclamation works (Note 2), B**	**Overall SS, C = A+B**	**WQO**
WSR 46 (dry season)	0.76 mg/L	1.4 mg/L	2.2 mg/L	5.5 mg/L
WSR 46 (wet season)	0.76 mg/L	2.3 mg/L	3.1 mg/L	3.7 mg/L

Note (i) The sediment loss rate, q = fill rate x density of sediment x loss rate to suspension due to bottom dumping x leakage rate = 0.097 m^3/s x 750 kg/m^3 x 3% x 2.75% = 0.06 Kg/s
Water depth, D = 5m
Distance from source, X = 900m
Diffusion velocity, ω = 0.01 m/s
Applying the dispersal formula in 9.10.4.19 above, SS due to redposition of Mf = q/ ($DX\omega\sqrt{\pi}$) = 0.06 / (5 x 900 x 0.01 x $\sqrt{\pi}$) = 0.00076 Kg/m^3 or 0.76 mg/L.

(ii) The deposition of Mf sediment in HKBCF is anticipated to be carried out in Year 2011. The figures are obtained from the modeling result of Scenario Year 2011 (Mitigated) in Table 9.20.

HKLR:

	SS due to redeposition of Mf (Note 1), A	**SS due to other reclamation works (Note 2), B**	**Overall SS, C = A+B**	**WQO**
WSR 27 (dry season)	0.81 mg/L	0	0.81 mg/L	8.3 mg/L
WSR 27 (wet season)	0.81 mg/L	0	0.81 mg/L	5.6 mg/L

Note (i) The sediment loss rate, q = fill rate x density of sediment x loss rate to suspension due to bottom dumping x leakage rate = 0.083 m^3/s x 750 kg/m^3 x 3% x 2.75% = 0.052 Kg/s
Water depth, D = 2m
Distance from source, X = 1,800m
Diffusion velocity, ω = 0.01 m/s
Applying the dispersal formula in 9.10.4.19 above, SS due to redposition of Mf = q/ ($DX\omega\sqrt{\pi}$) = 0.052 / (2 x 1800 x 0.01 x $\sqrt{\pi}$) = 0.00081 Kg/m^3 or 0.81 mg/L.

(ii) The deposition of Mf sediment in HKLR is anticipated to be carried out in Year 2011 and 2012. The figures are obtained from the modeling result of Scenario Year 2011 (Mitigated) and Year 2012 (Mitigated) in Table 9.20 and 9.22 respectively.

9.10.5.23 From the above Table, it should be noted that this proposed arrangement (with a pre-formed pit and with double-enclosures) for implementing a re-use of the Mf material in the reclamation should be acceptable from water quality protection point of view.

9.10.5.24 It should also be noted that the foregoing prediction on the effect regarding suspended solids is conservative, because:

(a) The leakage rate of 2.75% is very conservative, as the double-enclosures (sheetpiling plus silt-curtain) ought to be able to prevent any significant leakage to outside;

(b) The dispersal formula is conservative.

To verify the environmental acceptability of this new arrangement for handling Mf sediment, monitoring of metal and ecological parameters are recommended during the backfilling period of Mf sediment and the details of the programme will be included in the EM&A Manual.

9.10.6 Sediment Contaminants

9.10.6.1 During the site investigation, viborcore and grab samples were collected for HKBCF and HKLR as given in Section 7. Sub-samples were collected at different depths and were analysed by the elutriation tests. **Table 9.25a** shows the comparsion between the elutriate test results for heavy metals. The assessment criteria are listed in the last row of the table for reference. No exceedance of the assessment criteria for all heavy metals and PAH was found. However, exceedances are observed for Metalloid (i.e As).

Table 9.25a Elutriate Test Results (Metals, Metalloid and PAHs)

Sample location	Sampling Depth below seabed (m)	Metals (ug/L)								Metalloid (ug/L)	Organic-PAHs (µg/L)	
		Cd	Cr	Cu	Hg	Ni	Pb	Ag	Zn	As	LMW PAH	HMW PAH
A01	0.05 - 0.9	<0.2	<1	1	<0.1	2.1	<1	<1	<4	3.7	<0.20	<0.20
A01	0.9 – 1.9	<0.2	<1	<1	<0.1	<1	<1	<1	<4	4.4	<0.20	<0.20
A01	2.9 – 3.9	<0.2	<1	1.7	<0.1	2.5	<1	<1	<4	9.9	<0.20	<0.20
A01	7.9-8.9	<0.2	<1	<1	<0.1	1.1	<1	<1	<4	2.3	<0.20	<0.20
A01	9.9–10.8	0.37	<1	<1	<0.1	6.5	<1	<1	8.5	<2	<0.20	<0.20
A02	0.2-0.9	<0.2	<1	<1	<0.1	1.1	<1	<1	<4	23	<0.20	<0.20
A02	2.9-3.9	<0.2	<1	<1	<0.1	2.2	<1	<1	<4	**57**	<0.20	<0.20
A02	7.9-8.9	<0.2	<1	<1	<0.1	2.0	<1	<1	<4	13	<0.20	<0.20
A02	14.9-15.9	<0.2	<1	1.2	<0.1	1.7	<1	<1	5	7.5	<0.20	<0.20
A02	16.9-17.9	<0.2	<1	1.3	<0.1	1.9	<1	<1	5	4.3	<0.20	<0.20
A03	0.2-0.9	<0.2	<1	<1	<0.1	2	<1	<1	<4	2.9	<0.20	<0.20
A03	2.9-3.9	<0.2	<1	<1	<0.1	1.5	<1	<1	<4	**28**	<0.20	<0.20
A03	7.9-8.9	<0.2	<1	<1	<0.1	1.7	<1	<0.1	4.3	6.5	<0.20	<0.20
A03	14.9-15.9	<0.2	<1	<1	<0.1	3	<1	<1	<4	3.1	<0.20	<0.20
A03	15.9-16.35	0.2	<1	1.3	<0.1	9.1	<1	<1	9.6	2.3	<0.20	<0.20
A04	0.0-0.9	<0.2	<1	<1	<0.1	1.2	<1	<1	<4	11	<0.20	<0.20
A04	2.9-3.9	<0.2	<1	1.1	<0.1	<1	<1	<1	6.8	4.3	<0.20	<0.20
A04	7.9-8.9	<0.2	<1	1.1	<0.1	3.1	<1	<1	<4	9.9	<0.20	<0.20
A04	14.9-15.9	<0.2	<1	2.9	<0.1	3.3	<1	<1	<4	5.7	<0.20	<0.20
A04	18.05-18.9	<0.2	<1	1.5	<0.1	2.8	<1	<1	4.6	8.9	<0.20	<0.20
B05	0.25-0.9	<0.2	<1	<1	<0.1	1.5	1.4	<1	<4	2.3	<0.20	<0.20
B05	2.9-3.9	<0.2	<1	1.2	<0.1	2.1	<1	<1	4.3	2.9	<0.20	<0.20

Sample location	Sampling Depth below seabed (m)	Metals (ug/L)								Metalloid (ug/L)	Organic-PAHs (µg/L)	
		Cd	Cr	Cu	Hg	Ni	Pb	Ag	Zn	As	LMW PAH	HMW PAH
B05	7.9-8.9	<0.2	<1	1.3	<0.1	1.4	<1	<1	5.1	6.5	<0.20	<0.20
B05	14.9-15.9	<0.2	<1	1.5	<0.1	1.5	2.9	<1	<4	4	<0.20	<0.20
B05	15.9-16.1	<0.2	<1	<1	<0.1	1.5	2.1	<1	<4	<2	<0.20	<0.20
B06	0.35-0.9	<0.2	<1	1.2	<0.1	4.1	<1	<1	<4	17	<0.20	<0.20
B06	2.9-3.9	<0.2	1.1	1.3	<0.1	2.4	1.5	<1	9	18	<0.20	<0.20
B06	7.9-8.9	<0.2	<1	<1	<0.1	1.7	<1	<1	<4	3.4	<0.20	<0.20
B06	9.9-10.9	<0.2	<1	1.2	<0.1	2.3	<1	<1	14	3.8	<0.20	<0.20
B06	10.9-11.35	<0.2	<1	2.2	<0.1	11	1	<1	7.6	<2	<0.20	<0.20
B07	0.0-0.9	<0.2	<1	1.1	<0.1	1.5	<1	<1	7.4	4.7	<0.20	<0.20
B07	0.9-1.9	0.34	<1	1.6	<0.1	2.3	<1	<1	<4	22	<0.20	<0.20
B07	2.9-3.9	0.26	<1	1.1	<0.1	2.8	1	<1	<4	9.3	<0.20	<0.20
B07	7.9-8.9	<0.2	<1	1.5	<0.1	2.5	<1	<1	8.9	9.9	<0.20	<0.20
B07	14.9-15.9	0.38	<1	1.3	<0.1	2.9	<1	<1	<4	3.2	<0.20	<0.20
B08	0.0-0.9	<0.2	<1	<1	<0.1	3.1	<1	<1	<4	24	<0.20	<0.20
B08	2.9-3.9	<0.2	<1	<1	<0.1	1.1	<1	<1	<4	5.4	<0.20	<0.20
B08	7.9-8.9	<0.2	<1	<1	<0.1	<1	<1	<1	<4	6.8	<0.20	<0.20
B08	14.9-15.9	<0.2	<1	1.8	<0.1	3.9	1.9	<1	6.7	11	<0.20	<0.20
B08	18.0-18.9	<0.2	<1	<1	<0.1	1.8	<1	<1	<4	5.9	<0.20	<0.20
B09	0.1-0.9	<0.2	<1	<1	<0.1	2.2	<1	<1	5.4	3.4	<0.20	<0.20
B09	2.9-3.9	<0.2	<1	<1	<0.1	1.1	<1	<1	<4	4.8	<0.20	<0.20
B09	7.9-8.9	<0.2	<1	1.1	<0.1	2.7	<1	<1	5.3	13	<0.20	<0.20
B09	14.9-15.9	0.24	1	<1	<0.1	3.5	1.9	<1	6	3	<0.20	<0.20
B09	18.0-18.9	<0.2	<1	<1	<0.1	2.4	<1	<1	5.7	6.4	<0.20	<0.20
B10	0.05-0.9	<0.2	<1	1.6	<0.1	1.4	<1	<1	6.6	3.6	<0.20	<0.20
B10	0.9-1.9	<0.2	<1	1	<0.1	2.1	<1	<1	8.1	19	<0.20	<0.20
B10	2.9-3.9	<0.2	<1	1.3	<0.1	2.5	1	<1	4.6	14	<0.20	<0.20
B10	7.9-8.9	<0.2	<1	1.4	<0.1	2.7	<1	<1	5.4	10	<0.20	<0.20
B10	13.9-14.7	0.22	<1	1.8	<0.1	4	<1	<1	5.5	6.8	<0.20	<0.20
Ref.Sed.	/	<0.2	<1	<1	<0.1	<1	<1	<1	<4	9.4	<0.20	<0.20
Criteria	EU EQS	2.5	15	5	0.3	30	25	1.9[1]	40	25	0.2	0.2

Note [1]: USEPA, Criteria Maximum Concentration (CMC) of the USEPA Water Quality Criteria (Saltwater)

9.10.6.2 The elutriate test results for total PCBs and TBT presented in **Tables 9.25b**. The results show that the concentrations of these micro-pollutants in water were all below the corresponding detection limits and assessment criteria. It is therefore aniticipated that the potential impact associated with the release of PAHs, PCBs and TBT from sediments during dredging and filling is insignificant.

Table 9.25b Elutriate Test Results for Grab Samples (PCBs, TBT, Chlorinated Pesticides and Nutrients)

Sample Location	Sampling Depth below seabed (m)	Organic-non-PAHs (µg/L)	Organo-metallics (µg/L)	Chlorinated Pesticides (µg/L)	TKN (mg/L)	NH_3-N (mg/L)	NO_3-N (mg/L)	NO_2-N (mg/L)	Total P (mg/L)	Ortho-P (mg/L)
		Total PCBs	TBT							
A01	0.05 - 0.9	<0.01	<0.015	<0.10	1.9	1.6	0.15	0.21	0.12	<0.10
A01	0.9 – 1.9	<0.01	<0.015	<0.10	4.0	4.0	0.19	0.11	0.12	<0.10
A01	2.9 – 3.9	<0.01	<0.015	<0.10	4.0	3.2	0.15	0.13	0.17	<0.10

Sample Location	Sampling Depth below seabed (m)	Organic-non-PAHs (µg/L)	Organo-metallics (µg/L)	Chlorinated Pesticides (µg/L)	TKN (mg/L)	NH_3-N (mg/L)	NO_3-N (mg/L)	NO_2-N (mg/L)	Total P (mg/L)	Ortho-P (mg/L)
		Total PCBs	TBT							
A01	7.9-8.9	<0.01	<0.015	<0.10	1.6	1.3	0.25	0.14	<0.10	<0.10
A01	9.9–10.8	<0.01	<0.015	<0.10	1.6	1.2	0.25	0.14	<0.10	<0.10
A02	0.2-0.9	<0.01	<0.015	<0.10	<1.0	0.32	0.39	0.30	0.21	<0.10
A02	2.9-3.9	<0.01	<0.015	<0.10	2.7	2.0	0.31	0.37	0.26	0.16
A02	7.9-8.9	<0.01	<0.015	<0.10	4.3	3.8	0.59	0.29	0.15	<0.10
A02	14.9-15.9	<0.01	<0.015	<0.10	9.6	9.2	0.41	0.25	<0.10	<0.10
A02	16.9-17.9	<0.01	<0.015	<0.10	7.0	6.1	0.55	0.28	<0.10	<0.10
A03	0.2-0.9	<0.01	<0.015	<0.10	1.1	0.43	0.25	0.18	<0.10	<0.10
A03	2.9-3.9	<0.01	<0.015	<0.10	3.9	3.0	0.23	0.14	0.18	<0.10
A03	7.9-8.9	<0.01	<0.015	<0.10	6.0	5.1	0.34	0.17	0.13	<0.10
A03	14.9-15.9	<0.01	<0.015	<0.10	6.9	6.0	0.33	0.18	<0.10	<0.10
A03	15.9-16.35	<0.01	<0.015	<0.10	5.1	5.0	0.40	0.17	<0.10	<0.10
A04	0.0-0.9	<0.01	<0.015	<0.10	<1.0	<0.025	0.33	0.11	0.10	<0.10
A04	2.9-3.9	<0.01	<0.015	<0.10	1.8	1.0	0.35	0.099	<0.10	<0.10
A04	7.9-8.9	<0.01	<0.015	<0.10	5.4	4.7	0.33	0.099	0.23	0.13
A04	14.9-15.9	<0.01	<0.015	<0.10	12	12	0.35	0.094	0.11	<0.10
A04	18.05-18.9	<0.01	<0.015	<0.10	12	11	0.32	0.094	0.15	<0.10
B05	0.25-0.9	<0.01	<0.015	<0.10	3.2	2.7	0.24	0.14	<0.10	<0.10
B05	2.9-3.9	<0.01	<0.015	<0.10	5.0	4.8	0.30	0.17	0.15	0.10
B05	7.9-8.9	<0.01	<0.015	<0.10	2.9	2.4	0.34	0.16	<0.10	<0.10
B05	14.9-15.9	<0.01	<0.015	<0.10	2.2	1.3	0.19	0.50	0.11	<0.10
B05	15.9-16.1	<0.01	<0.015	<0.10	2.2	2.0	0.28	0.22	<0.10	<0.10
B06	0.35-0.9	<0.01	<0.015	<0.10	1.9	1.1	0.53	0.092	<0.10	<0.10
B06	2.9-3.9	<0.01	<0.015	<0.10	4.6	4.2	0.50	0.09	0.31	0.20
B06	7.9-8.9	<0.01	<0.015	<0.10	4.9	4.4	0.69	0.087	<0.10	<0.10
B06	9.9-10.9	<0.01	<0.015	<0.10	6.1	5.4	0.64	0.081	<0.10	<0.10
B06	10.9-11.35	<0.01	<0.015	<0.10	1.9	1.7	0.82	0.063	<0.10	<0.10
B07	0.0-0.9	<0.01	<0.015	<0.10	<1.0	<0.025	0.29	0.045	0.13	<0.10
B07	0.9-1.9	<0.01	<0.015	<0.10	1.0	0.39	0.28	0.091	<0.10	<0.10
B07	2.9-3.9	<0.01	<0.015	<0.10	1.6	1.3	0.28	0.046	<0.10	<0.10
B07	7.9-8.9	<0.01	<0.015	<0.10	4.0	3.8	0.28	0.058	0.14	<0.10
B07	14.9-15.9	<0.01	<0.015	<0.10	6.4	6.2	0.27	0.044	<0.10	<0.10
B08	0.0-0.9	<0.01	<0.015	<0.10	<1.0	0.20	0.35	0.14	<0.10	<0.10
B08	2.9-3.9	<0.01	<0.015	<0.10	1.9	1.7	0.33	0.13	0.10	<0.10
B08	7.9-8.9	<0.01	<0.015	<0.10	4.9	4.8	0.34	0.12	0.26	0.12
B08	14.9-15.9	<0.01	<0.015	<0.10	12	12	0.31	0.14	0.21	<0.10
B08	18.0-18.9	<0.01	<0.015	<0.10	11	10	0.35	0.13	0.11	<0.10
B09	0.1-0.9	<0.01	<0.015	<0.10	<1.0	0.060	0.50	0.33	0.14	<0.10
B09	2.9-3.9	<0.01	<0.015	<0.10	<1.0	0.16	0.58	0.42	0.12	<0.10

Sample Location	Sampling Depth below seabed (m)	Organic-non-PAHs (µg/L)	Organo-metallics (µg/L)	Chlorinated Pesticides (µg/L)	TKN (mg/L)	NH_3-N (mg/L)	NO_3-N (mg/L)	NO_2-N (mg/L)	Total P (mg/L)	Ortho-P (mg/L)
		Total PCBs	TBT							
B09	7.9-8.9	<0.01	<0.015	<0.10	7.9	7.0	0.57	0.27	0.44	0.29
B09	14.9-15.9	<0.01	<0.015	<0.10	14	13	0.40	0.32	<0.10	<0.10
B09	18.0-18.9	<0.01	<0.015	<0.10	14	13	0.41	0.33	0.10	<0.10
B10	0.05-0.9	<0.01	N/A*	<0.10	<1.0	0.059	0.29	0.048	<0.10	<0.10
B10	0.9-1.9	<0.01	<0.015	<0.10	<1.0	0.33	0.26	0.084	<0.10	<0.10
B10	2.9-3.9	<0.01	<0.015	<0.10	1.4	0.85	0.27	0.084	<0.10	<0.10
B10	7.9-8.9	<0.01	<0.015	<0.10	3.9	3.8	0.26	0.064	0.11	<0.10
B10	13.9-14.7	<0.01	<0.015	<0.10	5.5	5.3	0.28	0.062	<0.10	<0.10
Ref. Sed.	/	<0.01	<0.015	<0.10	1.1	0.87	<0.025	<0.025	<0.10	<0.10

9.10.6.3 **Table 9.25b** presents the elutriate test results for ammonia nitrogen, total phosphorus and total reactive phosphorus. The detected concentrations of ammonia nitrogen ranged from 0.025 to 13 mg/L, total phosphorus from < 0.1 to 0.29 mg/L and total reactive phosphorus from <0.1 to 0.44 mg/L respectively. Based on the EPD's marine water monitoring data, the average background concentrations of ammonia nitrogen, total phosphorus and and ortho-phosphate in the North Western waters were 0.01 mg/L, 0.05 mg/L, and 0.02 mg/L respectively.

9.10.6.4 As the WSR 41 (Artificial Reef at NE Airport) will be re-provisioned (**Section 9.12**), the closest sensitive receiver will be WSR 46 (Tai Mo To (near coral / CWD habitat range)), which is located at around 560m. To estimate the dilution factor, the formula in **Section 9.10.5.19** was adopted. On assuming that the radius of initial release is 10m, the predicted dilution factors is 56. The following table summarizes the concentrations of ammonia nitrogen, total phosphorus and total reactive phosphorus after dilution at WSR 46.

Table 9.25c Estimated Concentrations of Arsenic, Unionized Ammonia, Total Phosphorus and Reactive Phosphorus at the nearest WSR 46

Parameter	Average Background Concentration in Yr 2007 (mg/L)	Concentration obtained from Elutriate Testing (mg/L) except state otherwise	Estimated Dilution	Estimated Highest Concentration at WSR 46 (mg/L) except state otherwise	Net Increase (mg/L)
Arsenic	---	< 2 - 57 µg/L	56	1.02 µg/L	---
Unionized Ammonia	0.006[1]	< 0.001 – 0.62[2]	56	0.017	0.011
Total Phosphorus	0.05[1]	< 0.1 – 0.44	56	0.058	0.008
Reactive Phosphorus	0.026[1]	<0.1 – 0.29	56	0.031	0.005

Note [1]: Water Quality Monitoring at NM3 in Yr 2007
[2] Conversion factor 0.0476 at 23.2deg and pH=8 at NM3 in Yr 2007

9.10.6.5 To consider the worst-case condition, the estimated highest concentrations of these pollutants at WSR 46 were calculated by considering the highest concentration values obtained from elutriate testing as the source concentrations. The predicted concentrations of As, ammonia nitrogen, total phosphorus and total reactive phosphorus after dilution at WSR 46 are 1.02 µg/L, 0.017 mg/L, 0.058 mg/L and 0.031 mg/L respectively. The concentration of As at WSR 46 is well within the water quality criteria of 25 µg/L. Since the background concentrations are included in calculating the resulting concentrations for unionized ammonia and the nutrients, the estimated highest concentrations of unionized ammonia, total phosphorus and total reactive phosphorus at WSR 46 would be higher than the background levels. Nonetheless, the diluted concentration of unionized ammonia is still within the WQO of 0.021mg/L. The diluted concentrations of the phosphorus are very close to the background levels. The net increases in unionized ammonia (0.011 mg/L), total phosphorus (0.008 mg/L) and total reactive phosphorus (0.005 mg/L) for the worst-case condition are low.

9.10.6.6 The estimates are made by assuming no mitigation measures, i.e. no silt curtains to reduce the dispersion of pollutants from the dredging/filling sites. Since it has been identified that silt curtains need to be used in the seawall dredging and filling activities, release of pollutants from the dredging/filling sites should be minimal. The background concentrations of unionized ammonia, total phosphorus and total reactive phosphorus at WSR 46 are not likely to be elevated. It is considered that the impacts on sensitive receivers due to the increases in unionized ammonia, total phosphorus and total reactive phosphorus are insignificant.

9.10.6.7 Pore water tests were also conducted for the sediment samples. **Tables 9.25d and 9.25e** summarise the laboratory results. The parameters of Cd, Cr, Cu, Ni, Pb, Ag, Zn, As, PCBs, TBT and chlorinated pesticides in pore water were all below the corresponding reporting limits and the assessment criteria for release of contaminants during dredging and filling. For PAH, one of the samples (B10) exceed the EU limit of 0.2 µg/L. Nethertheless, given the long distance (> 200m) to the nearest sensitive receivers (WSR 46), the dilution factor is greater than 10. Hence adverse water quality impact is not anticipated.

Table 9.25d Pore Water Test Results (Metals, Metalloid and PAHs)

Sample Location	Metals (ug/L)								Metalloid (ug/L)	Organic-PAHs (µg/L)	
	Cd	Cr	Cu	Hg	Ni	Pb	Ag	Zn	As	LMW PAH	HMW PAH
A01	<0.2	<1	1.7	<0.1	1.2	1.9	<1	<4	4	<0.20	<0.20
A02	<0.2	<1	<1	<0.1	2.7	<1	<1	<4	8.7	<0.20	<0.20
A03	<0.2	<1	3.6	<0.1	2.1	1.5	<1	7.7	3.4	<0.20	<0.20
A04	<0.2	<1	<1	<0.1	1.2	<1	<1	<4	4.4	<0.20	<0.20
B05	<0.2	<1	<1	<0.1	<1	<1	<1	4.2	9	<0.20	<0.20
B06	<0.2	<1	1.2	<0.1	<1	<1	<1	<4	7.5	<0.20	<0.20
B07	<0.2	<1	2.4	<0.1	2.4	<1	<1	4.4	3.1	<0.20	<0.20
B08	<0.2	<1	<1	<0.1	<1	<1	<1	<4	4	<0.20	<0.20
B09	<0.2	1.2	3.1	<0.1	1.8	3.6	<1	10	6.1	<0.20	<0.20
B10	<0.2	<1	1.7	<0.1	1.7	<1	<1	4.2	3.3	<0.20	1.8
Ref. Sample.	<0.2	<1	<1	<0.1	1.5	<1	<1	<4	11	<0.20	<0.20
Criteria	2.5	15	5	0.3	30	25	1.9	40	25	0.2	0.2

Table 9.25e Pore Water Test Results (PCBs, TBT, Chlorinated Pesticides and Nutrients)

Sample Location	Organic-non-PAHs (µg/L)	Organo-metallics (µg/L)	Chlorinated Pesticides (µg/L)	TKN (mg/L)	NH_3-N (mg/L)	NO_3-N (mg/L)	NO_2-N (mg/L)	Total P (mg/L)	Ortho-P (mg/L)
	Total PCBs	TBT							
A01	<0.01	<0.015	<0.10	1.4	0.80	0.095	0.093	0.17	<0.10
A02	<0.01	<0.015	<0.10	3.3	3.30	No data[1]	<0.025	0.22	0.18
A03	<0.01	<0.015	<0.10	1.3	0.40	0.26	0.10	0.12	<0.10
A04	<0.01	<0.015	<0.10	<1.0	0.23	0.054	0.043	0.19	<0.10
B05	<0.01	<0.015	<0.10	2.8	2.50	<0.025	0.062	0.14	<0.10
B06	<0.01	<0.015	<0.10	2.8	2.50	<0.025	<0.025	0.25	0.13
B07	<0.01	<0.015	<0.10	<1.0	0.052	0.033	0.059	0.22	<0.10
B08	<0.01	<0.015	<0.10	1.4	1.00	<0.025	0.032	0.17	<0.10
B09	<0.01	<0.015	<0.10	1.8	1.60	<0.025	<0.025	0.49	0.32
B10	<0.01	<0.015	<0.10	<1.0	0.62	<0.025	<0.025	0.17	<0.10
Ref. Sed.	<0.01	<0.015	<0.10	4.0	3.7	<0.025	<0.025	0.73	0.68

Note [1]: Data are outside range and are considered as unreasonable.

9.10.6.8 Pore water tests were also conducted for the sediment samples. **Tables 9.25d and 9.25e** summarise the laboratory results. The parameters of Cd, Cr, Cu, Ni, Pb, Ag, Zn, As, PCBs, TBT and chlorinated pesticides in pore water are all below the corresponding reporting limits and the assessment criteria for release of contaminants during dredging and filling. For PAH, one of the samples (B10) exceed the EU limit of 0.2 µg/L. Nethertheless, given the long distance (> 200m) to the nearest sensitive receivers (WSR 46), the dilution factor is greater than 10. Hence, adverse water quality impact is not anticipated.

9.10.6.9 On assuming that the initial release distance of the bottom dump is 10m, the predicted dilution factors will be 56. **Table 9.25f** summarizes the concentrations of ammonia nitrogen, total phosphorus and total reactive phosphorus after dilution at WSR 46.

Table 9.25f Estimated Concentrations of Unionized Ammonia, Total Phosphorus and Reactive Phosphorus at the nearest WSR 46

Parameter	Average Background Concentration (mg/L)	Concentration obtained from Pore Water Testing (mg/L)	Estimated Dilution	Estimated Highest Concentration at WSR 46 (mg/L)	Net Increase (mg/L)
Unionized Ammonia	0.006[1]	< 0.0025 – 0.16	56	0.0089	0.0029
Total Phosphorus	0.05[1]	< 0.1 – 0.49	56	0.059	0.009
Reactive Phosphorus	0.026[1]	<0.1 – 0.32	56	0.032	0.006

Note [1]: Water Quality Monitoring at NM3 in Yr 2007
[2] Conversion factor 0.0476 at 23.2deg and pH=8 at NM3 in Yr 2007

9.10.6.10 To consider the worst-case condition, the estimated highest concentrations of these pollutants at WSR 46 were calculated by considering the highest concentration values obtained from elutriate testing as the source concentrations. The predicted concentrations of ammonia nitrogen, total phosphorus and total reactive phosphorus after dilution at WSR 46 are 0.0089 mg/L, 0.059 mg/L and 0.032 mg/L respectively. Since the background concentrations are included in calculating the resulting concentrations, the estimated highest concentrations of unionized ammonia, total phosphorus and total reactive phosphorus at WSR 46 would be higher than the background levels. Nonetheless, the diluted concentration of unionized ammonia is still within the WQO of 0.021mg/L. The diluted concentrations of the phosphorus are very close to the background levels. The net increases in unionized ammonia (0.0029 mg/L), total phosphorus (0.009 mg/L) and total reactive phosphorus (0.006 mg/L) for the worst-case condition are low.

9.10.6.11 The estimates are made by assuming no mitigation measures, i.e. no silt curtains to reduce the dispersion of pollutants from the dredging/filling sites. Since it has been identified that silt curtains need to be used in the seawall dredging and filling activities, release of pollutants from the dredging/filling sites should be minimal. The background concentrations of unionized ammonia, total phosphorus and total reactive phosphorus at WSR 46 are not likely to be elevated. It is considered that the impacts on sensitive receivers due to the increases in unionized ammonia, total phosphorus and total reactive phosphorus are insignificant.

9.10.7 Dissolved Oxygen Depletion

9.10.7.1 Similar to the estimation of sediment borne contaminants, the maximum potential instant DO depletion has been estimated using the estimated maximum potential increase in suspended solids. A summary of the highest depletion for selected points/sensitive receivers over the three unmitigated scenarios (2011, 2012 and 2013) is presented in **Table 9.25g**.

Table 9.25g Dissolve Oxygen Depletion

WSR	Max Depth Average SS (mg/L)	DO Depletion (mg/L)
WSR 09a	0.7	0
WSR 10	0.1	0
WSR 12	0.9	0
WSR 13	0.9	0
WSR 15	0.0	0
WSR 18	0.4	0
WSR 20	0.8	0
WSR 21	7.2	0.1
WSR 22c	1.5	0
WSR 23	5.7	0.1
WSR 25	23.7	0.4
WSR 26	80.2	1.2
WSR 27	0.9	0
WSR 28	0.0	0
WSR 30	0.0	0
WSR 41	29.9	0.4
WSR 42	0.1	0
WSR 45c	9.0	0.1
WSR 46	11.2	0.2
WSR 49	6.2	0.1

9.10.7.2 Among the selected points/sensitive receivers, the predicted highest maximum depth-average SS elevation is at the East Tung Chung Bay immediately south of the HKBCF reclamation site (WSR 26) and the predicted maximum depth-averaged is 80.2 mg/L (**Table 9.25g**) in the 2013 unmitigated scenario. With this level of SS elevation, the predicted maximal potential DO depletion is 1.2 mg/L. As noted in **Table 9.6a**, the DO of the NW Western water is generally high and on average ranges between 5.7 - 6.8 mg/L. Thus, 1.2 mg/L of short-term depletion will not be detrimental to the ecological systems of the area. Notwithstanding, the potential depletion at this site will be much reduced with the (1+1) silt curtain protection system implemented and there are no specific ecological receivers in this location.

9.10.7.3 For sites with specific sensitive use such as beaches (WSRs 12, 15 or 18) along the Tune Mun coastline, the estimated maximum depth-averaged SS increases are in the range of 0.0 to 0.9 mg/L and insignificant DO depletion (0.0 mg/L) are predicted. Among the ecological sensitive sites (WSRs 10, 22c, 27, 30, 41, 42, 45c and 49), the predicted highest depth-averaged SS elevation (29.9 mg/L in 2011 unmitigated scenario) is at the artificial reef at the NE airport (WSR 41) and with this level of SS elevation, the potential maximal DO depletion is only 0.4 mg/L which is well within the natural background fluctuation of the area.

9.10.7.4 Based upon the above worst case estimations, the predicted maximum DO depletion will be well within the natural background fluctuation, except at some areas in the immediate vicinity of the works area. This assessment approach is highly conservative and would not underestimate the risk as the hypothetical maximum increased in SS under the unmitigated scenarios is assumed, which if occurs at all, is only predicted for a small percentage of the time. Furthermore, the suspended sediment sources from fill materials which should not be contaminated at all and are not expected to exert high DO demand as would be the dredged spoils. Therefore, it is concluded there will be minimal DO depletion associated with the sediment plumes and they are predicted to be well within the environmental range supportive of marine life.

9.10.8 Water Quality Impacts on Chinese White Dolphins

9.10.8.1 The Chinese White Dolphin (CWD) is a species of major concerns with the study area and, as discussed in the Marine Ecology (**Section 10**), needs special attention. There has been some consideration on the need to establish a mixing zone to protect the Chinese White Dolphin (CWD) habitats around the project site, especially for the newly identified CWD hot-spot at the area between the Brothers and Sham Shui Kok. Annex 6 of the EIAO-TM provided objective criteria for establishing a reasonable mixing zone within which the initial dilution of a pollution input takes places and where water quality criteria can be exceeded. The EIAO-TM has not defined a fixed acceptable mixing zone, instead performance base criteria have been suggested.

<u>Criteria for Establishing a Mixing Zone</u>

9.10.8.2 In general, the criteria for acceptance of a mixing zone are that:

(a) it must not impair the integrity of the water body as a whole;

(b) it must not interfere with the migratory pathways of important species to a degree which is damaging to the ecosystem;

(c) it must not endanger sensitive uses e.g. beaches, breeding grounds, or diminish beneficial uses;

(d) it must not result in the accumulation of substances to such levels as to produce significant toxic effects in human or aquatic organisms;

(e) within a mixing zone the following basic water quality criteria shall be met

- materials not in such concentrations that settle to form objectionable deposits;
- floating debris, oil, scum, and other matter not in such concentrations that form nuisances; and

- substances not in such concentrations that produce objectionable colour, odour, taste, or turbidity.

Pollutants of Potential Concern

9.10.8.3 Prior to defining a mixing zone, the pollutants of potential concern and their characteristics should be established. As demonstrated by the results of on-site sediment quality testing in **Tables 7-10** of **Section 7**, the sediment of the project sites are generally free from the more toxic and persistent organic pollutants such PAHs, PCBs, TBT or chlorinated pesticides which are of most concern to the CWD. While some of the sediments within the site were classified as Category M, these were mainly due to the presence of low level of arsenic (max of 23 mg/kg dry wt. and below UCEL) and lead (max of 84 mg/kg dry wt. and below UCEL). The majority of Category M sediment is due to the presence of low level of arsenic, which is known to be naturally occurring in the North-western waters of Hong Kong. Nonetheless, the potential release of sediment bound pollutants and potential depletion of dissolved oxygen associated with this overall non-contaminated sediment have been assessed assuming a higher level of contamination (just below UCEL). Even based upon such a hypothetical worst-case release as discussed above, the risk of sediment borne contaminants is predicted to be very low and within the relevant criteria for the protection of marine life at fixed ecology and fisheries sensitive receivers or local hot-spots for the more mobile CWD. Therefore, the prime pollutant would the impact of suspended solids (SS).

Potential Ecotoxicological Effects of SS to CWD

9.10.8.4 There are no data on the toxicity threshold of SS to CWD, as often it is the associated contaminants, such as heavy metals and organochlorines (OCs) that may be stirred up, desorbed from the sediment substrate and redistributed into the water column during dredging operations, that are of concern. The resuspension of these environmental contaminants may increase the bioaccumulation in Chinese White Dolphins through the intake of prey items in the vicinity of a dredging site. The main class of pollutants of concern are the organochlorines (also referred to as persistent organic pollutants (POPs)), although some heavy metals and organotins may also be an issue (Jefferson et al. (2006)). However, the testing results have shown that these contaminants are generally not present in the project sites.

9.10.8.5 In the influential monograph on the population biology of Chinese White Dolphin (CWD) in Hong Kong waters, Jefferson (2000) confirmed that the some 1000 individuals of CWD in Hong Kong waters belong to the wider Pearl River Estuary population. The latest highest CWD estimate for any season in Hong Kong was 193 in autumn and including dolphins in Mainland waters, the total population size was considered to be about 1300-1500 animals (Jefferson 2007). The discharges from the Pearl River are the major factor contributing to the SS loading of the CWD's home range in PRD.

9.10.8.6 Parry (2000) undertook a detailed review of the suspended sediments in Hong Kong waters and some of the essential information about the SS of the PRE are extracted as below:

The Pearl River estuary is dominated by sedimentary accretion with the delta advancing seaward at between 50-150 m/year (Ravensrodd 1991). A range of annual water discharges and sediment loads for all the tributaries are quoted in the literature but are generally in the order of $320x10^9 m^3$ *of water and* $71x10^6$ *tons of sediment. Ninety percent of runoff occurs in the wet season between May and September and it is estimated that approximately 20% of the sediment load is deposited at the river mouth, the remainder being transported out to sea (Ren, 1987). The four channels of the main Pearl River estuary discharge a total of approximately 170M* m^3 *of water and some* $36x10^6$ *tons of sediment per year (Chen & Che, 1992).*

Kot and Hu (1995) stated that the mean annual sediment content of the estuary is 100 to 300 mg/l, with a wet season depth average of 300-500 mg/l and a dry season depth average of 20-100 mg/l. Kirby (1992), however, reported much larger depth averaged suspended solid concentrations, with concentrations of over 1400 mg/l. Gu and Zu (in Kirby, 1992) reported that satellite photographs, calibrated with suspended sediment samples, showed a pronounced lateral asymmetry in suspended sediments within the estuary. A sharp division occurred between the eastern and western zones, which for much of its length is coincident with the western margin of the Lingding channel. This strong asymmetrical distribution of suspended sediment concentrations is a result of the major river inputs being located on the west side of the estuary, combined with residual tidal flows from east to west, giving rise to an anticlockwise circulation within the estuary, possibly enhanced by the Coriolis effect. These effects are also likely to result in an asymmetrical turbidity maximum within the estuary.

Turbidity maximums are a feature of all macrotidal estuaries, with the tidal flow maintaining higher concentrations of suspended sediment in the upper estuary than in the river or sea.

Turbidity maximums are formed by river sediment moving down the estuary in the freshwater discharge which rises over the denser saline layer. The lack of mixing due to the suspension of turbulence allows the sediment to be carried in the freshwater surface layer. In freshwater the settling is negligible. However, once the salinity exceeds 1-2 ppm, flocculation can occur and settling commences from the surface seaward moving layer to the landward moving saline layer. As a general observation low tidal ranges tend to result in turbidity maximums with suspended solid concentrations of 100- 200 mg/l, whereas large tidal ranges result in concentrations of 1,000-10,000 mg/l (Dyer, 1986).

9.10.8.7 With the high natural fluctuation and asymmetry of the SS in the PRE, it must be assumed that these levels (that is, up to 10,000 mg/L) are the physiological tolerable range of CWD as the PRE is their prime habitat. For the purpose of impact assessment, the acceptable level shall be established and this shall be at least based on some speculated toxic effects. It is, however, difficult to establish a toxicological relationship between the suspended solids *per se* and CWD as marine mammals, who unlike other marine fauna are not filter feeders and do not depend on filamentous gill structure for gas exchange. Suspended solids *per se* can be a concern to fishes or other marine life that use gill structures for gaseous exchanges as high level of suspended solids can physically clog the gills, and if prolonged, can cause suffocation. Marine mammals, however, are air breathers and have lung structures for gas exchange. For this reason, secondary effects of depletion of water column dissolved oxygen associated with SS are, also, not a concern to CWD. For marine filter feeders (e.g., corals and some benthos), suspended solids can be a concern as the sudden high flow of SS can either overwhelm the filtering mechanism or completely block them leading to starvation. This again is not relevant to most marine mammals and CWD as they physical ingest food materials.

<u>Protective SS Criterion to CWD Preys</u>

9.10.8.8 Given the high SS levels the CWD experiences in its natural habitat ranges (that is, up to 10,000 mg/L) and the relative low predicted SS elevations (generally less than 50 mg/L 500m outside the sites after mitigation) due to the project works, it can reasonably be concluded that project related SS would unlikely induce significant adverse impacts on the CWD.

9.10.8.9 As a protective and precautionary measure, however, further hypothetical worse case impact suppositions are discussed below. The study of the stomach contents of stranded CWD indicated that fish families accounted for over 93% of all prey consumed by CWD (Barros et al 2004) and it may, thus, be postulated that if significant adverse impacts to fishes (major preys of CWD) are not predicted, than there should be no reason to anticipate significant adverse impacts to CWD. AFCD has sponsored a study of local species toxicology/tolerance to some common pollutants of concern, including suspended solids and the study reported that SS levels as high as 5,000 mg/L did not elicit notable impacts to fishes (CityU, 2001). A protective criterion of 50 mg/L for protection of fish was subsequently proposed and this has been largely adopted as the specific criteria for the protection of marine aquaculture facilities in local EIAs studies, including this Investigation. Taking this aboard, a 50 mg/L elevation would be highly conservative to CWD.

9.10.8.10 The predicted maximum extent of sediment plumes and the potential maximum elevations are shown together with the 2002-2008 long-term CWD density grid DPSE (which indicates relatively density of dolphins within a grid) in **Figures 9.18** to **9.29** for each of the modelling scenario times with and without (1+1) silt curtain mitigation. It should be cautioned that the maximum plumes envelope only indicates the potentially highest level at a place without any indication of the time or frequency that such a maximum elevation would occur. The frequency of the SS levels exceeding the WQO criteria (generally below 10 mg/L), and the even more conservative criteria for CWD, at representative CWD hot-spots including the Sha Chau and Lung Kwu Chau Marine Park (WSR 10), Sham Shui Kok (WSR 45c), the Tai Mo To (WSRs 46 and 49) are tabulated in **Tables 9.19** to **9.24** and shall be referenced for the more exact value of predicted maximum SS elevations and frequency of WQO exceedances. It is clear from these tables that the predicted maximum SS elevation at these points are well below the 50 mg/L criteria even without mitigation.

9.10.8.11 With reference to **Figures 9.18** to **9.29** and the CWD DPSE density grid and sediment plumes, it is clear that the prime CWD habitats are to the west of Lantau and, also, at the Sha Chau and Lung Kwu Chau Marine Park (left panel of the figures) but no project related sediment plumes are predicted in these prime CWD habitats despite the fact that there could be small sediment losses from bored piling along the HKLR alignment at west of Lantau. The project related sediment plumes are mainly confined to the more sheltered East Tung Chung Bay and often the majority of the plumes are confined to within the project site (right panel of the figures). While plumes can extend outside the project site, the maximum levels are generally constrained to less than 50 mg/L within 500m of the works site, also taking into account that high levels of elevations are not frequently predicted. Without mitigation, plumes dispersing into the Brothers/Sham Shui Kok area are generally below 10 mg/L, although a higher level of around <30 mg/L could be present in the bottom level.

9.10.8.12 **Figures 9.18** to **9.29** also demonstrate that, with the implementation of the extensive (1+1) silt curtain system which effectively encloses the entire project sites, the SS elevation band at around 500m of the site are largely reduced to <30 mg/L. This is well within the CWD tolerable range and establishing a SS mixing zone for CWD is not considered as being warranted. Notwithstanding the above, there will be a 250m CWD exclusion zone to protect the CWD from underwater noise disturbance during all dredging and reclamation works and this exclusion zone would, also, offer protection against water quality deterioration in the immediate vicinity of the works site, as has been predicted.

9.10.9 Construction Phase Runoff

9.10.9.1 Potential impacts on waters quality can occur during the construction phase as a result of construction site runoff containing elevated suspended solids and possibly oils due to erosion of exposed surfaces, stockpiles and material storage areas, fuel and oil storage and maintenance areas and dust suppression sprays. As all the streams and surface water courses downstream of the proposed works in both Tuen Mun and Lantau are already disturbed and channelised and as such, significant impacts to natural water courses will not occur as a result of the construction of the project. Therefore, construction runoff entering the marine environment via these culverts will be the main source of potential impacts.

9.10.9.2 Thus, a key issue will be the control of runoff from road and slopes works into the marine waters off Tai Ho Wan and Pillar Point. However, the extent of the excavation works are not substantial and the works in both north Lantau and Tuen Mun will be undertaken on land that is already disturbed and, as such, the works are not expected to significantly increase the area of impermeable surfaces which would cause an increased volume of runoff for any given rainfall event. In addition, the runoff from the works site will form only a small percentage of the total catchwater flows of these areas meaning that the level of dilution would be high. In addition, the runoff would be discharged below the catchwater, thus, making the contribution even lower.

9.10.9.3 Thus, even at elevated levels, by the time any sediment in suspension reaches the receiving waters, it can be expected to be extensively diluted. Notwithstanding this dilution, assuming the runoff is assimilated into the receiving waters off Tai Ho Wan within say 100m from the discharge location, the equivalent tidal volume (that is, the increase in volume between low tide and high tide) of the area inshore of this 100m line is estimated to be in the range 80,000 to 200,000m3 depending upon the tide type. The total runoff from construction works would be expected to be a fraction of this amount and, therefore, large levels of dilution would be expected. Any suspended solids would, also, be predicted to be dispersed and settle out rapidly.

9.10.9.4 Bearing in mind the dilution rates which would be achieved, the road runoff should not result in a significant increase in concentrations of contaminants. The total contaminant load in the road runoff will represent a small increase in the natural contaminant load and should not result in a significant detrimental impact on marine water quality especially when the small rainfall volumes with respect to the tidal volume are taken into account. Based upon these factors, significant effects on the water quality are not predicted.

9.10.9.5 The implementation of good construction site practices would be recommended, however, to reduce the suspended solid concentrations to a minimum. These land based mitigation measures are detailed in Section 9.11 below.

9.11 Mitigation Measures

9.11.1 Construction Phase

Marine Works (HKBCF Sequence A + HKLR + TMCLKL)

9.11.1.1 Mitigation during the marine works to reduce impacts to within acceptable levels have been recommended and will comprise a series of measures that restrict the method and sequencing of dredging/backfilling, as well as protection measures. Details of the measures are provided below and summarised in the Environmental Mitigation Implementation Schedule in EM&A Manual.

- formation of temporary seawall enclosing Portion A of HKBCF (notwithstanding a 100m of marine access) to be completed prior to the main phase of reclamation dredging and filling activities;
- construction of seawalls to be advanced by at least 200m before the main reclamation dredging and filling can commence. It should be noted that the protection by advanced seawall is a dynamic process depending on the progress of the construction activities and the stage when such protection could be realised is illustrated in **Figure 9.2A** and detailed in **Appendix 9D6**. The part of the works where such measures can be undertaken for the majority of the time includes the following locations:
  - TMCLKL northern reclamation;

  - TMCLKL southern reclamation (after formation of the nips);
  - Reclamation dredging and filling for Portion B of HKBCF;
  - Reclamation filling for Portion C of HKBCF;
  - Reclamation filling for Portion D of HKBCF; Reclamation filling for FSD berth of HKBCF; and
  - Reclamation dredging and filling for Portion 1 of HKLR;

- for the marine viaducts of HKLR, the bored piling will be undertaken within a metal casing;
- a maximum of 30% public fill to be used for all seawall and reclamation filling below +2.5mPD for HKBCF and HKLR projects;
- a maximum of 50% public fill to be used for seawall filling below +2.5mPD for TMCLKL northern and southern landfalls;
- a maximum of 30% public fill to be used for reclamation filling below+2.5mPD for TMCLKL southern landfall;
- a maximum of 100% public fill to be used for reclamation filling below +2.5mPD for TMCLKL northern landfall;
- where public fill is proposed for filling below +2.5mPD, the fine content in the public fill will be controlled to 25%;
- where sandfill is proposed for filling below +2.5mPD, the fine content in the sandfill will be controlled to 5%;
- Cage type silt curtains will be applied around all grab dredgers during the HKBCF, HKLR and TMCLKL southern reclamation works;
- single layer silt curtains will be applied around all works as given in **Appendix 9D6**;
- single layer silt surtain to be applied around the North-east airport water intake (WSR 25);
- when constructing Portion D of the HKBCF, one side of the seawall crossing the channel should be constructed first and prior to the other works. This would reduce the maximum flow speed across the channel and enhance the effectiveness of other mitigation measures such as silt curtain system;
- a temporary sheet piled wall shall be constructed north of the HKBCF island (**Appendix 9D6**), in order to allow the use of silt curtains during Phase 2 works; and
- silt curtain shall have the proofed effectiveness form the manufacturer and shall be fully maintained throughout the works by the contractor.

9.11.1.2 To ensure the water quality impacts are controlled, apart from the above measures, it would be essential for the works to be implemented following the construction sequence, production rates and other assumptions as outlined in **Appendix 9D5**. These measures shall include the following:

- The daily maximum production rates shall not exceed those assumed in the water quality assessment. A summary of these daily maximum production rates is tabulated in **Table 9.15a**; and
- The dredging and filling works shall be scheduled to spread the works evenly over a working day.

9.11.1.3 In addition, dredging operations should be undertaken in such a manner as to minimise resuspension of sediments. Standard good dredging practice measures should, therefore, be implemented including the following requirements which should be written into the dredging contract.

- trailer suction hopper dredgers shall not allow mud to overflow;
- use of Lean Material Overboard (LMOB) systems shall be prohibited;
- mechanical grabs shall be designed and maintained to avoid spillage and should seal tightly while being lifted;
- barges and hopper dredgers shall have tight fitting seals to their bottom openings to prevent leakage of material;
- any pipe leakages shall be repaired quickly. Plant should not be operated with leaking pipes;
- loading of barges and hoppers shall be controlled to prevent splashing of dredged material to the surrounding water. Barges or hoppers shall not be filled to a level which will cause overflow of materials or pollution of water during loading or transportation;
- excess material shall be cleaned from the decks and exposed fittings of barges and hopper dredgers before the vessel is moved;
- adequate freeboard shall be maintained on barges to reduce the likelihood of decks being washed by wave action;
- all vessels shall be sized such that adequate clearance is maintained between vessels and the sea bed at all states of the tide to ensure that undue turbidity is not generated by turbulence from vessel movement or propeller wash; and
- the works shall not cause foam, oil, grease, litter or other objectionable matter to be present in the water within and adjacent to the works site.

Marine Works (HKBCF Sequence B + HKLR + TMCLKL)

9.11.1.4 In general, the recommended mitigated measures for Sequence A are also applicable to Sequence B and will comprise a series of measures that restrict the method and sequencing of dredging/backfilling, as well as protection measures. Details of the measures are provided below and summarised in the Environmental Mitigation Implementation Schedule in EM&A Manual.

- the main dredging and filling works at the reclamation areas of HKBCF and TMCLKL (southern landfall) within the seawall boundary shall only be carried out when the whole Portion 1 seawall (except 100m gaps for marine access) as shown in **Figure 9A2-1** in **Appendix 9A2** is completed above the high water mark. Dredging and filling for seawalls and the pits to receive dredged Mf sediment within the site are exception. During the reclamation dredging and filling process, additional mitigation measures such as adding temporary steel sheet pile wall or additional layer of silt curtain should be considered if the monitoring results under the EM&A programme have shown exceedance on the Action Limit Levels of the related parameters;
- for the reclamation works other than those mentioned above for HKBCF and TMCLKL(southern landfall), construction of seawalls to be advanced by at least 200m before the main reclamation dredging and filling can commence. It should be noted that the protection by advanced seawall is a dynamic process depending on the progress of the construction activities and the

stage when such protection could be realised is illustrated in **Figure 9.2B** and detailed in **Part 9F1** of **Appendix 9F**. The part of the works where such measures can be undertaken for the majority of the time includes the following locations:

- TMCLKL northern reclamation;
- Reclamation filling for Portion D of HKBCF; Reclamation filling for FSD berth of HKBCF; and
- Reclamation dredging and filling for Portion 1 of HKLR;

- Installation of temporary sheet pile wall next to the northern boundary of the HKBCF+TMCLKL (southern landfall) to enable the provision of mitigation measure of floating type silt curtains at the areas where the current is strong (see **Figures 25308/041/301A and 302A** in **Appendix 9A2**). In view of the construction sequence in Sequence B, the following measures shall be applied:

- before the completion of the sheet pile wall next to the northern boundary of the HKBCF+TM-CLKL (southern landfall), seawall dredging at the area north of the demarcation line of the Phase 1 and 2 of HKBCF will not be carried out;
- before the seawall within the area of Phase 2 of HKBCF is formed above the high water mark (except for 100m gaps for marine access), sheet pile wall at the northern boundary of the HKBCF+TMCLKL (southern landfall) will not be removed.

- for the marine viaducts of HKLR, the bored piling will be undertaken within a metal casing;
- for HKBCF seawall filling, no soft public fill will be sued for filling below +2.5mPD;
- for TMCLKL southern landfill seawall filling, no soft public fill will be used for filling below +2.5mPD and the fill material below that level will consist of 50% sand and 50% rock;
- The filling materials for other parts of the works are same as those in Sequence A;
- where public fill is proposed for filling below +2.5mPD, the fine content in the public fill will be controlled to 25%;
- where sand fill is proposed for filling below +2.5mPD, the fine content in the sand fill will be controlled to 5%;
- Cage type silt curtains (with steel enclosure) as shown in **Figure 25308/041/308A** in **Appendix 9A2** will be used for all grab dredgers working during Sequence B of HKBCF and TMCLKL southern reclamation works. Normal cage type silt curtains will be used for the grabe dredgers during HKLR reclamation works;
- single layer silt curtains will be applied around all works as defined in **Part 9F2** of **Appendix 9F**;
- single layer silt curtain to be applied around the North-east airport water intake (WSR 25); and
- silt curtain shall have the proofed effectiveness from the manufacturuer and shall be fully maintained throughout the works.

9.11.1.5 For sequence B, a key measure to control the release of the resuspended solids outside the works areas is the completion of the peripheral seawalls for HKBCF and TMCLKL southern landfall before the main reclamation works, except the handling of Mf sediment which will be controlled within the temporary sheet pile walls and silt curtains. During the construction of seawalls, there would be limited protection against sediment losses except the silt curtain systems and temporary sheet piled walls dexceibed above. Thus it would be essential for the works to be implemented following the construction sequence, production rates and other assumptions as outlined in **Part 9F1** of **Appendix 9F**. The major sequences that should be followed are summarised below:

- HKBCF +TMCLKL southern landfall:
  - the construction sequence of seawall shall commence at the southern part of Portion 1 seawall in HKBCF, and then TMCLKL southern landfall seawall, northern part of Portion 1 seawall, Portion 2 and filanlly Portion 3 seawall in HKBCF;
  - the seawall dredging and filling works for TMCLKL southern landfall sahlls tart from the southern-most Portion N-c towards Portion N-a unless the northern temporary sheet pile wall has been installed;
  - before construction of the northen part of seawalls of HKBCF and TMCLKL (southern landfall), temporary sheet pile wall shall be installed next to the northern boundary of the HKBCF+TMCLKL (southern landfall) to enable the provision of mitigation measure of floating type silt curtains where the current is strong;
  - the main dredging and filling works at the reclamation areas of HKBCF and TMCLKL (southern landfall) within the seawall boundary shall only be carried out when the whole Portion 1 seawall (except 100m gaps for marine access) is completed above the high water mark.
- TMCLKL northern landfall reclamation:
  - reclamation filling shall not proceed until at least 200m section of leading seawall at both the east and west sides of the reclamation are formed above +2.5mPD, except for 100m gaps for marine access.
- HKLR reclamation:
  - reclamation filling shall not proceed until at least 200m section fo leading seawall are formed above +2.5mPD, expect for 100m gaps for marine access.
- The daily maximum production rates shall not exceed those assumed in the water quality assessment. A summary of these daily maximum production rates is tabulated in **Table 9.15b**; and
- The dredging and filling works shall be scheduled to spread the works evenly over a working day.

9.11.1.6 In addition, dredging operations should be undertaken in such a manner as to minimise resuspension of sediments. Standard good dredging practice measures should, therefore, be implemented including the following requirements which should be written into the dredging contract.

- mechanical grabs shall be designed and maintained to avoid spillage and should seal tightly while being lifted;
- barges and hopper dredgers shall have tight fitting seals to their bottom openings to prevent leakage of material;

- any pipe leakages shall be repaired quickly. Plant should not be operated with leaking pipes;
- loading of barges and hoppers shall be controlled to prevent splashing of dredged material to the surrounding water. Barges or hoppers shall not be filled to a level which will cause overflow of materials or pollution of water during loading or transportation;
- excess material shall be cleaned from the decks and exposed fittings of barges and hopper dredgers before the vessel is moved;
- adequate freeboard shall be maintained on barges to reduce the likelihood of decks being washed by wave action;
- all vessels shall be sized such that adequate clearance is maintained between vessels and the sea bed at all states of the tide to ensure that undue turbidity is not generated by turbulence from vessel movement or propeller wash; and
- the works shall not cause foam, oil, grease, litter or other objectionable matter to be present in the water within and adjacent to the works site.

Land Works

9.11.1.7 General construction activities on land should also be governed by standard good working practice. Specific measures to be written into the works contracts should include:

- wastewater from temporary site facilities should be controlled to prevent direct discharge to surface or marine waters;
- sewage effluent and discharges from on-site kitchen facilities shall be directed to Government sewer in accordance with the requirements of the WPCO or collected for disposal offsite. The use of soakaways shall be avoided;
- storm drainage shall be directed to storm drains via adequately designed sand/silt removal facilities such as sand traps, silt traps and sediment basins. Channels, earth bunds or sand bag barriers should be provided on site to properly direct stormwater to such silt removal facilities. Catchpits and perimeter channels should be constructed in advance of site formation works and earthworks;
- silt removal facilities, channels and manholes shall be maintained and any deposited silt and grit shall be removed regularly, including specifically at the onset of and after each rainstorm;
- temporary access roads should be surfaced with crushed stone or gravel;
- rainwater pumped out from trenches or foundation excavations should be discharged into storm drains via silt removal facilities;
- measures should be taken to prevent the washout of construction materials, soil, silt or debris into any drainage system;
- open stockpiles of construction materials (e.g. aggregates and sand) on site should be covered with tarpaulin or similar fabric during rainstorms;
- manholes (including any newly constructed ones) should always be adequately covered and temporarily sealed so as to prevent silt, construction materials or debris from getting into the drainage system, and to prevent storm run-off from getting into foul sewers;

- discharges of surface run-off into foul sewers must always be prevented in order not to unduly overload the foul sewerage system;
- all vehicles and plant should be cleaned before they leave the construction site to ensure that no earth, mud or debris is deposited by them on roads. A wheel washing bay should be provided at every site exit;
- wheel wash overflow shall be directed to silt removal facilities before being discharged to the storm drain;
- the section of construction road between the wheel washing bay and the public road should be surfaced with crushed stone or coarse gravel;
- wastewater generated from concreting, plastering, internal decoration, cleaning work and other similar activities, shall be screened to remove large objects;
- vehicle and plant servicing areas, vehicle wash bays and lubrication facilities shall be located under roofed areas. The drainage in these covered areas shall be connected to foul sewers via a petrol interceptor in accordance with the requirements of the WPCO or collected for off site disposal;
- the contractors shall prepare an oil / chemical cleanup plan and ensure that leakages or spillages are contained and cleaned up immediately;
- waste oil should be collected and stored for recycling or disposal, in accordance with the Waste Disposal Ordinance;
- all fuel tanks and chemical storage areas should be provided with locks and be sited on sealed areas. The storage areas should be surrounded by bunds with a capacity equal to 110% of the storage capacity of the largest tank; and
- surface run-off from bunded areas should pass through oil/grease traps prior to discharge to the stormwater system.

9.11.2 Operational Phase

9.11.2.1 No significant impacts are predicted for the operational stage. Notwithstanding, as a precautionary measures roadside gullies to trap silt and grit prior to discharging the stormwater into the marine environment. The sumps will be maintained and cleaned at regular intervals.

9.12 Cumulative Impacts

9.12.1.1 Cumulative impacts associated with the construction of the HKBCF (based on Sequence A for conservatism)+HKLR+TMCLKL together with other construction activities from other concurrent projects (**Table 9.13**) have been modelled and the methodology are summarised in **Appendix 9D5**. The results for the 3 scenario years are presented in **Appendices 9D8 (Part 9D8c), 9D9 (Part 9D9c) and 9D10(Part 9D10c)**, respectively.

2011 Scenario

9.12.1.2 **Table 9.26** shows the maximum elevated SS under mitigated measures with other concurrent projects in 2011. Only those sensitive receivers exceed the WQO are present. The SS at the surface layer of WSR 21, Ta Pang Po (near Sunny Bay Mangrove), exceed the WQO. Based on the contour plot (**Part 9D8c** of **Appendix 9D8**), the exceedances may be due to the sediment plume (unmitigated) from LLP. It is expected that the LLP will have extensive mitigation measures in place to avoid cumulative impacts with other projects and, thus, it is not expected that the plume would merge during actual construction.

9.12.1.3 Exceedances are predicted at WSR25, Cooling water intake at HKIA. To further minimize the impact on seawater intakes if required, installation of silt screen in the intakes can provide a further 60% reduction of the SS level. With the silt screen in place, all maximum and average SS results of these WSRs in both dry and wet seasons would meet the WQO criteria.

9.12.1.4 For the WSR 41, as the elevated SS level and exceedance time are much higher and longer, mitigation measures of the artifical reef is necessary. The affected artificial reefs (ARs) near the HKBCF reclamation had been deployed there for over eight years and it is considered that the relocation process would not keep the ARs intact once they are mechanically disturbed. As such, it might be more practicable to deploy replacement ARs as a compensation of the disturbance on ARs by the HKBCF reclamation works.

9.12.1.5 Exceedances are observed at WSR 46 (Tai Mo To coral / Dolphin Habitat) and WSR 49 (Dolphin Habitat). The exceedances are mainly due to the dredging / disposal operations of CMPs at East Sha Chau and the South Brothers and the Type I disposal operation at North Brothers MBA. Major measures will be implemented to reduce the demand for these facilities from the HKBCF+HKLR+TMCLKL projects, including the use of TBM for the TMCLKL's main tunnel and a high proportion of the dredged spoil from the HKBCF, HKLR and the southern reclamation of the TMCLKL is proposed to be exported outside the NWWCZ, thereby potentially reducing the operational rate of the CMPs and MBA. The combined plumes of the worst case CMPs and MBA operations would cause high level and frequent WQO exceedances. With careful scheduling of the concurrent projects and strict implementation of their respective mitigation measures (for example the CMP IVc has an operations plan that dictates that disposal should only take place in an upstream area, thus avoiding plumes outside the confines of the pits), the worst case cumulative impacts as modelled would not occur and significant cumulative impacts should be able to avoided.

9.12.1.6 The following table summarizes the maximum elevated sedimentation rate with mitigation measures at key sensitive receivers. With the mitigation measures, the maximum elevated sedimentation rate at key sensitive receivers can be reduced far below 200g/m^2/day.

WSR	Description	Elevated Sedimentation rate with HKBCF + HKLR +TMCLKL (g/m^2/day)		Elevated Sedimentation rate with HKBCF + HKLR +TMCLKL and other concurrent projects (g/m^2/day)	
		Dry	Wet	Dry	Wet
WSR 22c	Tai Ho Wan Outlet	1.8	0.7	10.8	11.9
WSR 27	San Tau SSSI	0.3	0.4	0.3	0.4
WSR 28	Airport Channel / Airport Cooling Water Intake (S)	0.0	0.0	0.0	0.0
WSR 41	Artificial Reef at NE Airport	68.6	50.1	120.9	117.9
WSR 46	Tai Mo To (near coral / CWD habitat range)	18.8	17.0	83.8	66.9
WSR 49	Tai Mo To (Deep Channel / CWD habitat range)	22.7	42.4	107	82

2012 Scenario

9.12.1.7 **Table 9.27** shows the maximum elevated SS under mitigated measures with other concurrent projects in 2012. Only those sensitive receivers exceed the WQO are present. For the WSR 41, as the elevated SS level and exceedance time are much higher and longer, re-provision of the artifical reef is necessary.

9.12.1.8 Exceedances are observed at WSR 46 (Tai Mo To coral / Dolphin Habitat) and WSR 49 (Dolphin Habitat). With a high proportion of the dredged spoil from the HKBCF, HKLR and the southern reclamation of the TMCLKL proposed to be exported outside the NWWCZ and careful scheduling of the construction programme, adverse water quality impact at these sensitive is not anticipated.

9.12.1.9 The following table summarizes the maximum elevated sedimentation rate with mitigation measures at key sensitive receivers. With the mitigation measures, the maximum elevated sedimentation rate at key sensitive receivers can be reduced far below 200g/m^2/day.

WSR	Description	Elevated Sedimentation rate with HKBCF + HKLR +TMCLKL (g/m^2/day)		Elevated Sedimentation rate with HKBCF + HKLR +TMCLKL and other concurrent projects (g/m^2/day)	
		Dry	Wet	Dry	Wet
WSR 22c	Tai Ho Wan Outlet	0.7	0.4	1.6	1.4
WSR 27	San Tau SSSI	0.1	0.1	0.1	0.1
WSR 28	Airport Channel / Airport Cooling Water Intake (S)	0.1	0.1	0.1	0.1
WSR 41	Artificial Reef at NE Airport	33.5	37.5	41	47.1
WSR 46	Tai Mo To (near coral / CWD habitat range)	18.3	18.7	50.6	29.0
WSR 49	Tai Mo To (Deep Channel / CWD habitat range)	16.8	25.2	52.5	42.2

2013 Scenario

9.12.1.10 **Table 9.28** shows the maximum elevated SS under mitigated measures with other concurrent projects in 2013. Only those sensitive receivers exceed the WQO are present. Exceedances are also predicted at WSR25, Cooling water intake at HKIA. To further minimize the impact on seawater intakes if required, installation of silt screen in the intakes can provide a further 60% reduction of the SS level. With the silt screen in place, all maximum and average SS results of these WSRs in both dry and wet seasons would meet the WHO criteria. For the WSR 41, as the elevated SS level and exceedance time are much higher and longer, re-provision is necessary.

9.12.1.11 The following table summarizes the maximum elevated sedimentation rate at key sensitive receivers. With the mitigation measures, the maximum elevated sedimentation rate at key sensitive receivers can be reduced far below 200g/m^2/day.

WSR	Description	Elevated Sedimentation rate with HKBCF + HKLR +TMCLKL (g/m^2/day)		Elevated Sedimentation rate with HKBCF + HKLR +TMCLKL and other concurrent projects (g/m^2/day)	
		Dry	Wet	Dry	Wet
WSR 22c	Tai Ho Wan Outlet	1.1	0.6	4.8	6.0
WSR 27	San Tau SSSI	0.4	0.2	0.4	0.2
WSR 28	Airport Channel / Airport Cooling Water Intake (S)	0.0	0.0	0.0	0.0
WSR 41	Artificial Reef at NE Airport	25.5	5.4	38.5	36.3
WSR 46	Tai Mo To (near coral / CWD habitat range)	4.0	5.2	23.9	22.1
WSR 49	Tai Mo To (Deep Channel / CWD habitat range)	8.6	11.2	46.3	56.5

Table 9.26 Predicted Maximum SS (mg/l) Elevations at Observation Points for the Scenario Year 2011 (Mitigated) with concurrent projects

Observation		Maximum SS (mg/L)								WQO/WQC							
		Dry Season				Wet Season				Dry Season				Wet Season			
Points	Name	S	M	B	DA	S	M	B	DA	S	M	B	DA	S	M	B	DA
WSR 21	Ta Pang Po (near Sunny Bay Mangrove)	3.9	4.3	4.8	4.3	1.8	2.0	2.3	1.9	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 25	Airport Cooling Water Intake (NE)	6.2	8.1	9.2	7.5	2.9	7.8	13.6	7.3	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 41	Artificial Reef at NE Airport	4.7	6.1	27.7	10.4	3.7	10.9	35.6	13.1	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 46	Tai Mo To (near coral / CWD habitat range)	17.4	18.6	29.5	18.7	16.0	17.4	21.6	17.5	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 49	Tai Mo To (Deep Channel / CWD habitat range)	9.9	11.0	13.0	11.1	7.3	8.4	9.7	8.4	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7

Table 9.27 Predicted Maximum SS (mg/l) Elevations at Observation Points for the Scenario Year 2012 (Mitigated) with concurrent projects

Observation		Maximum SS (mg/L)								WQO/WQC							
		Dry Season				Wet Season				Dry Season				Wet Season			
Points	Name	S	M	B	DA	S	M	B	DA	S	M	B	DA	S	M	B	DA
WSR 41	Artificial Reef at NE Airport	3.9	4.7	9.0	5.1	2.7	4.1	7.8	3.9	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 46	Tai Mo To (near coral / CWD habitat range)	6.8	7.5	8.1	7.4	3.3	4.1	7.4	3.6	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 49	Tai Mo To (Deep Channel / CWD habitat range)	4.2	4.8	5.2	4.7	2.0	2.2	3.1	2.2	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7

Table 9.28 Predicted Maximum SS (mg/l) Elevations at Observation Points for the Scenario Year 2013 (Mitigated) with concurrent projects

Observation		Maximum SS (mg/L)								WQO/WQC							
		Dry Season				Wet Season				Dry Season				Wet Season			
Points	Name	S	M	B	DA	S	M	B	DA	S	M	B	DA	S	M	B	DA
WSR 25	Airport Cooling Water Intake (NE)	5.1	6.4	7.3	5.8	1.9	5.7	4.1	3.5	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7
WSR 41	Artificial Reef at NE Airport	5.4	6.9	8.2	5.7	7.2	5.7	4.0	4.1	3.6	5.1	8.1	5.5	2.3	3.3	6.0	3.7

9.13 Model Sensitivity Test

9.13.1.1 Trailing suction hopper dredgers (TSHD) have been proposed for the artificial islands and immersed tube tunnel dredging works for the Mainland section of HZMB works with overflows for the major part of the working time, as stated in the Ocean Environmental Impact Assessment for the HZMB (HZMB OEIA) (COES 2008). The TSHD is a sea-going ship equipped with a suction ladder and at the end of the ladder is a draghead which can be lowered onto the seabed while the TSHD navigates at a reduced speed. During the forward movement of the TSHD, the draghead agitates a thin layer of the seabed and the loosened material, together with some water, is sucked into the suction pipe by means of a centrifugal pump, which is installed in the vessel's hull. The material is then pumped into the vessel's hopper until it is completely filled. During this loading phase, excess water may flow overboard together with some of the finer material, while the coarser fraction accumulates in the hopper.

9.13.1.2 One of the major environmental constraints of the TSHD is the suspended sediment generated by the overflow of excessive transport water with high fines content. Although there have been many advancements in the overflowing system of TSHDs in recent years to reduce the environmental impacts, the dredging of mud in Hong Kong cannot benefit from them as overflow is generally prohibited completely during dredging of mud. As such, the characteristics of sediment release during the overflowing cycle are less uncertain, especially in the local context. A set of overflowing parameters (1.31 kg/s for 45,00m^3 TSHD) have been proposed in the HZMB OEIA as detailed in **Appendix 9D5** and adopted in this EIA (scaled up to 2.82 kg/s for the larger 10,000m^3 TSHD). However, given the relatively high uncertainty of potential sediment release during the overflowing cycle, a sensitivity test of the effect of varying the overflow rate of the TSHD has been considered necessary. While overflows for mud dredging are not allowed, it is an essential requirement for the efficient and economic operation of the TSHD when working for sand dredging. There are also limited results of sand dredging with overflows and, as such, the overflow rate of 491 kg/s, as applied in a local modelling study for sand dredging (e.g., ERM 2001), has, therefore, been adopted for the sensitivity test.

9.13.1.3 The 2011 mitigated scenario with concurrent projects has been chosen as the test case for the sensitivity run as, at this time, the HZMB artificial islands dredging works are assumed to be closest to Hong Kong SAR boundary. Therefore, the model set-up has been essentially the same as for the 2011 mitigated (Option 1, **Table 9.16**) scenario with concurrent projects, but with an assumed higher TSHD overflow at the HZMB two artificial island. This setting has, also, allowed for the direct comparison of the effects of an assumed high overflow on the water quality of western waters. The results of the sensitivity test are presented in **Appendix 9D12** and briefly discussed below.

9.13.1.4 The two ZHMB artificial islands are located at the side of major north-south running Lingding Fairway, Rongshutou Fairway and Longgu Western Fiarway. The eastern HZMB artificial island is closer to Hong Kong SAR boundary (about 150m apart) and is about 3km north-west of Tai O. The main direction of flows in these area is north-south running (HZMB OEIA). The sediment plume form the dredging works of HZMB artificial islands are also mainly north-south running. A comparison of the surface SS plumes under typical tidal conditions are summarised in **Table 9.30** below.

9.13.1.5 As indicated in **Table 9.30**, the size of sediment plumes from the TSHD dredging and grab dredging at the HZMB artificial island are generally small and even if the plumes do cross the HKSAR boundary, they are generally at low levels and close to Hong Kong's WQO. However, under the hypothetical high overflow rates, very large plumes hitting both the west and south Lantau coast are predicted, although the sediment plumes from the HZMB works generally do not merge with the sediment plumes from the HKBCF+TMCLKL+HKLR. As a precautionary measure, it is recommended to carry out water quality monitoring along the marine border of Hong Kong and Mainland during the period of the artificial islands construction in HZMB Main Section in order to monitor whether the dredging overflow plume arising from this construction work would affect the water environment along the west and south coast of Lantau.

Table 9.30 Comparison of Surface Plumes During HZMB TSHD Assumed Overflows and Sensitivity Test Overflows

Tide State	Assumed Overflow		Sensitivity Test Overflow	
	Dry Season	Wet Season	Dry Season	Wet Season
Peak ebb	Time = 14:00; low level of southward SS elevation down to <3 mg/L band along the boundary	Time = 14:00; no surface plumes predicted in HKSAR	large southward plumes of down to the <30 mg/L band along the west Lantau reaching about Fan Lau Kok, but not get into Tai O or Yi O.	large southward plumes of down to <30 mg/L band along the west Lantau reaching west of Yi O, but not get into Tai O or Yi O. Plumes reaching about west of Fan Lau Kok at around down to <8 mg/L band
Peak flood	Time = 8:00; TSHD dredging just begin and no residual surface plumes predicted.	Time = 8:00; TSHD dredging just begin and no residual surface plumes predicted.	residual surface plume of around <4 mg/L band persist at west of Tai O	TSHD dredging just being and no residual surface plumes predicted.
LL, Spring	Time = 18:00; TSHD dredging stopped 2.5 hours ago and no residual surface plumes	Time = 16:00; TSHD dredging stopped 0.5 hours ago and no residual surface plumes	large residual plumes of about down to <30 mg/L band between west of Yi O and south of Fan Lau Kok.	residual southward plumes of down to <30 mg/L band between the AI and west of Yi O. A break off patch of down to <16 mg/L band at west of Fun Lau.
HH, Spring	Time = 10:00; small low level north-east plumes of down to <4 mg/L band along the HKSAR boundary to the north (~2.5 km) of the AI.	Time = 10:00; small low level plumes of down to <4 mg/L around the north of the AI.	large north-east plumes of down to <100 mg/L band along the HKSAR boundary to the north (~ 2.5km) of the AI. The eastern extend of down to <10 mg/L band is about 2.5km from the AI	high north-east plumes of down to <100 mg/L band along the HKSAR boundary to the north (~2.5km) of the AI. The eastern extend of down to <10 mg/L band is about 3.5km west of the AI
LL, Neap	Time = 20:00; TSHD dredging stopped at 15:30 no residual surface plumes predicted	Time = 20:00 TSHD dredging stopped at 15:30 no residual surface plumes predicted	residual plume of down to <7 mg/L band between the mouth of Tai O to about the mid-way between Yi O and Fan Lau Kok.	no residual surface plumes predicted
HH, Neap	Time = 14:00; small low level plumes of down to <7 mg/L band around the north of the AI.	Time = 14:00; small low level plumes of down to <7 mg/L band around the north of the AI.	north-east plumes of down to <100 mg/L band along the HKSAR boundary to the north (~ 2.5km) of the AI. The eastern extent of down to <10 mg/L band is about 2km of the AI	north-east plumes of down to <30 mg/L band about 2.5km north and 2.5km west of the AI.

Notes:
AI = HZMB Eastern Artificial Island;
LL = Lowest Low water level; HH = Highest high water level;
The assumed HZMB TSHD working time are between 8:00 – 11:30 (first cycle) and 12:00 – 15:30 (second cycle). However, grab dredging is continuous 24 hours a day.

9.14 Residual Impacts

9.14.1.1 Residual impact is predicted at artificial reef at NE Airport (WSR 41). However, with the re-provision of the artificial reef, the impact can be minimized.

9.15 Environmental Monitoring and Audit

9.15.1.1 The implementation of good construction works practice and good dredging practice as well as the various specific mitigation measures identified above is important to prevent pollution of marine water in the construction phase. It is, therefore, recommended that construction activities both on land and offshore should be subject to a routine audit programme throughout the construction period. Further details on the scope of this audit are provided in the project EM&A manual.

9.15.1.2 With the implementation of the recommended mitigation measures no residual adverse impacts on water quality would be expected. Nevertheless in view of the close proximity of the key sensitive receivers and the scale of the combined projects, it is considered appropriate to implement a water quality monitoring programme throughout the marine works construction period to verify that the intensity of sediment plumes caused by activities associated with dredging and backfilling are within the predicted acceptable bounds. The monitoring programme shall form an integral part of a management and control programme with a clearly defined Action Plan to trigger implementation of any necessary revision to works practice or provision of supplementary mitigation measures in the unlikely event that adverse impacts are identified. Further details of the monitoring programme and accompanying Action Plan are provided in the EM&A manual.

9.15.1.3 Since the marine works of HKBCF and HKLR are planned to be carried out concurrently with TMCLKL and the reclamation of TMCLKL(southern landfall) is indeed an integrated part of HKBCF reclamation, it is recommended that the water quality monitoring works of these three concurrent projects, also by the same project proponent, be conducted as a whole to enhance the efficiency and cost-effectiveness of the EM&A monitoring programme.

9.15.1.4 An important mitigation measure to control the potential sediment loss to an acceptable level is extensive use of a combination of silt curtain systems enclosing individual grab dredgers as well as the perimeter of the works area. The sediment reduction efficiency of this type of silt curtain applied separately are well established. For multiple layers of silt curtains, however, it can be expected that suspended solids that cannot be retained by the first layer of screen should be the very fine particle which would be difficult to be retained by the subsequent layers. Although this phenomena has been taken into account in estimating the combined efficiency of the multiple silt curtain system, there are only limited information about the actual performance of the combined system. As such, a field trial to verify the reduction effect of the silt curtain system during the EM&A stage is recommended as mentioned in **Sections 9.8.4.19** and **9.8.4.26** .

9.15.1.5 Furthermore, to ensure the San Tau Beach SSSI will not be adversely affected by the project as predicted, operation phase water quality monitoring at San Tau Beach SSSI is recommended. Further details of the specific EM&A requirements are detailed in **Section 15** of this report and in the EM&A Manual.

9.16 References

Binnie Consultants Limited (1996). Fill Management Study - Phase IV Investigations and Development of Marine Borrow Areas: Coral Growth at High Island Dam. For The Civil Engineering Department, Hong Kong SAR Government.

CityU (City University of Hong Kong) (2001). Agreement No. CE 62/98, Consultancy Study on Fisheries and Marine Ecological Criteria for Impact Assessment, Final Report, for the Agriculture, Fisheries and Conservation Department, HKSAR Government.

ERM Hong Kong, Ltd (1997). Environmental Impact Assessment Study for Disposal of Contaminated Mud In the East of Sha Chau Marine Borrow Pit. Prepared for Civil Engineering Department, HKSAR Government.

ERM Hong Kong, Ltd (2003a). The Proposed Submarine Gas Pipelines From Cheng Tou Jiao Liquefied Natural Gas Receiving Terminal, Shenzhen to Tai Po Gas Production Plant, Hong Kong – Environmental Impact Assessment Study. For The Hong Kong and China Gas Company Limited. (EIA – 089/2003)

ERM Hong Kong, Ltd (2003b). Proposed Aviation Fuel Receiving Facility at Sha Chau: Environmental Impact Assessment, Volume 1, January 1995.

ERM Hong Kong, Ltd (2005). Detailed Site Study for a Proposed Contaminated Mud Disposal Facility within the Airport East/East of Sha Chau. Prepared for Civil Engineering and Development Department, HKSAR Government.

HWR (1993) Disposal of Spoil at West Po Toi. An Assessment of the Stability and Losses of Dumped Spoil. Hydraulics and Water Research (Asia) Ltd Report HWR 067, July 1993 for Greiner Maunsell.

Maunsell (2008). Agreement No. CE 43/2005 (EP) Harbour Area Treatment Scheme (HATS) Stage 2A EIA Study – Investigation. Final Environmental Impact Assessment Report. Prepared for Drainage Service Department, HKSAR Government.

Meinhardt Infrastructure and Environment (2007). Contract P325 Environmental Assessment Services for Permanent Aviation Fuel Facility. Final Environmental Impact Assessment Report. Prepared for Airport Authority Hong Kong.

Mouchel Asia Limited (2002a). Environmental Assessment Study for Backfilling of Marine Borrow Pits at North of the Brothers (Agreement No Geo 01/2001) - Environmental Assessment Report. For The Civil Engineering Department, Hong Kong SAR Government.

Mouchel Asia Limited (2002b). Contract M811 Environmental Assessment Services for Permanent Aviation Fuel. Final Environmental Impact Assessment Report. Prepared for Airport Authority Hong Kong.

PlanD (Planning Department) (2008). Technical Notes on the Compliation of 2006-based TPDEM. Planning Department, HKSAR Government.

Parry, S. (2000). Suspended Sediment in Hong Kong Waters. GEO Report No. 106. Geotechnical Engineering Office, Civil Engineering Department, HKSAR Government.