5b. WATER QUALITY IMPACT (ARTIFICIAL ISLAND NEAR SKC)

5b.1 Introduction

5b.1.1.1 This Section presents an assessment of the potential water quality impacts associated with construction and operation of the IWMF at the artificial island near SKC. Recommendations for mitigation measures have been provided, where necessary, to minimize the identified water quality impacts to an acceptable level.

5b.2 Environmental Legislation, Standards and Guidelines

5b.2.1 Environmental Impact Assessment Ordinance (EIAO)

5b.2.1.1 The Technical Memorandum on Environmental Impact Assessment Process (EIAO-TM) is issued by the EPD under Section 16 of the EIAO. It specifies the assessment method and criteria that need to be followed in the EIA. Reference sections in the EIAO-TM provide the details of the assessment criteria and guidelines that are relevant to the water quality impact assessment, including:

- Annex 6 Criteria for Evaluating Water Pollution
- Annex 14 Guidelines for Assessment of Water Pollution

5b.2.2 Water Pollution Control Ordinance (WPCO)

5b.2.2.1 The Water Pollution Control Ordinance (Cap. 358) is the major legislation relating to the protection and control of water quality in Hong Kong. According to the Ordinance and its subsidiary legislation, Hong Kong waters are divided into ten water control zones (WCZ). Corresponding statements of Water Quality Objectives (WQO) are stipulated for different water regimes (marine waters, inland waters, bathing beaches subzones, secondary contact recreation subzones and fish culture subzones) in each of the WCZ based on their beneficial uses. The study area for the IWMF at the artificial island near SKC includes the Southern, Southern Supplementary, Second Southern Supplementary, North Western, North Western Supplementary, and Western Buffer Water Control Zones while the potential development site at SKC is located in Southern WCZ. The corresponding WQOs at the Southern WCZ are listed in **Table 5b.1**.

Table 5b.1 Summary of Water Quality Objectives for Southern WCZ

Parameters	Objectives	Sub-Zone
Offensive odour, tints	Not to be present	Whole zone
Visible foam, oil scum, litter	Not to be present	Whole zone
Dissolved Oxygen (DO) within 2 m of the seabed	Not less than 2.0 mg/l for 90% of samples	Marine waters
Depth-averaged DO	Not less than 4.0 mg/l for 90 % of samples	Marine waters excepting fish culture subzones
	Not less than 5.0 mg/l for 90% of samples	Fish culture subzones
	Not less than 4.0 mg/l	Inland waters

Parameters	Objectives	Sub-Zone
pH	To be in the range of 6.5 - 8.5, change due to human activity not to exceed 0.2	Marine waters excepting bathing beach subzones; Mui Wo (A), Mui Wo (B), Mui Wo (C), Mui Wo (E) and Mui Wo (F) subzones
	To be in the range of 6.0 – 9.0	Mui Wo (D) sub-zone and other inland waters.
	To be in the range of 6.0 –9.0 for 95% of samples, change due to human activity not to exceed 0.5	Bathing beach subzones
Salinity	Change due to human activity not to exceed 10% of ambient	Whole zone
Temperature	Change due to human activity not to exceed 2 ℃	Whole zone
Suspended Solids (SS)	Not to raise the ambient level by 30% caused by human activity	Marine waters
	Change due to waste discharges not to exceed 20 mg/l of annual median	Mui Wo (A), Mui Wo (B), Mui Wo (C), Mui Wo (E) and Mui Wo (F) subzones
	Change due to waste discharges not to exceed 25 mg/l of annual median	Mui Wo (D) subzone and other inland waters
Unionized Ammonia (UIA)	Annual mean not to exceed 0.021 mg(N)/l as unionized form	Whole zone
Nutrients	Shall not cause excessive algal growth	Marine waters
Total inorganic nitrogen (TIN)	Annual mean depth-averaged inorganic nitrogen not to exceed 0.1 mg(N)/l	Marine waters
E. coli	Not exceed 610 per 100 ml, calculated as the geometric mean of all samples collected in one calendar year	Secondary contact recreation subzones and fish culture subzones
	Not exceed 180 per 100 ml, calculated as the geometric mean of all samples collected from March to October inclusive in 1 calendar year. Samples should be taken at least 3 times in 1 calendar month at intervals of between 3 and 14 days.	Bathing beach subzones
5-Day Biochemical Oxygen Demand (BOD_5)	Change due to waste discharges not to exceed 5 mg/l	Inland waters
Chemical Oxygen Demand (COD)	Change due to waste discharges not to exceed 30 mg/l	Inland waters

Parameters	Objectives	Sub-Zone
Dangerous Substances	Should not attain such levels as to produce significant toxic effects in humans, fish or any other aquatic organisms	Whole zone
	Waste discharges should not cause a risk to any beneficial use of the aquatic environment	Whole zone

Source: Statement of Water Quality Objectives (Southern Water Control Zone).

5b.2.3 Sediment Quality Assessment Criteria

5b.2.3.1 Environment, Transport and Works Bureau (ETWB) Technical Circular Works (TCW) No. 34/2002 "*Management of Dredged/Excavated Sediment*" sets out the procedure for seeking approval to dredge / excavate sediment and the management framework for marine disposal of dredged / excavated sediment. This Technical Circular outlines the requirements to be followed in assessing and classifying the sediment. Sediments are categorized with reference to the Lower Chemical Exceedance Level (LCEL) and Upper Chemical Exceedance Level (UCEL) as follows:

- Category L - Sediment with all contaminant levels not exceeding the LCEL. The material must be dredged, transported and disposed of in a manner that minimizes the loss of contaminants either into solution or by suspension.
- Category M - Sediment with any one or more contaminant levels exceeding the LCEL and none exceeding the UCEL. The material must be dredged and transported with care, and must be effectively isolated from the environment upon final disposal unless appropriate biological tests demonstrate that the material will not adversely affect the marine environment.
- Category H - Sediment with any one or more contaminant levels exceeding the UCEL. The material must be dredged and transported with great care, and must be effectively isolated from the environment upon final disposal.

5b.2.3.2 The sediment quality criteria for the classification of sediment are presented in **Table 5b.2**.

Table 5b.2 Sediment Quality Criteria for the Classification of Sediment

CONTAMINANTS	LCEL	UCEL
Heavy Metal (mg/kg dry weight)		
Cadmium (Cd)	1.5	4
Chromium (Cr)	80	160
Copper (Cu)	65	110
Mercury (Hg)	0.5	1
Nickel (Ni)	40	40
Lead (Pb)	75	110
Silver (Ag)	1	2
Zinc (Zn)	200	270
Metalloid (mg/kg dry weight)		
Arsenic	12	42
Organic-PAHs (μg/kg dry weight)		
PAHs (Low Molecular Weight)	550	3,160
PAHs (High Molecular Weight)	1,700	9,600
Organic-non-PAHs (μg/kg dry weight)		
Total PCBs	23	180

Source: Appendix A of ETWB TCW No. 34/2002 Management of Dredged / Excavated Sediment

Note: LCEL – Lower Chemical Exceedance Level

UCEL – Upper Chemical Exceedance Level

5b.3 Description of the Environment

5b.3.1 Existing Baseline Marine Water Quality

5b.3.1.1 Marine water quality monitoring data routinely collected by EPD were used to establish the baseline condition. The EPD monitoring data collected in 2008 were summarised in **Table 5b.3** for four selected stations close to the Project site in Southern WCZ (namely SM12, SM13, SM17 and SM6 respectively). The locations of these monitoring stations are shown in **Figure 5b.1**. Descriptions of the baseline conditions for the Southern WCZ provided below sections are extracted from the EPD's report "*2010 Marine Water Quality in Hong Kong*" which contains the latest information published by EPD on marine water quality at the moment of preparing this EIA report.

Table 5b.3 Baseline Marine Water Quality Condition for Southern WCZ

Parameters		Lantau Island (South)			West Lamma	WPCO WQO (in marine waters)
		SM12	SM13	SM17	SM6	
Temperature (℃)		23.7 (16.7 - 28.6)	23.9 (17.0 - 29.3)	23.2 (16.9 - 27.8)	23.0 (17.2 - 28.2)	Not more than 2℃ in daily temperature range
Salinity (psu)		29.9 (23.1 - 33.4)	29.5 (21.7 - 33.6)	31.1 (24.9 - 34.0)	31.8 (28.4 - 34.0)	Not to cause more than 10% change
Dissolved Oxygen (DO) (mg/L)	Depth Average	7.0 (5.4 - 8.6)	7.2 (5.1 - 8.5)	6.4 (4.0 - 7.9)	6.8 (4.6 - 8.2)	Not less than 4 mg/L for 90% of the samples
	Bottom	6.5 (4.7 - 7.9)	6.7 (5.2 - 8.1)	5.6 (2.1 - 7.8)	7.2 (6.1 - 8.6)	Not less than 2 mg/L for 90% of the samples
Dissolved Oxygen (DO) (% Saturation)	Depth Average	98 (81 - 129)	101 (74 - 127)	89 (59 - 105)	94 (68 - 106)	Not Available
	Bottom	91 (71 - 109)	94 (76 - 121)	77 (30 - 102)	101 (86 - 128)	Not Available
pH		8.0 (7.7 - 8.3)	8.0 (7.7 - 8.4)	7.9 (7.7 - 8.2)	8.0 (7.7 - 8.3)	6.5 - 8.5 (±0.2 from natural range)
Secchi Disc Depth (m)		2.1 (1.1 - 3.5)	2.3 (1.5 - 3.6)	2.5 (1.8 - 4.0)	2.6 (1.8 - 3.8)	Not Available
Turbidity (NTU)		5.0 (1.8 - 9.5)	4.9 (2.3 - 10.9)	4.9 (1.9 - 12.8)	4.1 (0.7 - 11.8)	Not Available
Suspended Solids (SS) (mg/L)		6.5 (1.5 - 14.2)	5.5 (1.7 - 13.3)	4.6 (1.7 - 11.7)	4.2 (1.3 - 11.0)	Not more than 30% increase
5-day Biochemical Oxygen Demand (BOD_5) (mg/L)		1.1 (0.4 - 2.2)	1.1 (0.3 - 2.5)	0.7 (0.5 - 1.3)	1.1 (0.5 - 2.5)	Not Available
Ammonia Nitrogen (NH_3-N) (mg/L)		0.070 (0.030 - 0.163)	0.043 (0.015 - 0.117)	0.038 (0.010 - 0.140)	0.028 (0.016 - 0.041)	Not Available
Unionised Ammonia (UIA) (mg/L)		0.003 (<0.001 - 0.009)	0.002 (<0.001 - 0.005)	0.001 (<0.001 - 0.003)	0.001 (<0.001 - 0.003)	Not more than 0.021 mg/L for annual mean
Nitrite Nitrogen (NO_2-N) (mg/L)		0.038 (0.006 - 0.088)	0.039 (0.006 - 0.091)	0.029 (<0.002 - 0.074)	0.024 (0.007 - 0.046)	Not Available
Nitrate Nitrogen (NO_3-N) (mg/L)		0.178 (0.029 - 0.477)	0.183 (0.030 - 0.503)	0.132 (<0.002 - 0.372)	0.097 (0.005 - 0.300)	Not Available
Total Inorganic Nitrogen (TIN) (mg/L)		0.29 (0.07 - 0.61)	0.27 (0.07 - 0.63)	0.20 (0.02 - 0.46)	0.15 (0.03 - 0.36)	Not more than 0.1 mg/L for annual mean
Total Kjeldahl Nitrogen TKN) (mg/L)		0.22 (0.13 - 0.32)	0.19 (0.12 - 0.33)	0.17 (0.10 - 0.27)	0.16 (0.10 - 0.22)	Not Available
Total Nitrogen (TN) (mg/L)		0.44 (0.20 - 0.78)	0.41 (0.21 - 0.78)	0.33 (0.13 - 0.57)	0.28 (0.14 - 0.48)	Not Available
Orthophosphate Phosphorus (OrthoP) (mg/L)		0.013 (0.003 - 0.030)	0.012 (0.003 - 0.039)	0.012 (0.005 - 0.030)	0.009 (0.003 - 0.016)	Not Available
Total Phosphorus (TP) (mg/L)		0.03 (<0.02 - 0.04)	0.03 (<0.02 - 0.05)	0.03 (<0.02 - 0.04)	0.02 (<0.02 - 0.03)	Not Available
Silica (as SiO_2) (mg/L)		0.90 (0.21 - 2.00)	0.87 (0.24 - 2.37)	0.85 (0.24 - 2.33)	0.72 (0.17 - 1.67)	Not Available

Parameters	Lantau Island (South)			West Lamma	WPCO WQO (in marine waters)
	SM12	SM13	SM17	SM6	
Chlorophyll-*a* (µg/L)	7.9 (1.3 - 27.3)	7.0 (1.3 - 31.7)	3.4 (0.9 - 14.1)	4.0 (0.5 - 11.3)	Not Available
E. coli (cfu/100 mL)	43 (1 - 840)	2 (<1 - 24)	1 (<1 - 4)	2 (<1 - 11)	Not Available
Faecal Coliforms (cfu/100 mL)	93 (2 - 2100)	4 (1 - 55)	2 (<1 - 5)	2 (1 - 45)	Not Available

Notes:
1. Data source: Marine Water Quality in Hong Kong in 2010.
2. Unless otherwise specified, data presented are depth-averaged values calculated by taking the means of three depths: Surface, Mid-depth, Bottom.
3. Data presented are annual arithmetic means of the depth-averaged results except for E. coli and faecal coliforms which are annual geometric means.
4. Data in brackets indicate the ranges.

5b.3.1.2 The Southern WCZ covers an area located to the south of Hong Kong Island and to the east of Lantau Island, is directly open to the South China Sea. It is a large expanse of open sea and as such enjoys good levels of dissolved oxygen (DO), but the western parts of it are affected by the discharge from the Pearl River further to the west, in particular during the wet summer months when the river's fresh water flow increases. A number of parameters are affected by the Pearl River, including salinity, suspended solids (SS) and total inorganic nitrogen (TIN). Typically, higher levels of SS and TIN were found at the western stations than at those further eastern, while the situation was the reverse for salinity. This phenomenon became more obvious in the summer month.

5b.3.1.3 Although full compliance (100%, including the four selected stations close to the Project site) with the WQOs for unionized ammonia (NH_3) and *E. coli* was achieved in 2010, there was a decrease in TIN compliance rate due to the higher TIN levels recorded mainly in the summer months from June to September. The higher levels of TIN recorded in the southern water during the 2010 summer months could be related to the heavy rainfalls recorded in the Pearl River Delta area in the same period.

5b.3.2 Existing Baseline Marine Sediment Quality

5b.3.2.1 The potential site at SKC and the proposed submarine cables are located in remote / rural area. The potential for sediment contamination at or in the vicinity of the Project site is considered low. Sediment quality monitoring data were routinely collected by EPD in Hong Kong. The sediment quality monitoring stations closest to the Project site are Stations SM13, SM6 and SM7 (as shown in **Figure 5b.1**). A summary of EPD monitoring data collected at these three selected stations in 2010 is presented in **Table 5b.4**.

Table 5b.4 Baseline Marine Sediment Quality Condition

Parameters	Lantau Island South	West Lamma Channel		Sediment Quality Criteria	
	SM13	SM6	SM7	LCEL	UCEL
Heavy Metal (mg/kg dry weight)					
Cadmium (Cd)	<0.1 (0.1-<0.1)	<0.1 (0.1-<0.1)	<0.1 (0.1-<0.1)	1.5	4
Chromium (Cr)	21 (17-23)	30 (25-37)	36 (30-47)	80	160
Copper (Cu)	10 (8-13)	17 (14-20)	29 (18-38)	65	110
Mercury (Hg)	0.07 (0.05-0.18)	0.09 (0.07-0.15)	0.12 (0.08-0.20)	0.5	1
Nickel (Ni)	13 (11-17)	21 (17-25)	22 (19-26)	40	40
Lead (Pb)	23 (20-28)	33 (28-38)	39 (32-44)	75	110
Silver (Ag)	<0.2 (0.2-<0.2)	<0.2 (0.2-<0.2)	0.4 (0.2-0.4)	1	2

Parameters	Lantau Island South	West Lamma Channel		Sediment Quality Criteria	
	SM13	SM6	SM7	LCEL	UCEL
Zinc (Zn)	57 (44-73)	86 (68-100)	110 (88-140)	200	270
Metalloid (mg/kg dry weight)					
Arsenic	5.4 (4.4-6.0)	6.9 (5.8-7.9)	7.6 (6.1-8.9)	12	42
Organic PAHs (mg/kg dry weight)					
PAHs (Low Molecular Weight)	90 (90-90)	93 (90-110)	92 (90-110)	550	3160
PAHs (High Molecular Weight)	23 (20-29)	55 (22-120)	95 (40-160)	1700	9600
Organic-non-PAHs (mg/kg dry weight)					
Total PCBs	18 (18-18)	18 (18-18)	18 (18-18)	23	180

Note: LCEL – Lower Chemical Exceedance Level
UCEL – Upper Chemical Exceedance Level

5b.3.2.2 Based on the monitoring data (refer to **Table 5b.4**), the sediments collected at SM13 (to the northwest of SKC), SM6 and SM7 (in the West Lamma Channel) were uncontaminated materials.

5b.4 Water Sensitive Receivers

5b.4.1.1 Locations of the water sensitive receivers (WSRs) within the Study Area are shown in **Figure 5b.1**. Water sensitive receivers (WSRs) identified at or in the vicinity of the artificial island near SKC and the submarine cable alignment include:

- Horseshoe Crab;
- Gazetted Beaches;
- Fish Culture Zones; and
- Coral Communities.

5b.4.1.2 According to the recent dive surveys, the seabed along the southwest shoreline of Shek Kwu Chau was found to be mainly composed of bedrocks, boulders, muddy and sandy bottom. Limited marine life was seen except only some coral communities found along the southwest coastline of Shek Kwu Chau. Detailed description and assessment of the impact on marine ecology including coral communities are reported separately under the ecology impact assessment in Section 7b.

5b.4.1.3 No WSD flushing water intake is identified in the vicinity of the Project site.

5b.5 Assessment Methodology

5b.5.1.1 The Assessment Area as specified in the EIA Study Brief covers an area within 300m of the Project site boundary, and all relevant water sensitive receivers, nearby watercourses and the associated water systems.

5b.5.1.2 The water sensitive receivers that may be affected by various construction activities for the IWMF were identified. Potential sources of water quality impact that may arise during the construction and operation phase of the Project were described. All the identified sources of potential water quality impact were then evaluated and their impact significance determined. The need for mitigation measures to reduce any identified adverse impacts on water quality to acceptable levels was determined.

5b.6 Identification of Potential Impacts

5b.6.1 Construction Phase

5b.6.1.1 The major construction works of the Project would be seabed dredging for reclamation and installation of submarine cables, site formation, construction of facilities and construction of the access road. Potential water quality impact during construction phase of the IWMF would be occurred from:

- Drainage and construction site runoff during site formation and foundation piling;
- General construction activities;
- Accidental spillage and accumulation of solid wastes;
- Sewage effluent produced by on-site workforce; and
- Disturbance and re-suspension of seabed sediments for marine works associated with reclamation and installation of submarine cables.

Drainage and Construction Site Runoff

5b.6.1.2 Runoff from the construction works area may contain increased loads of sediments, other suspended solids and contaminants. Potential sources of pollution from site drainage include:

- Runoff and erosion from exposed soil surfaces, earth working areas and stockpiles;
- Release of grounting and cement materials with rain wash;
- Wash water from dust suppression sprays; and
- Fuel and lubricants from maintenance of construction vehicles and mechanical equipment.

5b.6.1.3 Sediment laden runoff during site formation works, if uncontrolled, may carry pollutants (adsorbed onto the particle surfaces) into the nearby coastal waters.

General Construction Activities

5b.6.1.4 Land-based construction works may have the potential to cause water pollution. Various types of construction activities would generate wastewater. These include general cleaning and polishing, dust suppression and utility installation. These types of wastewater would contain high concentration of suspended solids. Wastewater would also be generated from the accumulation of solid waste such as debris, rubbish, plastic package and construction materials. If uncontrolled, these would lead to deterioration in water quality.

Accidental Spillage

5b.6.1.5 Variety of chemicals would be used for carrying out construction activities. These chemicals may include petroleum products, spent lubrication oil, grease, mineral oil, solvent and other chemicals. Accidental spillages of chemicals in the works area may contaminate the surface soils. The contaminated soil particles may be washed away by construction site runoff causing water pollution.

Sewage Effluent

5b.6.1.6 Domestic sewage would be generated from the workforce during the construction phase. However, this sewage can be adequately treated by interim sewage treatment facilities, such as portable chemical toilets, which can be installed within the construction site.

Disturbance and Re-suspension of Seabed Sediments

5b.6.1.7 The proposed marine construction works will involve reclamation, construction of breakwaters and anti-scouring protection layer at the southwest coastline of SKC as shown in **Figure 5b.2**.

5b.6.1.8 The proposed construction method will adopt an approach where seawalls and breakwaters will first be formed to fully enclose the reclamation. Containment of fill within the reclamation area by seawalls and breakwater is proposed, with the seawalls and breakwaters constructed first (above high water mark) with filling carried out behind the completed seawalls and breakwater. Under this context, seawall and breakwater represents the same structure in the construction while differ only in their functionality. Breakwaters are built to protect the shore from erosion by wind and wave, thus are built so that they face outward to the rough sea. In contrast, seawall serves as an interface between the calm sea and the reclaimed land where coastline protection is not necessary. Seawalls are built facing sheltered sea where wave action is expected to be weak. In this sense, the coastline at the northeastern and northwestern side of the main reclaimed area should be classified as seawalls, while the rest of the coastline in the site acts as breakwaters. The opening that needs to be provided for marine access will be shielded by four layers of silt curtains to control sediment plume dispersion away from the site. The opening and closing of the silt curtain system would be controlled by the site staff of the contractor. Barges that need to pass the silt curtain would have to signify the control staff and wait until permission is granted. The silt curtains would be fixed at one end on the end of breakwater at marine access opening, while the movement of the other end would be controlled by appropriate vessels. The silt curtain system should be kept closed unless passage of vessels or barges is required. The silt curtain system should be closed as soon as the barges passes through the marine access opening in order to minimize the period of curtain opening. The vessels which control the opening of the silt curtain system would be anchored at the breakwater when the marine access opening is closed to ensure the silt curtain system could tightly shield the marine access opening. Filling should only be carried out behind the silt curtain when the silt curtain is completely closed. This approach was adopted by the approved Central Reclamation Phase III (CRIII) project as well as the approved EIA for WDII and CWB as effective measure to control the dispersion of filling material from the site. The application of silt curtain at marine access opening is indicatively shown in **Appendix 5.5-3**. The silt curtain at marine access opening would be fixed at one end of the end of the breakwater at the side of the SKC coastline whereas the movement of the other end at the side of the open sea would be controlled by appropriate vessel(s). As shown in **Table 5b.17**, the 90th percentile depth-average current velocity at the artificial island near SKC would be below 0.5 m/s for both dry and wet season. To further enhance the effect of silt curtain at the marine access opening, the northern breakwater would be constructed before the commencement of reclamation. The breakwater at northwestern side as well as seawall surrounding the reclamation area should effectively slow down the current flow across the marine access opening, allow effective control of sediment dispersion by the silt curtain. The silt curtain system should be regularly checked and maintained to ensure proper functioning. The marine access opening would be small (about 50 m wide, as shown in **Figure 5b.5**) and would be situated at the northwestern side of the reclamation area, away from any coral community at the southeastern shore of the SKC. As shown in **Figure 5b.5**, the northern breakwater should be sufficiently large to shield the current directed to the relatively small marine access opening. All dredging operation will be shielded by frame-type silt curtains to control sediment plume dispersion away from the site. Filling will be carried out behind the seawall and breakwater, which would be fully completed except for the 50 m gap for marine access. Therefore, the sediment plume can be effectively contained within the reclamation area. The seawall discharge for disposal of brine water generated from the desalination plant would be located near the sea surface. The seawall discharge may either be constructed by cutting a hole on the seawall or submerging a pre-fabricated pipe from the seawall into the sea surface. Neither of these construction methods would cause significant impact on water quality. No disturbance to the seabed sediment is expected.

5b.6.1.9 For minimizing the dredging and filling of the overall reclamation work, the seawall and breakwater at the perimeter of the reclaimed land is proposed to be in form of a cellular cofferdam which consists of circular cells connected together to form close working environment. The use of sheetpiling to aid construction has been adopted in recent approved EIAs including Hong Kong-Zhuhai-Macao Bridge EIA and the South Island Line (East) EIA. No significant water quality impact is expected in this EIA except negligible localized disturbance of bottom sediment. The disturbed sediment would be highly localized and would be settled shortly after. To confine any potential loss of fine during the piling work, floating-type silt curtain would be used to surround the circular cell during the piling works. Floating-type silt curtain would be applicable at the surrounding of the circular cells even at the closest location from the coral communities (which is about 6 m away from the boundary of the breakwater) as the minimum required clearance for application of floating-type silt curtain would be about 2 m. (This means the minimum distance between the silt curtain and the nearest coral communities would be 4 m.) The application of floating-type silt curtain surrounding the circular cell during sheetpiling process is indicatively shown in **Appendix 5.5-1**. Each circular cell is formed by interlocking straight-web steel piles and is filled with appropriate fill materials. The breakwater protecting the water basin is also proposed to be in form of this cellular sheet-piled structure. No pre-dredging would be required for the sheetpiling. All the filling work for construction of the breakwater and seawall will be enclosed by the sheet pile. Silt curtain would be applied at the surrounding of the circular cells during the filling of cell. Thus the loss of filling material during construction of seawalls and breakwaters is expected to be minimal, if not negligible. Details on the reclamation at the artificial island near SKC are provided in **Section 2**. The loss of fines during the installation of sheet pile and cofferdam would be minor. Thus, potential water quality impact of SS will mainly arise during the localized dredging for anti-scouring protection layer. To minimize the loss of fine during the dredging for anti-scouring protection layer, the dredging would be carried using closed grab dredger. Frame-type silt curtain would also be applied to surround the close grab during the dredging operation. The maximum extent of dredging required for the Project construction is shown in **Figure 5b.4**.

5b.6.1.10 To further minimize the environmental impacts, the overall reclamation works will be implemented in phases as shown in **Figure 5b.5** and **Plate 5b.4**. In phase one, the cofferdam section enclosing the reclamation area would be first constructed. In addition, the section of breakwater preventing the wave from striking the reclamation area directly from the northwest direction would also be constructed. Appropriate measures, such as application of silt curtain around the circular cell when filling, would be also applied to reduce the potential impacts on water quality. Afterwards, the reclamation can be started within the fully formed breakwater and seawall (Phase 2). Appropriate measures, such as silt curtain shielding the marine access opening, would be applied to reduce the potential impacts on water quality. In Phase 3, the remaining breakwater and berth will be constructed while the enclosed area within the cofferdam is being filled and surcharge loading of the reclaimed area is in progress. The detail work phasing at the northwestern seawall of the reclamation area is indicatively shown in **Appendix 5.5-3**. MSW treatment facilities and the associated supporting facilities will then start to be constructed after the surcharge loading. As described in **Section 2**, the construction of cofferdam would involve the piling of circular cell of metal sheet into the seabed. No dredging would be required for the installation of these circular cells. As the dredging and filling is bounded behind the sheet piles and cofferdams, it is not likely that suspended solid will be generated and enters the nearby water body. As discussed above, silt curtain would be applied to control the loss of filling material during the filling of circular cell as well as during reclamation. Thus significant loss of fine to the water column is not expected. Band drains may be required to remove excessive water from the reclaimed area. Any surcharge discharge from the band drains, which contains no extra pollutant except suspended fine, could be discharged into the sea via silt removal facilities. Details of the construction phasing are provided in **Section 2**.

5b.6.1.11 Whereas the installation of submarine cables will employ subsea burying machine to form narrow cable trench at sea bed up to 5 meter deep by water jetting and lay the submarine cable spontaneously. The trench will be backfilled at the same time with the sediments settling to the trench. The trench dimensions will be about 5 m depth x 3 m width. A short length of cable trench will be formed by open cut method using dredger for closing sections near shore ends. The whole submarine cable laying process would take about 20 working days to complete. The proposed cable alignment option is shown in **Figure 5b.3**.

5b.6.1.12 To prevent the tidal action from undermining the breakwaters, anti-scouring dredging would be required around the breakwaters and seawalls. A layer of sediment of about 1 m thick would be dredged and layer of rock and rubble would be laid to protect the seabed where the breakwaters stand. The reclamation, the localized dredging works for anti-scouring protection layer at SKC as well as the installation of submarine cables would disturb the bottom sediments (refer to **Section 5b.6.1.9**). As a result, fine sediment would be suspended into the water column, which may then be transported away from the works area by tidal currents to form sediment plumes. The quantities of fine sediment lost to suspension during reclamation and dredging will primarily depend on production rate. Impact from suspended solids may be caused by sediment plumes being transported to sensitive areas. Disturbance to the marine sediments may also cause the potential release of sediment-bound contaminants such as heavy metals and nutrients into the water column.

5b.6.2 Operation Phase

5b.6.2.1 Potential sources of water quality impacts generated from the operation of the Project include:

- Wastewater generated from the Waste Treatment Process;
- Sewage generated from floor & vehicle washing;
- Sewage generated from the IWMF staff & visitors;
- Transportation of bottom ash, fly ash and APC residues to WENT Landfill for disposal;
- Discharge of saline water from the proposed desalination plant; and
- Disturbance of seabed due to future maintenance dredging.

5b.6.2.2 Besides, change in coastline configuration as a result of the presence of the proposed breakwaters and reclamation could change of flow regime, water quality and sedimentation pattern in marine water. There will be no impacts to water quality from the operation of the proposed submarine cables.

<u>Wastewater Generated from the Waste Treatment Process</u>

5b.6.2.3 The IWMF Phase I will comprise a 3,000 tpd of moving grate incineration plant and a demonstration scale mechanical treatment plant of about 200 tpd capacity. Desalination plant may also be adopted as a water supply system in the IWMF. Wastewater will be generated from the mechanical treatment plant, the incineration plant and the desalination plant (if adopted) in the IWMF Phase I. No spent cooling water discharge is anticipated from the Project operation.

Mechanical Treatment Plant

5b.6.2.4 In the IWMF, "mechanical treatment + dewatering + post-composting" process is recommended for the mechanical treatment plant. A relatively small amount of wastewater will be generated from the treatment processes.

Incineration Plant

5b.6.2.5 Wastewater will also be generated from various processes throughout the incineration plant including:

5b.6.2.6 *Boiler* - The practice of continuously removing a small percentage of boiler feed water from the boiler to maintain boiler water chemistry is referred to as boiler blowdown. Although the boiler steam cycle is essentially a closed-loop system, impurities can build up in the boiler which, over time, cause scaling and corrosion of the boiler tubes. These effects eventually lead to boiler tube failure. To reduce such problems, continuous boiler blowdown is employed. The hot blowdown water is passed through a heat exchange to recover heat before becoming a source a plant wastewater. The blowdown water is replaced with contaminant-free feed water make-up.

5b.6.2.7 *Evaporative Quench Tower* - If the incineration plant adopts an evaporative quench tower, a fraction of the water from the cooling system loop is continuously blown down as in the boiler system. Since a considerable amount of the cooling water is lost through evaporation in the cooling tower, high concentrations of impurities would develop in the cooling water if blowdown was not used.

5b.6.2.8 *Boiler Feedwater Treatment System* - The purpose of the boiler feedwater treatment system is to provide demineralized water for boiler make-up. Demineralized water is needed in the boiler to prevent scaling and corrosion due to mineral deposits. The treatment system typically involves filtering the feed water to remove suspended solids, and removing metals and minerals in a de-mineralizer. The de-mineralizer contains cation and anion exchangers are periodically regenerated using sulfuric acid and caustic soda respectively. Oxygen is removed from the demineralized water using a deaerator. Processed demineralized water is then stored in tanks and drawn off as needed for boiler feeder water, cooling water and other processes. The operation of the various filters, ion exchangers and deaerators requires periodic back flushing of the system to remove the collected contaminants from the treatment system. This process wastewater is then stored in a neutralization tank where appropriate amounts of acid or caustic are add to adjust the pH.

5b.6.2.9 *MSW Bunker Leachate / Ash Leachate* - Includes free water that drains from the MSW or ash. This wastewater is typically collected using floor drains and stored in sumps.

5b.6.2.10 *Miscellaneous Blowdown Sources* - Other processes that use process water can be minor sources of process water blowdown, these may include water cooled feed chutes, water cooled bearings, cooling water jacketing etc.

<u>Sewage Generated from Floor & Vehicle Washing</u>

5b.6.2.11 Approximately 31m^3 of sewage would be generated daily during floor washing and vehicle washing in the IWMF. As the sewage would contain contaminants from MSW, treatment of the sewage will be required before disposal or reuse for other applications.

<u>Sewage Generated from the IWMF Staff & Visitors</u>

5b.6.2.12 The sewage generated from human activities in the IWMF would include the sewage from the IWMF staff and visitors, as well as the sewage generated from the canteen, and community facilities. It is estimated that approximate 96.25 m^3/d sewage would be generated from the IWMF staff and visitors and the associated activities, as shown in **Table 5b.5**.

Table 5b.5 Estimated Amount of Sewage Generated from the IWMF Staff & Visitors and the Associated Activities

Items	No. of Employee or Visitor	Unit Flow Factor (1) (m^3/d/person)	Flow (m^3/d)
Staff and Visitors			
Staff of incineration plant and MT plant	200	0.08	16.00
Staff of canteen	25	1.50	37.50
Staff of Community facilities	20	0.35	7.00
Visitors	450	0.06	27.00
		Sub-total	87.50
		10% Contingency	8.75
		Total	**96.25**

Note (1): The unit flow factors adopted to estimate the sewage flow generated from the staff and visitors in the IWMF are primarily based on the guidelines laid down in EPD's Guidelines for Estimating Sewage Flows for Sewage Infrastructure Planning Version 1.0 (GESF).

<u>Reuse and Treatment of Wastewater Generated from Waste Treatment Process and Sewage from Floor & Vehicle Washing and the IWMF Staff & Visitors</u>

5b.6.2.13 **Table 5b.6** shows the estimated quantity and possible characteristic of wastewater generated from treatment process and sewage from floor & vehicle washing and the IWMF staff & visitors.

Table 5b.6 Estimated Quantity and Possible Characteristics of Wastewater Generated from Treatment Process and Sewage from Floor & Vehicle Washing and the IWMF Staff & Visitors

		Flow (m^3/d)	pH	BOD (mg/L)	COD (mg/L)	SS (mg/L)	Temp. (℃)	Chloride (mg/L)
Incineration Plant	Miscellaneous Blowdown Sources	1	6-8	50	30	50	20	
	Boiler Feedwater Treatment System (Demineralizer Drain)	30	9-11	-	-	20	20	3,000
	Pump Leak Water	10	6-8	-	-	50	20	50
	Boiler and Evaporative Quench Tower (Boiler Blow Drain)	80	10-12	-	-	50	50	50
Mechanical Treatment Plant Drain		5	6.5 - 9	6,000 – 8,500	20,000 - 25,000	9,000 - 10,000	-	-

		Flow (m^3/d)	pH	BOD (mg/L)	COD (mg/L)	SS (mg/L)	Temp. (℃)	Chloride (mg/L)
Sewage from Floor and Vehicle Washing	Floor Washed Drain	1	7-9	50	30	500	20	100
	Vehicle Washed Drain	30	6-8	300	200	500	20	100
Sewage from the IWMF Staff & Visitors		88	6-8	250	520	250	20	-

5b.6.2.14 Generally, wastewater shown in **Table 5b.6** can be categorized into two types including high organic loading wastewater and low/nil organic loading wastewater. High organic loading wastewater, such as sewage from floor & vehicle washing and the IWMF staff & visitors, will be treated by secondary wastewater treatment plant provided on-site to remove the organic pollutants for reuse on-site (see **Section 5b.6.2.15** below). The bunker leachate / ash leachate from incineration plant (as described in **Section 5b.6.2.9**) would be highly polluted and would be conveyed to the incineration plant and co-incinerated with MSW and is therefore not included in **Table 5b.6**. On the other hand, low/nil organic loading wastewater, mainly coming from plant machinery such as dimineralizer drain, contains only trace amount of or no organic pollutants. It only requires simple treatment such as sedimentation or neutralization or even not requires any treatment before being used for flue gas cooling in quench tower or ash quenching. As the artificial island near SKC would be built on reclaimed land in rural area, it is envisioned that the IWMF Phase I would be designed with a net zero discharge of process and sanitary wastewater.

5b.6.2.15 A wastewater treatment plant would be provided on-site to provide treatment to some wastewater generated from the IWMF (such as sewage from the IWMF staff & visitors) for reuse in the incineration plant and the mechanical treatment plant or for washdown and landscape irrigation in the IWMF site following the effluent qualities shown below. The following recommended effluent qualities for reuse purposes are based on the "*Guidelines for Water Reuse*" published by the USEPA.

- pH : 6 – 8
- BOD : 10 mg/L
- Turbidity : 2 NTU
- Total Coliform/100 mL : non-detectable
- Cl_2 residual : 1 mg/L

5b.6.2.16 Because of the compacted area in SKC, membrane bioreactor (MBR), which requires small footprint, is proposed for the IWMF for mainly human sewage treatment. Based on the above effluent standards and wastewater characteristics and quantity shown in **Table 5b.6**, the wastewater treatment facilities enclosed by the reinforced concrete structure under the reception hall of the incineration plant would occupy an area of about 2,000m^2.

<u>Desalination Plant</u>

5b.6.2.17 If desalination plant is adopted as a water supply system in the IWMF, the brine water generated would be either discharged back to the sea where the seawater is collected for desalination or reused for ash quenching. The brine water drained from the desalination plant is concentrated seawater (about 1.7-1.8 time more concentrated than the raw seawater). The design flow of the desalination plant, if required will be about 1,520 m^3 per day. The potential water quality impacts due to the discharge of saline water have been assessed by mathematical modelling as described in **Section 5b.7**.

Maintenance Dredging

5b.6.2.18 Maintenance dredging maybe required to provide sufficient clearance between the boat and the seabed for safe marine traffic within the marine embayment. Currently, there is no plan for regular maintenance dredging. The need of maintenance dredging would depend on the exact sedimentation and scouring condition after the completion of the Project. Assessment on the water quality impact has been described in **Section 5b.7**.

5b.7 Prediction and Evaluation of Environmental Impacts

5b.7.1 Land-based Construction Phase Impact

Drainage and Construction Site Runoff

5b.7.1.1 Runoff from the construction works area may contain increased loads of sediments, other suspended solids and contaminants. As a good site practice, mitigation measures should be implemented to control construction site runoff and drainage from the works areas, and to prevent runoff and drainage water with high levels of suspended solids from entering the nearby water bodies. It is estimated that the volume of runoff generated on site would be about 1500 m^3/day. With the implementation of adequate construction site drainage and provision of sediment removal facilities as described in **Section 5b.8.1.1**, it is anticipated that unacceptable water quality impacts would not arise. The construction site drainage would be collected by the temporary drainage system installed by the Contractor and then treated on-site before discharging into the sea via silt removal facilities. Water pumped out from foundation piling would also be discharged into the sea via silt removal facilities. The Contractor would be required to obtain a license from EPD for discharge to the coastal waters.

General Construction Activities

5b.7.1.2 Land-based construction activities may generate wastewater and cause water pollution. Their impacts are likely to be minimal, provided that good construction practices and proper site management would be observed. Effluent discharge from temporary site facilities should be controlled to prevent direct discharge to the neighbouring water environment. It is anticipated that water quality impacts caused by general construction activities would be insignificant with adequate implementation of recommended mitigation measures as described in **Sections 5b.8.1.2** and **5b.8.1.3**.

Accidental Spillage

5b.7.1.3 Site drainage should be well maintained and good construction practices should be observed to ensure that oil, fuels and solvents are managed, stored and handled properly and do not enter the nearby water streams. No adverse water quality impacts are expected with proper implementation of the recommended mitigation measures (refer to **Sections 5b.8.1.4 to 5b.8.1.7**).

Sewage Effluent

5b.7.1.4 Domestic sewage would be generated from the workforce during the construction phase. However, this sewage can be adequately treated by interim sewage treatment facilities, such as portable chemical toilets, which can be installed within the construction site. It is unlikely that sewage generated from the site would have a significant water quality impact, provided that sewage is not discharged directly to the water environment, and chemical toilets are used and properly maintained.

5b.7.2 Construction Phase Impact from Cofferdam Construction

5b.7.2.1 The cofferdam construction would be adopted for construction of breakwater under this Project. The cofferdam construction would involve piling as well as material filling. Water quality impact may arise during the piling works as well as the filling of circular cells. With reference to the recent EIAs such as Hong Kong-Zhuhai-Macao Bridge EIA and South Island Line (East) EIA, no significant water quality impact is expected for sheetpiling in these 2 EIAs except localized disturbance on the bottom sediment. To confine any potential loss of fine during the piling work, floating-type silt curtain would be used to surround the working area during the piling works. As shown in **Appendix 5.5-1**, the nearest non-translocatable coral community would be around 6 m from the boundary of breakwater, As the necessary clearance for application of silt curtain is around 2 m, application of silt curtain surrounding the circular cell during the sheetpiling would be feasible. The application of floating type silt curtain during the sheetpiling is indicatively shown in **Appendix 5.5-1**. Public fill would be used for filling of the circular cells. The loss of fine during the filling of circular cells would be minimal as the filling would be carried out within completed sheetpile cell, which would be further surrounded by silt curtain. The application of floating type silt curtain during the filling of circular cell is indicatively shown in **Appendix 5.5-2**. Water trapped inside the cofferdam, if any, would be pumped out for treatment before discharge. It is expected that the water quality impact due to the cofferdam construction would be minimal.

5b.7.3 Construction Phase Impact from Loss of Filling Material from the Reclamation Area and Localized Dredging for Anti-Scouring Protection Layer

Ambient and Tolerance Values

5b.7.3.1 The sediment plumes passing over a sensitive receiver will cause the ambient suspended solids concentrations to be elevated. The level of elevation will determine whether the impact is adverse. The determination of the acceptability of elevations in suspended solids (SS) concentrations is based on the Water Quality Objectives (WQO). The WQO for SS is defined as being an allowable elevation of 30% above the background. It is proposed to represent the ambient SS value by the 90th percentile of SS concentrations measured under the EPD routine marine water quality monitoring programme at the stations (namely SM12 and SM13) nearest to the WSRs that would be potentially affected by the localized dredging / filling works (including the horseshoe crab at northern SKC, over 700 coral communities at southwest SKC, the gazetted beaches at southern Lantau Island and east Cheung Chau as well as the fish culture zone at Cheung Sha Wan on the eastern coastline of Lantau Island) as shown in **Figure 5b.1**. The relevant EPD data and allowable elevations in suspended sediment concentration are summarized in **Table 5b.7**. The 90th percentile SS values presented in **Table 5b.7** were calculated based on the EPD monitoring data collected in the period from 2007 to 2010.

Table 5b.7 Ambient and Tolerance Values for Suspended Solids Concentrations in the Vicinity of Sensitive Receivers

Sensitive Receiver (Relevant EPD Monitoring Station)	Dry Season		Wet Season	
	90th Percentile	30% Tolerance	90th Percentile	30% Tolerance
Horseshoe Crab at northern SKC, Coral Communities at Southwest Coastline of SKC, Gazetted beaches at southern Lantau Island (SM13)	16.3 mg/L	4.9 mg/L	8.2 mg/L	2.5 mg/L
Gazetted beaches at east Cheung Chau and Cheung Sha Wan fish culture zone (SM12)	20.9 mg/L	6.3 mg/L	11.6 mg/L	3.5 mg/L

5b.7.3.2 The allowable elevation in SS concentration as defined by the WQO for a particular site corresponds to the 30% tolerance level. The calculated maximum SS concentrations from the filling and dredging have been compared with the 30% tolerance values in the above table to determine the acceptability of the impacts. To represent the long term environmental baseline for suspended solid near the Project site, the SS tolerant values are calculated from data of 2007 to 2010. The use of the data from 2007 to 2010 would be conservative as the minimum tolerant values calculated (2.5 mg/L) would be lower than the value calculated from all data since 1999 (3.1 mg/L).

Discussion of the Potential Sediment Plume Impacts

5b.7.3.3 The potential site at SKC is located in the open water in the southern waters of Hong Kong. As shown in the marine chart (see **Plate 5b.1** below), the potential site is located in the deeper water of the Southern WCZ where the water depths in the vicinity are over 10 m. Any sediment plume generated at the Project site would be transported along the tidal currents. During ebb tides, the plume would be dispersed by the currents which flow from Siu A Chau North in the west to the southeast and eventually into the deep South China sea. During flood tides, any sediment plume generated at the Project site would be dispersed by the offshore oceanic waters flowing from the southeast to the west.

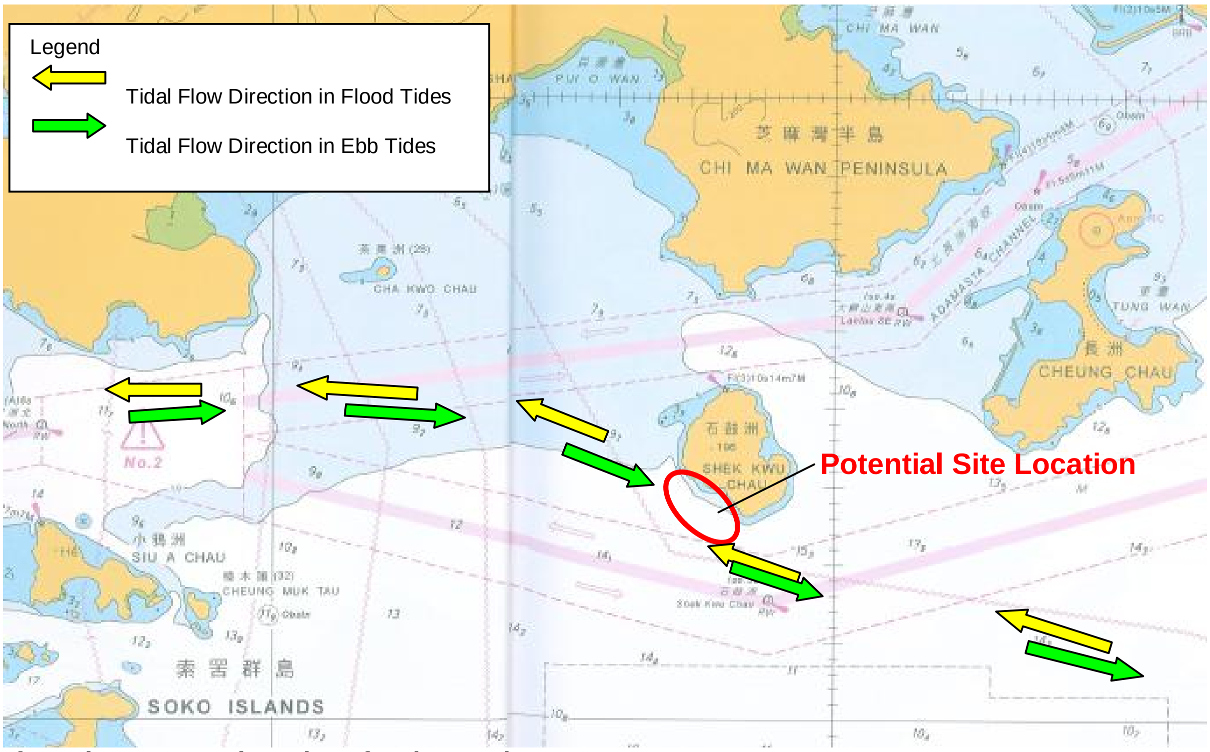


Plate 5b.1 Marine Chart for the Study Area

5b.7.3.4 The WSRs closest to the proposed filling and dredging works at SKC include the horseshoe crab at northern SKC, coral communities at southwestern SKC, the gazetted beaches at southern Lantau Island and east Cheung Chau as well as the fish culture zone at Cheung Sha Wan on the eastern coastline of Lantau Island (as shown in **Figure 5b.1**). Besides the coral communities identified at the southwest coastline of SKC, all the other WSRs are considered to have a low potential to be significantly influenced by the dredging work as these WSRs are not located along the key transportation paths of any sediment plume formed during the dredging work at SKC. The typical flow patterns around the Study Area, which is obtained from the Delft3D Regional Update model developed under Agreement No. CE42/97, are shown in **Plate 5b.2** and **Plate 5b.3** below. The arrows shown in **Plate 5b.2** and **Plate 5b.3** represent the water flow directions during typical ebb and flood tide respectively.

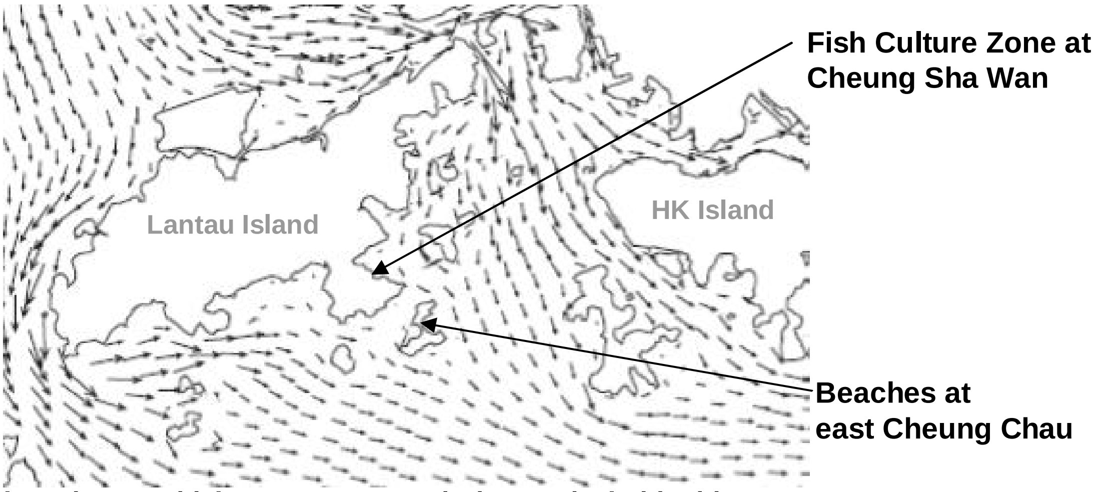


Plate 5b.2 Tidal Current Pattern during Typical Ebb Tide

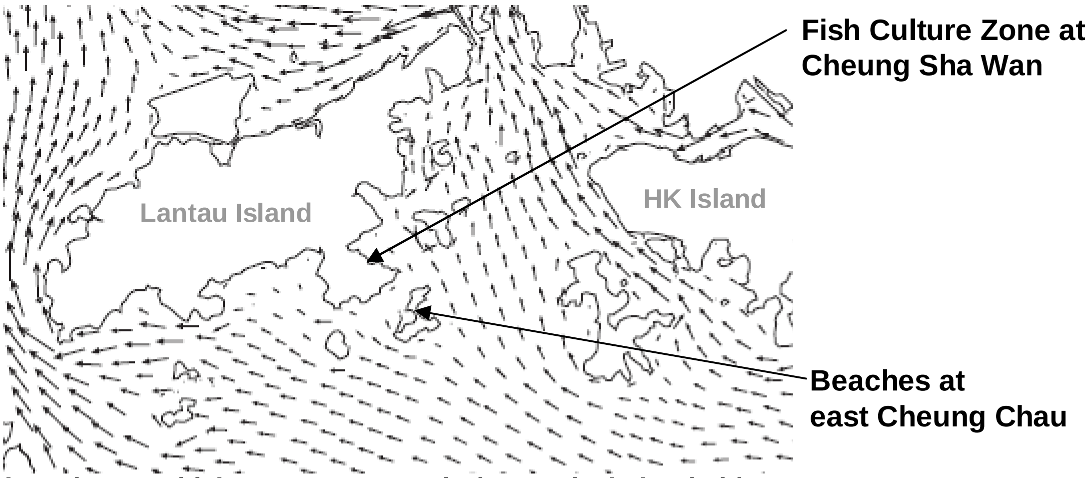


Plate 5b.3 Tidal Current Pattern during Typical Flood Tide

5b.7.3.5 As shown in **Plate 5b.2** and **Plate 5b.3**, the fish culture zone at Cheung Sha Wan and the gazetted beaches at east Cheung Chau are largely influenced by the tidal flow discharged from the Kap Shui Mun near Ma Wan during ebb tides as well as by the offshore waters from the open South Sea during flood tides. Hence, these WSRs are expected to have no major influence from the proposed dredging works at SKC.

<u>Near Field Sediment Dispersion Modelling</u>

5b.7.3.6 The method of calculation of the near field concentrations of suspended sediment plumes is the same as that used in the approved EIA study for Outlying Islands Sewerage Stage 1, Phase II Package J – Sok Kwu Wan Sewage Collection, Treatment & Disposal Facilities [(1)]. In this method, a simple model is used to calculate the depth averaged suspended sediment concentrations along the centreline of a plume by solving the advection-diffusion equation for a continuous line source [(2)]. This model is considered appropriate for the calculation of suspended sediment concentrations from the proposed dredging / filling work because the equation is based on a continuous line source of sediment, which is a reasonable approximation of the loss of sediment due to suspension during grab dredging / filling. It is appropriate for areas where the tidal current is uni-directional for each phase of the tidal cycle (i.e. the ebb and flood phases), which is the case at SKC where the tidal current is also uni-directional for each phase of the tidal cycle.

(1) Maunsell Consultants Asia Limited (2003)
(2) R E Wilson, A Model for the Estimation of the Concentrations and Spatial Extent of Suspended Sediment Plumes. Estuarine and Marine Coastal Science (1979), Vol 9, pp 65-78

This method is applicable for suspended sediment plumes of length no greater than the maximum tidal excursion. The sediment plume generated from the proposed dredging / filling work at SKC would be transported along the tidal flow around the southwest coastline of SKC which generally runs from the southeast to the west and from the west to the southeast during flood and ebb tides respectively. The maximum depth-averaged tidal current speeds around SKC could be up to 0.42 m/s and a representative period for each phase of the tidal cycle in Hong Kong is 6 hours. The tidal excursion may be calculated according to the following equation:

Tidal Excursion = Maximum Tidal Current Speed * Period * 2 / π

5b.7.3.7 The tidal excursion is thus calculated to be approximately 5.7 km. Hence the proposed assessment approach is considered appropriate for the dredging / filling works at SKC because of the low rate of dredging / filling and thus the expected limited extent of the plumes, which will certainly be within the tidal excursion. The formula which is used is as follows:

$$C(x) = \frac{q}{(D \times x \times \omega \times \sqrt{\pi})}$$

where **C(x)** = concentration at distance x from the source;
q = sediment loss rate (0.65kg/s);
D = water depth (10 m);
x = distance from source;
ω = diffusion velocity (0.01 m/s).

5b.7.3.8 Any sediment plume generated from the proposed dredging / filling works at SKC would be transported by the tidal flow around the SKC. The representative water depth at the reclamation area of the artificial island near SKC would be over 10 m. In the calculation of suspended sediment concentrations, a depth of 10 m near the SKC has been selected to give a worst case assessment as concentration is inversely proportional to depth. The value for diffusion velocity is the same as that which was used in the previous approved study for the near field assessment of sediment plumes from the construction of the submarine outfall of Sok Kwu Wan Sewerage Treatment Works. The diffusion velocity represents reductions in the centre-line concentrations due to lateral spreading.

5b.7.3.9 The use of the above equation is limited to situations where the value of γ, as defined by the following equation, is small and where ω / u is also small.

γ = W * t / D

where **W** = settling velocity of suspended sediment;
t = time;
D = water depth (10 m).

5b.7.3.10 The sediments suspended by the dredging / filling operations may be split into a fine fraction and a coarse fraction. The fine fraction is assumed to remain in suspension indefinitely, which is based on the fact that the settling velocity for the sediment particles according to Stokes Law is offset by local turbulence. The value of settling velocity, **W**, for the coarse fraction of the sediment (based on the Stokes Law) would depend on the sediment particle size. The value for **t** will be taken to be half of the tidal period, which may be taken to be the time between the ebb and flood phases of the tidal cycle. In Hong Kong this is the greatest for the ebb phase of a spring tide where the time from high water to low water could be up to 8 hours. The value of **γ** is therefore subject to the sediment particle size. In case the diameter of the coarse fraction of the sediment is small and the calculated value of **γ** is also small, the sediment plume dispersion formula as described above would be considered valid to provide a reasonable estimation of the extent of the sediment dispersion plume. However, if the diameter of the coarse fraction of the sediment is large and the calculated value of **γ** is also large, the formula would tend to give an overestimation of the extent of the sediment plume and hence, a conservative prediction would be provided (which is also considered acceptable for the purpose of this EIA).

5b.7.3.11 The average current speed in the vicinity of the artificial island near SKC is conservatively taken to be 0.1 m/s, the value of ω / u (where ω is the diffusion velocity and u is the current speed) is calculated to be 0.1, which is considered to be small and the use of the sediment plume dispersion formula is considered valid.

Prediction and Evaluation of Impacts from Filling for the Reclamation Area

Consideration of Mitigation Measures and Sediment Loss Rate

5b.7.3.12 The filling of reclamation area will be conducted at a production rate of 7,000 m^3 per day under unmitigated scenario. Filling would be carried out after the seawall surrounding the reclamation area is formed. A marine access opening would be left to allow barges to enter the reclamation area by sea. The fine portion of the filling material may potentially disperse out of the reclamation site from the marine access opening. Filling will be carried out for 12 hours per day (6 days per week). Four layers of silt curtains would be deployed at the marine access opening to control the dispersion of filling material from the reclamation area. The phasing and deployment of silt curtains at the marine access opening is indicative shown in **Appendix 5.5-3** and **Appendix 5.5-4**. The sediment loss rate was calculated based on the following assumptions:

5b.7.3.13 Based on the approved EIA for *"Further Development of Tseung Kwan O Feasibility Study*" as well as "*Tuen Mun – Chek Lap Kok Link - Investigation*", the loss rate during sand filling would be about 5% of fine content from the filling material. The fine content of sand is assumed to be 5% of the bulk under the above 2 studies. Since the filling material used under this Project would be consisted of rock, sand and public fill, the fine content of the composite filling material could not be simply determined. As the fine content for the rock (negligible fine content) and sand (about 5% fine content [(3)]) is expected to be lower than that of public fill (25% fine content [(4)]), it would be conservative to assume the filling material to be consisted of entirely public fill. It is assumed under this assessment that 5% of the fine content in the public fill would be lost during the filing operation, which is based on the assumption adopted under the approved EIA for "*Hong Kong - Zhuhai - Macao Bridge Hong Kong Boundary Crossing Facilities*". The density of public fill adopted under this assessment is 1,900 kg/m^3, which is the same as the value adopted under the above approved "*Tuen Mun – Chek Lap Kok Link - Investigation*" EIA. Thus the resultant loss of the filling material during the reclamation works would be 3.85 kg/s under unmitigated scenario.

5b.7.3.14 According to a field trial taken under the VEP-296/2009 "*Central Reclamation Phase III (CRIII) - Water Quality Assessment on the Use of Type A Fill in Final Reclamation Area East*", the efficiency of application of double silt curtains at the marine access opening of the reclamation area was found to about 86%. The value of 80% is adopted for the mitigation measure under this assessment to estimate the extent of sediment plume due to the reclamation works for conservative reason.

5b.7.3.15 The current speeds around the Project site are less than 0.5 m/s where deployment of silt curtain at the marine access opening is considered practical. The silt removal efficiency of 80% is considered applicable under the mitigated filling scenario with the application silt curtain systems at the marine access opening.

(3) Further Development of Tseung Kwan O Feasibility Study (2005) and Tuen Mun – Chek Lap Kok Link – Investigation (2009)
(4) General Specification of Civil Engineering Works (CED, 2002)

Model Results

5b.7.3.16 The results of the calculation of suspended solid concentrations under unmitigated filling scenario are given in **Table 5b.8**.

Table 5b.8 Calculated Suspended Sediment Elevation under Unmitigated Filling Scenario

Distance from Source (m)	Suspended Sediment Concentration (mg/L)
50	434.2
100	217.1
200	108.6
250	86.8
300	72.4
400	54.3
500	43.4
600	36.2
700	31.0
800	27.1
900	24.1

Note: The assessment result is calculated based on the following assumptions:

1. the filling material would be consisted of 100% public fill;
2. the fine content for public fill is assumed to be 25% and 5% of the fine content would be loss to the water column during the filling process. The density of public fill is assumed to be 1900 kg/m^3;
3. no silt curtain would be applied at the marine access opening.

Coral Communities

5b.7.3.17 As shown in **Table 5b.8**, the level of SS elevation due to the reclamation filling at the closest coral community (minimum distance from the dredging boundary to the nearest non-translocatable coral community is 250 m) would reach 86.8 mg/L under unmitigated scenario, which would be above the relevant assessment criteria.

5b.7.3.18 Moving the artificial island near SKC further south (to reduce the level of impact from the proposed marine works) was considered not feasible due to marine safety reason as explained in **Section 2**. For mitigating the impact on SS elevation on coral, it is proposed that a silt curtains system should be applied at the marine access opening to control the dispersion of filling material. As discussed in **Section 5b.7.3.14**, the assumed silt removal efficiency for silt curtains system at marine access opening adopted under this assessment is 80%. During the initial period of reclamation, this silt-removal efficiency of the silt curtains system at marine access opening 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 detailed methodology for the field trial of silt curtain system at marine access opening for verification of the silt removal efficiency should be submitted to EPD for approval prior to the trial. 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.

5b.7.3.19 To further reduce the elevation in SS due to the reclamation filling, the use of public fill for any filling works below +2.5 mPD (ie below high watermark) should be limited as the fine content in public fill would generally be higher than that of sand and rock. The proposed composition of the filling material used for reclamation filling at different locations is summarized in **Table 5b.9**. It is proposed that the use of public fill below +2.5 mPD should be controlled at maximum 300 m^3/day (which contribute to a loss rate of 0.03 kg/s) for Area A (reclamation area between 250m and 400m away from the nearest coral community). The rest of the filling material should be consisted of at most 4000 m^3/day of sand (which contribute to a loss rate of 0.07 kg/s) and at least 2700 m^3/day of rock (which does not contribute to any loss of fine) for Area A. For Area B, the corresponding maximum filling rate would be limited to 1,000 m^3/day (which contribute to a loss rate of 0.11 kg/s) and 3,300 m^3/day (which contribute to a loss rate of 0.06 kg/s) for public fill and sand fill respectively, while filling rate for rock fill would remained at 2,700 m^3/day. For filling of the reclamation are after the closure of the marine access opening, it is assumed that the loss of fine would be completely contained and would not contribute to any elevation in suspended solid outside the reclamation area. The filling material in such case would consist entirely of public fill and the filling rate would be up to 7,000 m^3/day. The proposed composition for filling at various reclamation areas is summarized in **Table 5b.9**. The following **Plate 5b.4** shows the delineation of Area A and B within the reclamation. The results of the calculation of suspended sediment concentrations for reclamation filling at Area A and B under mitigated scenario are given in **0**.

Plate 5b.4 Different Filling Zones and Distance from nearest Coral Communities

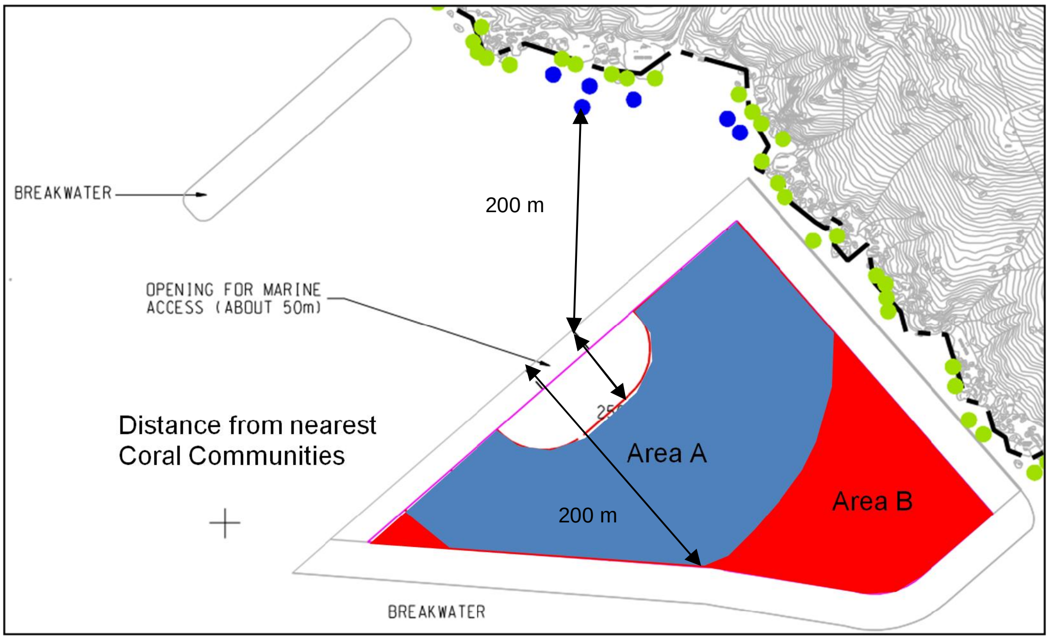


Table 5b.9 Proposed Composition of Filling Material used for Filling at Different Locations

Area	Area Code	Filling Rate (m^3/d)		
		Public Fill	Sand	Rock
Reclamation area between 250m and 400m away from the nearest coral community (or between 50m and 200m away from opening for marine access) (see **Plate 5b.4**)	A	300	4,000	2,700
Reclamation area more than 400m away from the nearest coral community (or more than 200 away from opening for marine access) (see **Plate 5b.4**)	B	1,000	3,300	2,700
Filling of the reclamation area which has been completely confined by cellular cofferdam (i.e. the opening for marine access has been closed)	-	7,000	0	0

Table 5b.10 Calculated Suspended Sediment Elevation under Mitigated Filling Scenario

Distance from Source (m)	Suspended Sediment Concentration contributed from: (mg/L)			
	Public Fill	**Sand**	**Rock**	**Total**
For Area A	300 m^3/day	4000 m^3/day	2700 m^3/day	7000 m^3/day
50	8.4	3.7	0.0	12.1
100	4.2	1.9	0.0	6.0
200	2.1	0.9	0.0	3.0
242	1.7	0.8	0.0	2.5
250	1.7	0.7	0.0	2.4
300	1.4	0.6	0.0	2.0
400	1.0	0.5	0.0	1.5
500	0.8	0.4	0.0	1.2
600	0.7	0.3	0.0	1.0
700	0.6	0.3	0.0	0.9
800	0.5	0.2	0.0	0.8
900	0.5	0.2	0.0	0.7
For Area B	1,000 m^3/day	3,300 m^3/day	2,700 m^3/day	7000 m^3/day
50	6.9	12.4	0.0	19.3
100	3.4	6.2	0.0	9.7
200	1.7	3.1	0.0	4.8
250	1.4	2.5	0.0	3.9
300	1.1	2.1	0.0	3.2
400	0.9	1.6	0.0	2.4
500	0.7	1.2	0.0	1.9
600	0.6	1.0	0.0	1.6
700	0.5	0.9	0.0	1.4
800	0.4	0.8	0.0	1.2
900	0.4	0.7	0.0	1.1

Note: The assessment result is calculated based on the following assumptions:

1. the filling material would be composed of public fill, sand and rock in the amount stated in the table;
2. the fine content for public fill is assumed to be 25% and 5% of the fine content would be loss to the water column during the filling process. The density of public fill is assumed to be 1900 kg/m^3;
3. the fine content for sand is assumed to be 5% and 5% of the fine content would be loss to the water column during the filling process. The density of sand is assumed to be 1600 kg/m^3;
4. the filling of rock do not contribute to any loss of fine during the filling process;
5. silt curtain would be applied at the marine access opening and its silt removal efficiency would be 80%.

5b.7.3.20 As shown in **Table 5b.10**, the predicted maximum SS elevation at 250 m from the nearest filling operation at Area A (before fully enclosed by seawall, see **Figure 5b.9**) would be 2.4 mg/L, which complied with the SS criterion of elevation from 30% of the ambient SS. Indeed, the predicted SS elevation would already comply with the assessment criteria at 242 m away from the nearest filling operation, as shown in **Figure 5b.9**. Since the maximum SS elevation is calculated from the shortest distance (250 m) from the nearest coral community, the distance from the nearest filling operation to the nearest coral community should be higher than 250 m for most of the time. Similarly, the maximum SS elevation due to filling at Area B is predicted to be under 2.4 mg/L at the nearest coral community, which is at least 400 m away. Therefore the SS elevation due to the filling operation should be much lower than the predicted level for most of the time. Please note that the above assessment only limits the use of filling material for reclamation filling below +2.5 mPD; the use of filling material above +2.5 mPD is not restricted as no loss of fine to water column is expected from filling above high watermark.

5b.7.3.21 To ensure the actual efficiency of the silt curtains system would be at least as high as the level assumed in the assessment, a field trial should be carried out at the early stage of the reclamation to determine the silt removal efficiency of the silt curtains system (with total four layers of silt curtains). The silt curtain at the marine access opening is indicatively illustrated at **Appendix 5.5-3** and **Appendix 5.5-4**. The details for the field trial are provided in the EM&A manual.

Prediction and Evaluation of Impacts from Localized Dredging for Anti-Scouring Protection Layer

Consideration of Mitigation Measures and Sediment Loss Rate

5b.7.3.22 The localized dredging works for anti-scouring protection layer for seawalls and breakwaters at SKC will be conducted at a production rate of 4,000 m^3 per day under unmitigated scenario. Dredging will be carried out by a single closed grab dredger for 12 hours per day (6 days per week). Deployment of frame-type silt curtains around the closed grab dredgers is also recommended for the dredging works. The sediment loss rate was calculated based on the following assumptions:

5b.7.3.23 Based on the approved EIA for *"Construction of an International Theme Park in Penny's Bay of North Lantau together with its Essential Associated Infrastructures* (Theme Park)", the sediment loss rate from grab dredging in areas with significant amount of debris or big boulders on the seabed would be 25 kg/m^3 dredged, whilst the loss rate in areas where debris is less likely to hinder operations would be 17 kg/m^3 dredged. Dredging in the Project site is unlikely to encounter significant amount of debris or big boulder as confirmed by the recent marine dive survey. According to the EIA for "Hebe Haven Yacht Club Development – Phase 2" (**Table 5.2**), the sediment loss per cubic metre dredged by closed grab would be 11 kg/m^3 , 14 kg/m^3 and 20 kg/m^3 for large, medium and small grab size respectively. The grab to be used for this project (2 m^3) is likely to fall into the category of medium to small. A loss rate of 20 kg/m^3 dredged is assumed for conservative reason.

5b.7.3.24 According to the Contaminated Spoil Management Study, the implementation of silt curtain around the closed grab dredgers will further reduce the dispersion of SS by a factor of 4 (or about 75%).

5b.7.3.25 The current speeds around the Project site are less than 0.5 m/s [(5)] where deployment of silt curtain is considered practical. The calculated sediment loss rate would be about 0.46 kg/s after deploying the silt curtain around the works area.

Model Result

5b.7.3.26 The results of the calculation of suspended sediment concentrations are given in **Table 5b.11**.

Table 5b.11 Calculated Suspended Sediment Elevation under Unmitigated Dredging Scenario (Silt Curtain Implemented)

Distance from Source (m)	Suspended Sediment Concentration (mg/L)
15	174
50	52.2
100	26.1
200	13.1
300	8.7
400	6.5

(5) Based on the model results predicted by the regional Update Model developed under Agreement No. CE 42/97, Update on Cumulative Water Quality and Hydrological Effect of Coastal Developments and Upgrading of Assessment Tool

Distance from Source (m)	Suspended Sediment Concentration (mg/L)
500	5.2
600	4.4
700	3.7
800	3.3
900	2.9

Coral Communities

5b.7.3.27 As shown in **Table 5b.11**, the level of SS elevation due to the dredging operation at the closest coral community (minimum distance from the dredging boundary to the nearest non-translocatable coral community is >15 m) would reach 174 mg/L under unmitigated scenario, which would be above the relevant assessment criteria.

5b.7.3.28 For mitigating the impact on SS elevation on coral, no dredging operation would be carried out within 100 m from the nearest coral communities. The anti-scouring protection layer would be constructed without dredging near the coral communities. As discussed in **section 5b.7.3.24**, frame-type silt curtain would be applied to enclose the grab during the dredging operation to reduce the loss of fine to the water column. The deployment of frame-type silt curtain at grab for anti-scouring protection layer dredging is indicative shown in **Appendix 5.5-5**. To further mitigate the impact on the SS elevation on coral, it is proposed to reduce the dredging rate for anti-scouring protection to the suggested level specified in **Table 5b.12** and **Figure 5b.4**.

Table 5b.12 Calculated Suspended Sediment Elevation under Mitigated Dredging Scenario (Silt Curtain Implemented and Dredging Rate Reduces)

Distance from the Nearest Coral (m)	Maximum Allowable Production Rate (m^3/day)	Maximum SS Elevation (mg/L)
Above 100	380	2.5

5b.7.3.29 **Table 5b.13** below summarizes the recommended dredging rate for this Project. The permitted number of grab per hour is also shown in **Table 5b.13**, which should be specified in the construction contract for this Project to be followed by the dredging contractor. It is recommended to employ closed grab with small capacity of 2 m^3 to control the dredging rate. Daily site audit including full-time on-site monitoring by the ET is recommended during the dredging for anti-scouring layer protection for checking the compliance with the permitted no. of grab to be performed per hour by the dredging contractor as specified in **Table 5b.13**.

Table 5b.13 Recommended Maximum Dredging Rate and Permitted Number of Grab Per Hour

Distance from the Nearest Coral (m)	Recommended Dredging Rate (m^3 per day)	Permitted No. of Grab per Hour Using Grab Size of Approx. $2m^3$
Above 100	380	No more than 15

5b.7.3.30 As shown in **Table 5b.12**, after the reduction of dredging rate, the resulted maximum SS elevation would greatly reduced to 2.5 mg/L, which complied with the SS criterion of elevation from 30% of the ambient SS. Since the maximum SS elevation is calculated from the shortest distance (100 m) from the nearest coral community, the distance from the dredging source to the nearest coral community should be higher than 100 m. Therefore the SS elevation due to the dredging operation should be much lower than the predicted level. It is believed that the adverse impact due to SS elevation from the dredging operation would not be anticipated.

Sediment Elevation and Sedimentation Impact upon Coral Communities

5b.7.3.31 As shown in **Table 5b.8** and **Table 5b.12**, full compliance with the SS criterion is predicted at all the identified coral communities. As compared with the baseline SS level at SKC (11.6 mg/L and 8.6 mg/L for SM12 and SM13 respectively in 2008), the maximum elevation in SS level (2.5 mg/L) only contribute to a small increment. As shown in the **Appendix 5.1**, the baseline sedimentation rate at SKC would be 6 $g/m^2/day$. It is expected that an increase in SS level for 2.5 mg/L by the dredging operation would only lead to a minor increase the sedimentation rate as well. It is expected that the resulted maximum sedimentation during the filling and dredging operation would be far below the assessment criteria of 200 $g/m^2/day$. Also, the coral communities were predicted to be outside the impact zone of the sediment plume, which implied that the suspended solid at the coral sites would be similar to the baseline concentration. No adverse impact in terms of sedimentation would be expected at these coral sites.

5b.7.3.32 As discussed in **Section 5b.7.3.2**, the maximum SS elevation predicted at the nearest coral community would be 2.5 mg/L, which would fulfills the criteria for SS elevation. It is therefore believed that no adverse SS impact on the coral community at Southwest Coastline of Shek Kwu Chau would be anticipated. Detailed assessment of the effect of SS upon these coral communities and further mitigation measures recommended for protection of these coral communities are separately provided under the ecological impact assessment in Section 7b.

Horseshoe Crab at Northern Shek Kwu Chau

5b.7.3.33 Horseshoe crab was identified at northern SKC about 600 m from the dredging works. The allowable increases in suspended sediment concentrations is 3.2 mg/L in the dry season and 2.5 mg/L in the wet season (see **Table 5b.7**), derived from data collected at EPD Station SM13. The modelling results in **Table 5b.12** showed the level of SS elevation would be lower than 2.5 mg/L at location above 100 m under mitigated dredging scenario, which complies with the criteria values of 3.2mg/L and 2.5mg/L for dry and wet season respectively. Similarly the level of SS elevation would be lower than 2.5 mg/L at location above 250 m under mitigated filling scenario. A study on the horseshoe crabs (6) shows that the horseshoe crabs at San Tau has been subject to impact associated with the reclamation and dredging works for the airport at Chek Lap Kok. However, San Tau still remains as an important breeding and nursery ground for horseshoe crabs. Adult and juvenile horseshoe crabs are expected to be tolerant of SS and sediment deposition. It is believed that the impact of elevated SS level and sedimentation rate to horseshoe crab would be minor. Details on the potential ecological impact are discussed in Section 7b.

Other Sensitive Receivers

5b.7.3.34 Besides the coral communities and horseshoe crab, the nearest WSRs (including the gazetted beaches at southern Lantau Island and east Cheung Chau as well as the Cheung Sha Wan Fish Culture Zone) are located at more than 2 km from the dredging works. The allowable increases in suspended sediment concentrations is 3.2 mg/L in the dry season and 2.5 mg/L in the wet season (see **Table 5b.7**), derived from data collected at EPD Station SM13. The modelling results in **Table 5b.12** showed that at 100 m from the dredging operation, the suspended sediment concentrations would be below 2.5 mg/L. Similarly the level of SS elevation would be lower than 2.5 mg/L at location above 250 m under mitigated filling scenario. Predicted suspended sediment concentrations at the gazette beaches and fish culture zone therefore complied well with the WQO. All the remaining WSRs are farther away and therefore would not be adversely affected by the SS plume generated from the Project.

(6) Li, H.Y. (2008). The Conservation of Horseshoe Crabs in Hong Kong. M.Phil Thesis, City University of Hong Kong.

Oxygen Depletion from Dredging

5b.7.3.35 The sediment oxygen demand (SOD) of the sediment samples collected for biogas risk investigation has been used to determine the reductions in dissolved oxygen (DO) concentration, based on the predicted increases in suspended sediment concentrations in accordance with the following equation:

$$DO_{Dep} = C * SOD * K * 10^{-6}$$

where DO_{DEP} = Dissolved oxygen (DO) depletion (mg/l)
C = Predicted maximum suspended solids (SS) concentration (mg/l)
SOD = Sediment oxygen demand (mg/kg) measured in the sediment samples collected from marine SI
K = Daily oxygen uptake factor (set as 1)

5b.7.3.36 In the calculation, the daily oxygen uptake factor, K, was set to be 1, which means instantaneous oxidation of the sediment oxygen demand. This was a conservative prediction of DO depletion since oxygen depletion is not instantaneous. It is worth noting that the above equation does not account for re-aeration which would tend to reduce impacts of the SS on the DO concentrations in the water column.

5b.7.3.37 The calculation was performed using the highest levels of sediment oxygen demand (SOD) measured in the sediment samples collected during the sediment sampling for conservative predictions. The highest SOD level (575 mg/kg) was recorded at Station MI11. Locations of the sampling stations are given in **Figure 6b.1**.

5b.7.3.38 The predicted maximum DO depletion during dredging was used to evaluate the water quality impacts. The calculated maximum DO depletion was subtracted from the measured background DO level to determine the resultant DO level in marine water. The 10 percentile values of the measured DO levels were used as the background levels, following the approach adopted in the approved EIAs for "*Dredging Works for Proposed Cruise Terminal at Kai Tak*" and "*Wan Chai Development Phase II & Central-Wan Chai Bypass*". The proposed analysis, which is on the conservative side, will likely overestimate the impact on DO. The predicted maximum DO depletions are given in **Table 5b.14**.

Table 5b.14 Calculation of the Effects of Increased Suspended Solids Concentration on Dissolved Oxygen Concentration under Unmitigated Scenario

Maximum SS Elevation at Important Ecological Sites (mg/L)	SOD in Sediment (mg/kg)	Maximum DO Depletion (mg/L)	Background Depth-averaged DO (mg/L)	Resultant DO (mg/L)	WQO for Depth-averaged DO
174	575	0.1	5.90	5.8	≥4 mg/l

5b.7.3.39 No significant DO depletion was predicted at the sensitive receivers in SKC even under unmitigated scenario. The dredging activities would cause a maximum DO depletion of 0.1 mg/L at the nearest sensitive receiver. Full compliance with the WQO for depth-averaged DO was predicted in SKC. Hence, no adverse impacts at the sensitive receivers on the DO levels in SKC would be expected from the dredging works.

5b.7.4 Construction Phase Impact from Installation of Submarine Cables

5b.7.4.1 The cable burying machine would include an injector lowered to the seabed. The injector fluidizes a trench using high pressure water jets and the cable is immediately laid within the trench. The sides of the trench slip around the cable, burying it and leaving a small depression in the seabed. The maximum width of the seabed fluidized by the injector is 3 m and the cable is buried to a maximum depth of 5 m. During the jet plough cable laying process the seabed sediments will be disturbed and a small percentage will be lost to suspension in the lower part of the water column in the immediate vicinity of the jet plough.

The analysis of the potential transport of fine sediments suspended into the water column during the cable laying process has been conducted based on the assumptions and methodology adopted under past approved studies for similar cable laying works such as the "*VSNL Intra Asia Submarine Cable System – Deep Water Bay (EP-294/2007)*" and the "*Proposed 132kV Submarine Cable Route for Airport "A" to Castle Peak Power Station Cable Circuit, CLP Power (EP 267/2007)*".

5b.7.4.2 During cable laying, the seabed sediment will be released at the bottom of the water column which will result in high localized suspended sediment concentrations and high settling velocities. This is because at high concentrations within a much localized area, suspended sediment will tend to form large aggregations of sediment particles (the process of flocculation) which have a higher settling velocity than the individual sediment particles. It is expected that the suspended sediments will remain within 1 m of the seabed, which is independent of the water depth. The current velocities at the seabed are lower than those near the water surface due to such effects as bottom friction. Based on the model results generated from the Update Model [(7)], it is assumed that the current velocity at the seabed would be less than 0.4 m/s in the vicinity of the cable works area. The suspended solids will tend to form around the cable laying works; however, the potential impacts have been addressed using a conservative assumption that a crosscurrent carries the sediment towards the sensitive receivers.

5b.7.4.3 Typically the settling velocity of SS is determined by examining the relationship between SS initial concentrations and the cohesive nature of the sediment being disturbed. Typically, as SS concentration increases, so will settling velocity as sediment particles flocculate, gain mass and settle faster. However, this relationship does not hold true when initial SS concentrations exceed values such as 1 kg/m^3. Based on the review of the cable installation rate and the cross sectional area of the cable trench, the initial SS concentration was anticipated to exceed the value of 1 kg/m^3. Hence, a conservative settling velocity of 10 mm/s has been adopted. However, as the sediment progressively settles onto the seabed, suspended sediment concentrations will gradually reduce. In order to account for the gradually reducing concentrations, the above settling velocity is halved, which gives a conservative value of **5.0 mm/s**. This is the same approach adopted in the approved EIA for "*a 1,800MW Gas-fired Power Station for Lamma Extension*". The time taken for the sediment to settle onto the seabed will thus be the maximum height of the sediment divided by the average settling velocity.

Settling Time = 1 m / 0.005 m·s^{-1} = **200 s**

5b.7.4.4 The distance travelled by the sediment will thus be the settling time multiplied by the current velocity.

Distance Travelled = 200 s x 0.4 m·s^{-1} = **80 m**

5b.7.4.5 The above calculation indicated that the sediments disturbed during laying of the submarine cable will settle onto the seabed within approximately 80m of the cable alignment. All the identified WSRs are located beyond the above predicted distance. It is anticipated that the works will not cause significant impacts to the water quality. In addition, the whole submarine installation works will be completed within a short duration and the potential impacts are considered short term and acceptable.

5b.7.4.6 As shown in **Figure 5b.3**, the most of the influence zone of the laying works would be far away from the Shek Kwu Chau site. The laying of submarine cables in this area would not cause cumulative water quality impact with the dredging for sheet piling at the Shek Kwu Chau site. No concurrence works between laying of cables and dredging/reclamation works within the same location is allowed. For works close to each other, the construction program should be arranged so that the dredging/reclamation works within area bounded

(7) Agreement No. CE 42/97, Update on Cumulative Water Quality and Hydrological Effect of Coastal Developments and Upgrading of Assessment Tool

by the breakwaters and the laying of cables would not operate within a distance of 80m from each other to avoid any accumulative impact on the environment (in case if such tight schedule is necessary).

5b.7.4.7 During submarine cable laying works, a water quality monitoring programme should be conducted to ensure no unacceptable water quality impacts will occur at the nearby WSRs.

5b.7.5 Consideration of Cumulative Construction Phase Impacts

5b.7.5.1 Two projects may be carried out concurrently with the IWMF Project at the artificial island near SKC:

ESB-209/2009 – Outlying Islands Sewerage Stage 2 - South Lantau Sewerage Works (2013-2017)

Marine works

5b.7.5.2 The concurrent project would involve the construction of a Sewage Treatment Works (STW) at San Shek Wan. Although the STW building would be located outside the study area of the IWMF at Cheung Sha, nevertheless, its associated submarine outfall, which is approximately 800 m in length and 300 mm in diameter, would extend from the shore of San Shek Wan into the Southern Water Control Zone. The proposed submarine outfall of the concurrent project would require dredging works. Construction of this concurrent project is tentatively scheduled to commence in September 2013 with a view to completion by September 2017. As this concurrent project is still under its early investigation stage, the exact time / programme for construction of the submarine outfall is currently unknown.

5b.7.5.3 While the tentative construction schedule for the IWMF project is 2013 to 2018, there may be an overlapping period for the two projects. As the water quality impacts generated from the proposed reclamation and submarine cable installation works are predicted to be localized and will not encroach any WSRs, no significant cumulative impact on marine ecology due to water quality would be anticipated. The location of the proposed outfall of the Outlying Islands Sewerage Project is shown in **Figure 5b.7**. The distance of the proposed outfall from the IWMF site is approximately 4.9 km.

ESB-187/2008 – Improvement of Fresh Water Supply to Cheung Chau (2010 – 2013)

Marine works

5b.7.5.4 This concurrent project would construct a submarine water main across Adamasta Channel, between Northern Channel of Cheung Chau and Chi Man Wan Peninsula, to replace the existing submarine water main. Works of the concurrent project that would overlap with the IWMF Project include the laying of submarine water main (~1400m in length and ~500mm in diameter) across Adamasta Channel within the Southern Water Control Zone.

5b.7.5.5 According to the tentative schedule of the concurrent project, which is 2010 to 2013, the submarine water main laying works may overlap with the construction works for the IWMF Project (2013-2018). Considering that the overlapping time would be short, and that the water quality impacts generated from the IWMF marine works are predicted to be localized and will not encroach any WSRs, no significant cumulative impact on marine ecology due to water quality would be anticipated. The location of the new water main of the Fresh Water Supply Improvement Project is shown in **Figure 5b.7**. The distance of the proposed submarine water main is at least 5 km away from the IWMF site.

5b.7.5.6 Other concurrent projects, such as the Tuen Mun-Chek Lap Kok Link, Hong Kong-Zhuhai-Macau Bridge Hong Kong Link Road and Boundary Crossing Facilities would also involve dredging, filling and other marine works in the study area. Yet these projects are distant from the SKC site and are blocked by the landmass of Lantau Island. Cumulative water quality impact is not expected.

5b.7.6 Operation Phase Impact from Project Effluent

Wastewater from Waste Treatment Process and Sewage from Floor & Vehicle Washing and the IWMF Staff & Visitors

5b.7.6.1 As discussed in **Section 5b.6.2.14**, the IWMF facilities would be designed with a net zero discharge of process and sanitary wastewater. A wastewater treatment plant would be provided on-site to treat high organic loading wastewater (such as sewage from floor & vehicle washing and the IWMF staff & visitors) for reuse in the incineration plant and mechanical treatment plant or for washdown and landscape irrigation. The bunker leachate / ash leachate from incineration plant (as described in **Section 5b.6.2.9**) would be highly polluted and would be conveyed to the incineration plant and co-incinerated with MSW. All other wastewater (i.e. low/nil organic loading wastewater mainly coming from plant machinery such as demineralizer drain) only requires simple treatment such as sedimentation or neutralization or even not requires any treatment before being used for flue gas cooling in quench tower or ash quenching. Therefore, no adverse water quality impact would be expected.

Transportation of bottom ash, fly ash and APC residues to WENT Landfill for disposal

5b.7.6.2 As discussed in **Section 2**, the IWMF would comprise (a) an advanced thermal incineration plant of about 3,000 tpd capacity and (b) a demonstration-scale mechanical treatment plant of about 200tpd or less for mixed MSW. The main waste type to be generated during the operation of the thermal incineration plant would be bottom ash, fly ash and air pollution control (APC) residues. For treating 3,000 tpd of mixed MSW, it is estimated that approximately 660 tpd of bottom ash and 120 tpd of fly ash and APC residues would be generated from the thermal incineration plant.

5b.7.6.3 The bottom ash is considered to be inert provided that the combustion systems in the incinerator are designed and operated correctly, and would be disposed of at landfill. Fly ash and APC residues from the flue gas stream can also be disposed of at landfill after proper treatment. The pollution load in fly ash and APC residues would likely be higher and more readily leachable than that in bottom ash. Cement solidification or chemical stabilization would be adopted to pre-treat the fly ash and APC residue to ensure that they would conform to the proposed Incineration Residue Pollution Control Limits and leachability criteria.

5b.7.6.4 The transportation of bottom ash, fly ash and APC residues to WENT Landfill for disposal would be carried out by means of marine transportation once everyday. Accidental spillage of the incineration waste would be the major risk concerning the marine transportation. Given that the bottom ash are inert while the fly ash and APC residues are solidified with cement or other chemicals, the accidentally spilled incineration waste and the contaminants within are not likely to dispersed widely and cause significant water quality impact.

5b.7.6.5 Moreover, as suggested in **Section 6**, the ashes would be stored in covered container during transportation, the possibility for accidental exposure of the ashes to the environment would be low. Transportation of incineration waste would also be avoided during adverse weather condition to prevent unanticipated risk. It is believed that the risk to the environment concerning the accidental spillage of ashes during marine transportation is low.

5b.7.6.6 As the incineration waste would be stored within covered container which prevent the contact between the incineration waste and marine water, leaching of pollutants from the incineration waste may not occur even if the containers fall into the sea accidentally. Even if spillage occurs under a very remote condition with some of the incineration waste containers damaged, the containers could still be effective in limiting the dispersion of leached contaminants. As discussed in **Section 5b.7.6.4**, the flying ash and APC residue from the incineration plants would be solidified and the leaching of pollutant would be limited. For the non-solidified bottom ash which passes the leachability criteria of Incineration Residue Pollution Control Limits (IRPCL), the possible level of leaching would be far lower than the contaminant levels listed in the IRPCL. In case of spillage, the dropped containers which contain the incineration waste are expected to fall to the seabed and could be recovered by the cleanup operation following the spillage. This would prevent the prolonged localized impact on water quality in case some of the containers are opened or damaged.

5b.7.6.7 It is expected that the possibility for the spillage of incineration waste would be scant. In case of spillage, the leaching of pollutant from the incinerated waste would be limited and the consequential impact on water quality, ecology and fishery resources would be low. A comprehensive emergency response plan for any accidental spillage should be submitted by the operation contractor to the EPD for agreement before the operation of the facilities. Salvage and cleanup action to recover the spilled incineration waste containers following the spillage should be carried out according to the emergency response plan to mitigate the environmental impact in case of spillage. Further details on the management of waste are given in **Section 6**.

<u>Discharge of Saline Water from Desalination Plant</u>

5b.7.6.8 Approximately 1,520 m^3/day of saline water would be generated from the proposed desalination plant and discharged to the sea. As the IWMF would be in 24-hour operation, continuous water supply will be required. Location of the discharge outfall is shown in **Figure 5b.6**. The peak saline water discharge rate is expected to be similar to the average discharge rate. The brine water drained from the desalination plant is just concentrated seawater (about 1.7-1.8 time more concentrated than the raw seawater), with a low discharge volume. There will be no temperature elevations in the brine water discharge as compared to the ambient water temperature. No other biocides / anti-fouling chemicals (such as chlorine and C-treat-6) will be used for the proposed desalination plant. Instead, membrane would be backwashed frequently to prevent fouling problem. The backwash water, which contains chemical for cleansing the membrane filter, would be diverted to the onsite sewage treatment works. Backwash water would be either re-used or treated by secondary wastewater treatment plant provided on-site. The saline water should be discharged at the southern boundary of the proposed reclamation site.

5b.7.6.9 A comparison of the characteristics of the saline water discharge with the standards for effluents discharged into the inshore waters of Southern Water Control Zone is given in **Table 5b.15** below:

Table 5b.15 Comparison of Saline Water Discharge from Desalination Plant with Effluent Discharge Standard

Parameters	**Saline Water** Note 1	**Discharge Standard** Note 2 & 3	**Compliance with Discharge Standard**
pH	6 – 8	6 – 9	Yes
Temperature (℃)	14 – 29	40	Yes
Suspended Solids (mg/L)	6 – 30	30	Yes
BOD (mg/L)	0.4 – 3.0	20	Yes
Total Residual Chorine (mg/L)	<1	<1	Yes

Notes: 1. It is calculated based on the assumption that the brine water produced is generally 1.7-1.8 times more concentrated than raw seawater for SS and BOD. There will be no temperature elevations in the saline water discharge as compared to the ambient water temperature. The characteristics of the baseline seawater quality are obtained from "*Marine Quality in Hong Kong in 2008*" published by EPD.

2. Discharge standard for flow rate of >1500 and ≤2000 m3/day based on "*Technical Memorandum – Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters (TM-DSS)*".
3. The effluent discharge standards do not specify a standard for salinity.

5b.7.6.10 The WQO stated that change of salinity due to human activity should not exceed 10% of ambient levels. Based on the assumption that the salinity in the effluent of the desalination plant will be raised 1.8 times of feedwater (ambient seawater), the required dilution to meet the WQO was calculated to be about 8 times. The near-field effluent dispersion model, namely the VISJET model, has been used to simulate the impact of the saline water discharges. Key inputs to the near-field dispersion model including outfall configuration, ambient current speed, vertical density profile and effluent flow rate. The ambient current speed and vertical density profile are extracted from the far field hydrodynamic model output from the Delft3D Update Model developed under the EPD Study "*Agreement No. CE 42/97 Update on Cumulative Water Quality and Hydrological Effect of Coastal Developments and Upgrading of Assessment Tool*". A monitoring point was set up in the hydrodynamic model of the Update Model near the proposed Project site. The far field hydrodynamic model of the Update Model is 3 dimensional with a total of 10 vertical water layers.

5b.7.6.11 The density profiles at the monitoring point was extracted and analyzed on days of spring tide and neap tide in both dry and wet seasons. The model results shown that the vertical density in dry season was found to be uniformly distributed over the entire water column while in wet season, a stratification of seawater was observed. Based on the analysis of ambient density profiles, two sets of density profiles were adopted for near field simulation, including one set of density profile predicted for dry season (with no sign of stratification) and one set of density profile predicted for wet season (with the highest degree of stratification predicted over the entire 15-day wet season simulation period). The current profiles extracted at the same monitoring point was also analyzed and calculated as 10 and 90 percentile values (for dry and wet seasons). The near field impact was simulated for different combinations of vertical density profile and ambient current velocity using the design effluent flow rate (1,520m^3/day) to determine the minimum initial dilution rate. Details of the ambient density profile and current velocity profile adopted in the modelling exercises are given in **Table 5b.16** and **Table 5b.17**. It is assumed that the desalination plant would discharge the brine water through a seawall discharge outfall at 0.5 m below the chart datum, which would be submerged under the water surface during low tides. Details of the near field modelling scenarios are given in **Table 5b.18**. The minimum initial dilution obtained from the VISJET modelling was used to assess the salinity impact upon the nearby water and ecological sensitive receivers.

Table 5b.16 Density Profile at SKC IWMF Desalination Plant Outfall

Depth from water surface (m)	Density (kg/m^3)	
	Dry Season (D)	Wet Season (W)
0.76	1.0150	1.0067
2.27	1.0150	1.0068
3.79	1.0150	1.0075
5.30	1.0150	1.0101
6.82	1.0150	1.0124
8.33	1.0150	1.0137
9.85	1.0150	1.0145
11.36	1.0150	1.0152
12.88	1.0150	1.0152
14.39	1.0150	1.0152
15.15	1.0150	1.0152

Table 5b.17 Current Velocity Profile at SKC IWMF Desalination Plant Outfall

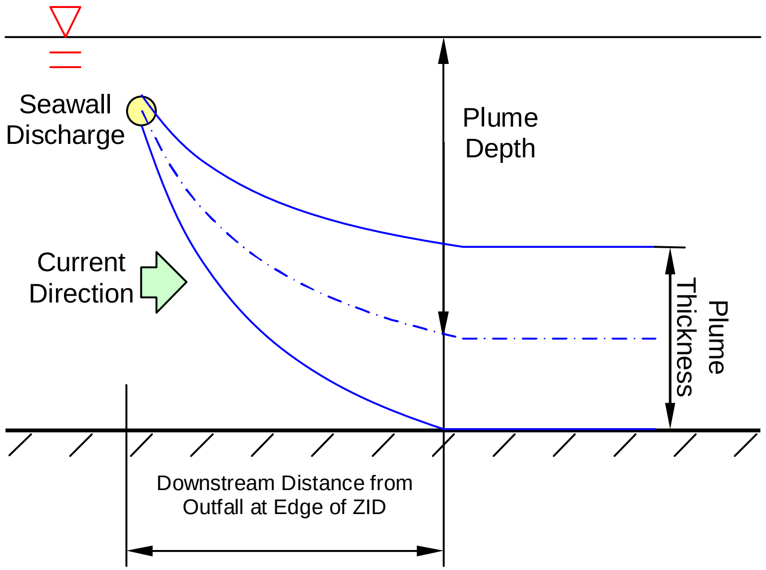
Depth from water surface (m)	Current Velocity (m/s)			
	Dry Season		Wet Season	
	10%ile (dv10)	90%ile (dv90)	10%ile (wv10)	90%ile (wv90)
0.76	0.0604	0.3369	0.1140	0.6427
2.27	0.0555	0.3342	0.1530	0.6734
3.79	0.0532	0.3307	0.1746	0.6403
5.30	0.0517	0.3260	0.1401	0.5553
6.82	0.0506	0.3201	0.1210	0.4561
8.33	0.0498	0.3128	0.0897	0.3540
9.85	0.0491	0.3038	0.0538	0.2801
11.36	0.0484	0.2921	0.0364	0.2365
12.88	0.0475	0.2763	0.0316	0.2104
14.39	0.0457	0.2514	0.0250	0.1698
15.15	0.0457	0.2514	0.0250	0.1698

Table 5b.18 Summary of Proposed Model Runs

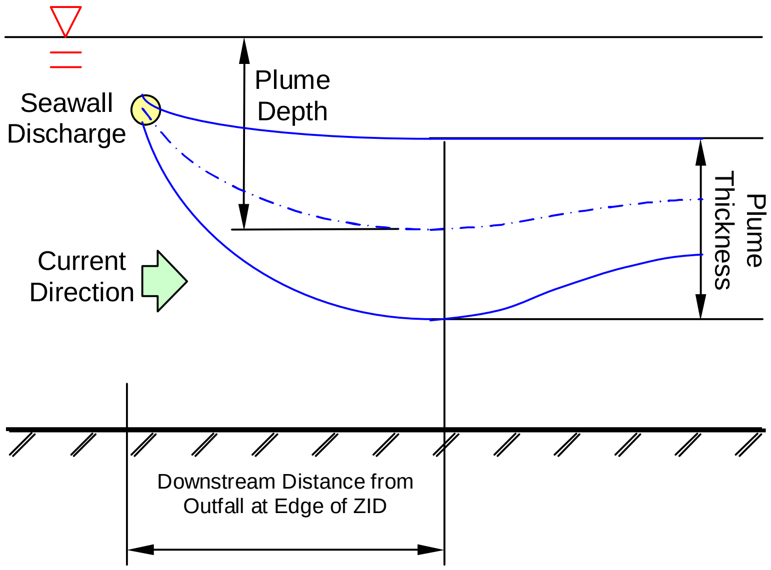
Model Run No.	Run ID	Density Profile	Ambient Current Velocity
1	D-dv10	D	dv10
2	D-dv90	D	dv90
3	W-wv10	W	wv10
4	W-wv90	W	wv90

Prediction and Evaluation of Near Field Modelling Results

5b.7.6.12 The VISJET model was used to simulate the near-field plume behavior of the outfall discharges within a relatively short distance from the effluent discharge location. Hence, the zone of initial dilution (ZID) of the effluent plume could be located. For a surface plume / bottom plume (for discharge of dense liquid such as brine), initial dilution is defined as the dilution obtained at the centre line of the plume when the plume reaches the surface / sink to bottom. For a trapped plume, initial dilution is defined as the dilution obtained at the center line of the plume where the plume reaches the maximum rise height / maximum depth (for discharge of dense liquid) when the vertical momentum / buoyancy of the plume become zeros. Key model outputs include initial dilution and downstream distance from the seawall discharge outfall at the edge of the ZID. Effluent plume properties of bottom plume and trapped plume for the discharge of concentrated brine is illustrated in **Plate 5b.5** below.



Case 1 – Plume Hits the Seabed



Case 2 – Plume Trapped

Plate 5b.5	**Illustration of Plume Properties of Surfacing Plume and Trapped Plume**

5b.7.6.13 **Table 5b.20** summarizes the results from the VISJET simulations. The predicted initial dilutions in **Table 5b.20** were corrected with the background concentration build up due to the tidal effects. The basic assumption of any near field model is mixed with clean water. In actuality this is not true, particularly in a tidally mixed environment. The average tracer background build up concentrations were calculated from the far field Update model. The background build up was quantified by performing a conservative tracer run on the effluent. A conservative tracer, i.e. without decay or reaction, was used. The initial concentration of the tracer in the desalination plant seawall discharge outfall was set to be 1000 mg/l. It should be noted that the results from the grid cell into which the tracer is loaded is not representative of the true background build up as this cell will always contain the background build up plus the continuous tracer loading. Therefore, the necessary far field tracer results were taken from a cell located adjacent to the outfall grid cells. The average tracer results were predicted in both dry and wet seasons and were used for the background build up corrections. **Table 5b.19** shows an example of the background build up correction (Run ID: D-dv10).

Table 5b.19 Example for Background Build Up Correction

Run ID	Minimum Initial Dilution [1]	Initial Tracer Concentration in Effluent [2] (mg/L)	Average Tracer Concentration [3] (mg/L)	Corrected Minimum Initial Dilution [4]
	(A)	**(B)**	**(C)**	**(D)**
D-dv10	106	1000	1.68	90

Note:
1. Minimum initial dilution predicted by VISJET model. This dilution occurred in the dry season (Run ID: D-dv10).
2. Effluent tracer concentration assumed in the far field modelling.
3. Average background build up concentration for dry season predicted by the far field model.
4. The average background build up concentration for dry season was used for the correction in this case as the minimum dilution occurred under the dry season scenario. Corrected Initial Dilution, (D) = (B) ÷ {[1 x (B) + ((A) – 1) x (C)] ÷ (A)}

Table 5b.20 Summary of Initial Dilutions Predicted at the Edge of ZID

Run ID	Initial Dilution at the Edge of ZID [1]	Corrected Initial Dilution at the Edge of ZID [2]	Downstream Distance from Centre of the Outfall at the Edge of ZID (m) [3]
D-dv10	106	90	4.5
D-dv90	4802	529	60.5
W-wv10	113	103	8.4
W-wv90	321	251	71.8

Note:
1. Initial dilutions at the edge of the ZID calculated by VISJET model.
2. Initial dilutions at the edge of the ZID were corrected using the background build up concentration predicted by the far field Update model.
3. Definition of ZID is provided in **Section 5b.7.6.12**.

5b.7.6.14 As shown in **Table 5b.20**, the predicted minimum dilution rate is 90 which occurred in dry season with the smallest ambient current velocity (D-dv10). The maximum predicted downstream distance is about 72m away from the outfall. According to **section 5b.7.6.10**, the required dilution rate is about 8 times which is far less than the smallest (worst-case) predicted dilution rate of 90 from the near field modelling results. The closest identified WSR to the Project site (such as the coral communities identified at the southwest coastline of SKC) is more than 200m away from the brine water discharge outfall which is outside the influence zone of the brine water discharge. It is therefore expected that the water quality impact due to the discharge of saline water from the desalination plant is negligible. Although the brine water discharge would unlikely contain any poisonous, noxious or polluting matter as it would be only a concentrate of seawater of nil / relatively low level of contamination, the project proponent will still confirm with the Regional Office of EPD on the need for applying a discharge license for the discharge of concentrated brine before the commencement of the IWMF Project. As the concentrated saline discharge may promote corrosion of the metallic sheetpiles near the saline water outfall, cathodic protection as well as corrosion resistance coating would be adopted to protect the metallic pile sheets against corrosion. Corrosion of the metal pile sheets can be controlled and no relevant water quality impact is expected.

5b.7.7 Operation Phase Impact due to Maintenance Dredging

5b.7.7.1 Depend on the actual sedimentation and scouring condition, maintenance dredging within the embayment area maybe needed to provide safe marine access route for the daily marine transportation. The need for maintenance dredging should be determined by onsite survey after the completion of this Project. Currently, no regular maintenance dredging is proposed under this Project. It is suggested that any maintenance dredging in the future should not be carried out within 100 m of the nearest coral community, similar to that of the dredging for anti-scouring protection layer. The dredging should also be carried out with the implementation of frame-type silt curtain to control the dispersion of SS. The application of frame-type silt curtain at the grab for any potential maintenance dredging is indicative shown in **Appendix 5.5-6**. The recommended dredging rate should be no greater than 380 m^3/day. As shown in **Table 5b.12,** the maximum SS elevation for such dredging condition should be under 2.5 mg/L, which is below the allowed margin of 30% ambient level. No adverse water quality impact would be expected from the proposed maintenance dredging. The extent of the recommended dredging is shown in **Figure 5b.8**.

5b.7.8 Operation Phase Impact on Flow Regime

5b.7.8.1 The potential site at SKC is located in the open water in the deeper southern waters of Hong Kong and is influenced by the Pearl River plume as well as the offshore oceanic waters. The typical tidal flow patterns around the southern waters are shown in **Plate 5b.2** and **Plate 5b.3** above. During the flood tides, the waters around the Project site would be influenced by the currents from the offshore oceanic waters which generally contain a low pollution level. Hence, the water quality at SKC is considered to be mainly affected by the Pearl River discharges which generally contain a relatively high level of pollutants such as SS and nutrients.

5b.7.8.2 The proposed reclamation is facing the large open South Sea in the southern waters of Hong Kong and is located outside all the major water channels in Hong Kong and therefore would unlikely have any major impact upon the tidal flushing capacity in Hong Kong and the generalized flow pattern in the southern waters. To assess the potential impact upon the tidal flow as a result of the proposed reclamation during the operation phase, a cross section is defined between SKC and Wanshan Archipelago (see **Plate 5b.6** below). This cross section is selected as it is generally perpendicular to the main tidal currents running across the area. On the other hand, the Adamasta Channel at the north of SKC is located opposite to the reclamation of the artificial island and is relatively distant from the reclamation (about 1.5 km away) when compared with the SKC-Wanshan Archipelago cross-section (located adjacent to the reclamation). In view of the geographic settings and physical distance, it is considered that the Adamasta Channel would not be subjected to significant change in flow regime due to the reclamation. The beaches of South Lantau, including Tai Long Wan (3.25 km away), Yi Long Wan (2.75 km away), Pui O (5.25 km away), Lower Cheung Sha (8.75 km), etc. would be further away from the reclamation and are located within different marine embayment where current velocity is low. It is expected that these beaches would not be significantly affected by any change in flow regime and beach erosion at these beaches is not expected. The Cheung Chau Typhoon Shelter is distant (5 km away), located within marine embayment and is shielded by the SKC island as well as the breakwaters of the typhoon shelter itself. Thus significant change in flow regime at the Cheung Chau Typhoon Shelter is not expected as well.

Plate 5b.6 Location of Cross Section

5b.7.8.3 Taking into account the water depths along this cross section and the maximum current velocity along this open water (of up to 0.4 m/s) and assuming that the current velocity would be uniform across the cross section, the maximum flow discharge across this cross section was calculated to be roughly 120,000 m^3/s (with cross-section width about 17km and average depth around 18 m). Based on the reclamation layout as shown in **Figure 5b.2** as well as the water depths and current velocity immediately around the southwest coastline of SKC, it was calculated that the proposed reclamation at SKC (with cross-section width about 300 m [perpendicular to the current flow direction] and average depth around 10 m) would block no more than 1% ([300 m × 10 m] ÷ [17000 m × 18 m] = 0.98%) of the tidal flow discharge. Hence, no significant change in the generalized flow patterns in the southern waters would be expected from the proposed reclamation.

5b.7.9 Operation Phase Impact on the Channel between the SKC Southwest Shore and the Proposed Facilities

5b.7.9.1 As shown in **Figure 5b.2**, a channel would be formed between the SKC Southwest Shore and Proposed Facilities after the reclamation works. The channel is around 10 – 40 m wide and is about 350 m long. The depth of water may various greatly from locations as the channel locates at coastal area. For the deeper side of the channel (near the reclaimed area), the water depth is about 8.9 m. As discussed in **Section 7b**, coral communities are found within the channel. The survival of these coral communities would depend mostly on sedimentation, gaseous and nutrient exchange as well as light penetration. As shown in **Plate 5b.8**, the current flows from northwest to southeast direction and vice verse during flood and ebb tide, similar to that of the direction of the channel. This would allow the flood and ebb current to pass through the channel easily. The constriction at the opening of the channel would likely increase the overall current speed within the channel when compare with the original state. Therefore, increase in the sedimentation rate within the channel is not anticipated. Instead, the increase in current speed may result in scouring and erosion of the seabed. As the non-translocatable coral communities within the channel are mostly attached to hard substratum (such as bed rocks and boulders), these communities would not be directly affected by the scouring effect due to the increase current speed. Moreover, as shown in **Plate 5b.7** below, the seabed at the channel location is very steep, which suggest the substrate would likely be composed of bed rock and boulder. The subtidal ecological survey discussed in **Section**

7b.4.9 also confirms the composition of the substrate at the seabed near the southwestern shore of SKC. As the substrate at the seabed near the southwestern shore of SKC consists mainly of hard material, which is not prone to erosion, the risk of erosion in the channel and the associated change in water quality (SS elevation due to erosion and reduction in light penetration) in unlikely. The increase in water current would not adversely affect the gaseous and nutrient exchange within the channel. Considering the effects due to increase in current speed as listed above, no water quality impact on coral community within the channel is expected.

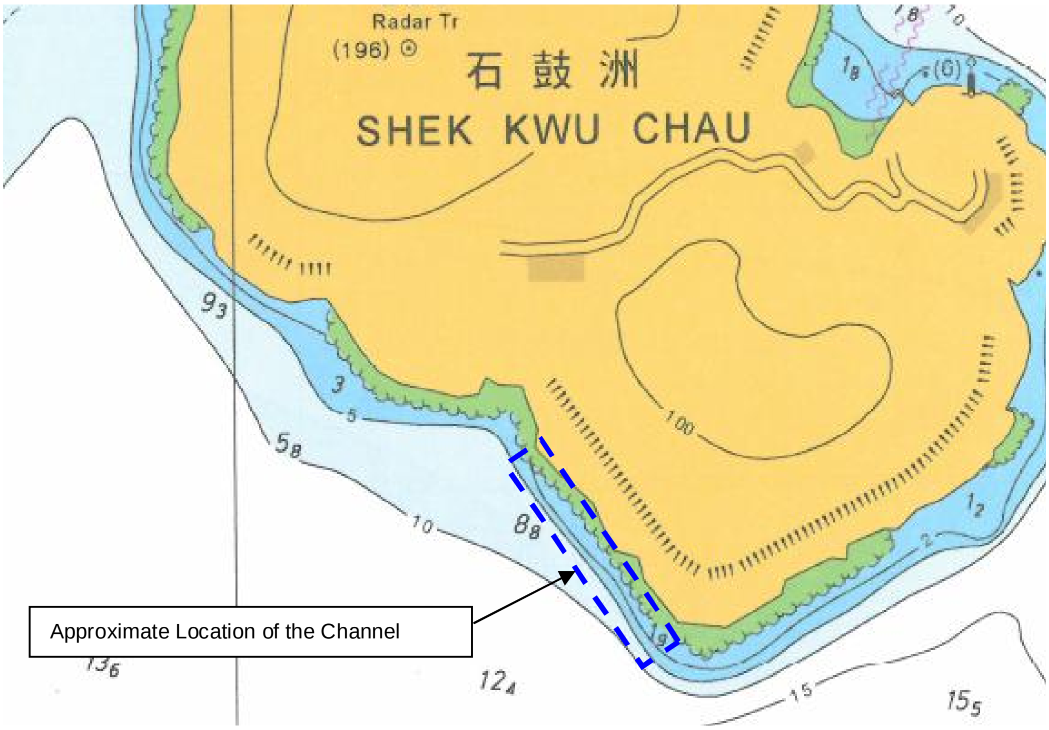


Plate 5b.7 Seabed Level at Southern SKC

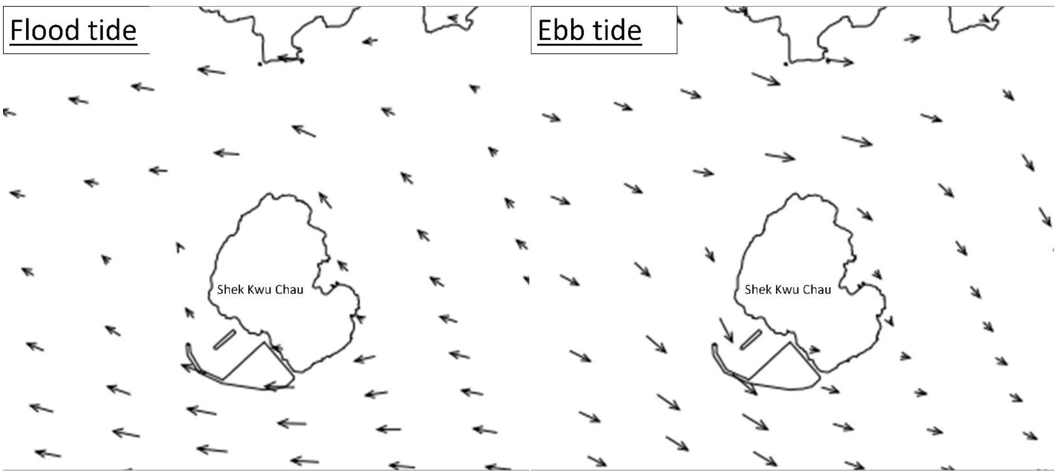


Plate 5b.8 Typical Localized Current Flow Pattern at SKC (Extracted from the Delft3D Detailed HATS Model developed under the Approved EIA for Harbour Area Treatment Scheme (HATS) Stage 2A

5b.7.9.2 In addition, there will be no pollution discharge into the area within the proposed breakwater and the channel between the SKC shore and the proposed facilities. As discussed in **Section 5b.6.2.14**, the IWMF would be designed with a net zero discharge of process and sanitary wastewater. The only discharge would be the concentrated saline water from the desalination plant. Since the proposed outfall discharge locates at the Southern side of the breakwater (above 200 m away from the opening of the channel), any saline discharged from the desalination plant should be fully diluted (please refer to **Section 5b.7.6** for the extent of mixing zone of saline discharged from the desalination plant) and will not affect the water quality within the channel.

5b.7.9.3 Floating refuse may be washed into the channel and pose a risk for deterioration of water quality of the channel. It is suggested that regular collection of refuse within the channel area should be done to avoid deterioration of water quality of the channel. It is expected that water quality impact due to floating refuse would be minimal if measure could be taken to regularly collect refuse within the channel.

5b.7.10 Operation Phase Impact on Dissolved Oxygen within the Breakwaters Sheltered Water

5b.7.10.1 The breakwaters around the SKC would reduce the water current within the sheltered water for the safety of the vessels in the Project Site. However, the effect of slowing down the water is limited as the breakwaters only partially enclose the sheltered area, leaving a huge void for water to exchange with the surrounding. The width of the opening of breakwater at the narrowest location is about 210 m. As the current flow from northwest to southeast and vice verse during flood and ebb tide in the Project Site, the 210 m opening of the breakwater, which opens at the northwest direction, would allow effective water exchange in either tide condition. Assuming a humble current velocity of 0.05 m/s (which is approximate the 10^{th} percentile flow velocity as shown in **Table 5b.17**) across the opening during an ebb or flood tide, the water within the 15 hectares embayment area would be completely replaced within 4 hours. It is expected that the exchange of water with the surrounding would be sufficient in the embayment area. Data from the EPD marine water quality station SM13 shows that the level of dissolved oxygen (10^{th} percentile DO around 5.8-5.9 for 2007-2009) is well above the WQO of the Southern Water. It is expected that the effect on dissolved oxygen due to the slow down of water current would be minimal.

5b.7.11 Operation Phase Impact on Sediment Deposition and Water Quality

5b.7.11.1 Ecological sensitive receivers including benthic and coral communities would be sensitive to sediment deposition. The marine embayment formed by the proposed breakwaters would reduce the local currents and stimulate sediment deposition within the embayment area, which may have an effect on the intertidal and subtidal habitats at or near the Project site. In addition, construction of the breakwaters and reclamation as well as any future maintenance dredging for safe marine access would unavoidably cause a direct loss of intertidal and subtidal habitats at or near the Project site. Detailed ecological impact assessment is provided separately in **Section 7b**.

5b.7.11.2 The key pollution / sediment source within the Study Area would be the Pearl River in the far field. The baseline sedimentation rates simulated by the Update Model [(8)] which took account of the cumulative effect from all the coastal pollution discharges including the Pearl River are given in **Appendix 5.1**. The sedimentation rate criterion adopted under the approved EIA for Liquefied Natural Gas (LNG) Receiving Terminal and Associated Facilities for protection of marine ecological sensitive receivers was 200 $g/m^2/day$. As shown in **Appendix 5.1**, the maximum baseline sedimentation rates predicted in the Study Area are lower than 6 $g/m^2/day$ which are well below the assessment criterion of 200 $g/m^2/day$. Based on the Project layout as shown in **Figure 5b.2**, reduction in the local tidal currents is expected within or near the new breakwaters. As there is a great safety margin of over 97% between the baseline sedimentation rates and the criterion

(8) Agreement No. CE 42/97, Update on Cumulative Water Quality and Hydrological Effect of Coastal Developments and Upgrading of Assessment Tool

value, and considering that there would be no existing / planned sediment source within the new breakwaters, it is not expected that the presence of the proposed breakwaters and reclamation land would cause any adverse ecological impact in terms of sediment deposition rate during the operation phase.

5b.7.11.3 No additional pollution loading will be discharged into the area within the proposed breakwaters where the coral communities would be located. Hence no significant water quality impact in terms of sediment deposition upon the coral communities would be expected from the Project. The water quality effects upon the coral communities identified within the Project site due to the saline water discharges from the desalination plant have been assessed by near field dispersion modelling (refer to **Sections 5b.7.6.8** to **5b.7.6.14**). Detailed impact assessment on the identified coral communities and necessary mitigation measures for protection of these coral communities are given in Section 7b.

5b.7.11.4 All other identified WSRs, such as the beaches at Lantau South and Cheung Chau East would not be directly influenced by the tidal flow running across the Project site (refer to **Section 5b.7.7**) and in view that these WSRs are even far more away from the Project activities (more than 5 km away), no adverse change in sediment deposition and water quality is expected upon the WSRs due to the Project operation.

5b.8 Mitigation Measures

5b.8.1 Construction Phase

<u>Drainage and Construction Site Runoff</u>

5b.8.1.1 The site practices outlined in ProPECC PN 1/94 "*Construction Site Drainage*" should be followed as far as practicable in order to minimise surface runoff and the chance of erosion. These practices include the following items:

- At the start of site establishment, perimeter cut-off drains to direct off-site water around the site should be constructed with internal drainage works and erosion and sedimentation control facilities implemented. Channels (both temporary and permanent drainage pipes and culverts), earth bunds or sand bag barriers should be provided on site to direct storm water to silt removal facilities. The design of the temporary on-site drainage system will be undertaken by the contractor prior to the commencement of construction.
- Boundaries of earthworks should be surrounded by dykes or embankments for flood protection, as necessary.
- Sand/silt removal facilities such as sand/silt traps and sediment basins should be provided to remove sand/silt particles from runoff to meet the requirements of the TM-DSS. The design of efficient silt removal facilities should be based on the guidelines in Appendix A1 of ProPECC PN 1/94, which states that the retention time for silt/sand traps should be 5 minutes under maximum flow conditions. The detailed design of the sand/silt traps shall be undertaken by the contractor prior to the commencement of construction. The design of a typical sand trap, extracted from ProPECC PN 1/94, is provided in **Appendix 5-3**.
- Water pumped out from foundation piles must be discharged into silt removal facilities.
- Measures should be taken to minimize the ingress of site runoff and drainage into excavations. Drainage water pumped out from excavations should be discharged into storm drains via silt removal facilities.
- During rainstorms, exposed slope/soil surfaces should be covered by a tarpaulin or other means, as far as practicable. Other measures that need to be implemented before, during and after rainstorms are summarized in ProPECC PN 1/94.

- Exposed soil areas should be minimized to reduce potential for increased siltation and contamination of runoff.
- Earthwork final surfaces should be well compacted and subsequent permanent work or surface protection should be immediately performed.
- Open stockpiles of construction materials or construction wastes on-site should be covered with tarpaulin or similar fabric during rainstorms.

General Construction Activities

5b.8.1.2 Construction solid waste should be collected, handled and disposed of properly to avoid entering to the nearby watercourses and public drainage system. Rubbish and litter from construction sites should also be collected to prevent spreading of rubbish and litter from the site area. It is recommended to clean the construction sites on a regular basis.

5b.8.1.3 There is a need to apply to EPD for a discharge licence for discharge of effluent from the construction site under the WPCO. The discharge quality must meet the requirements specified in the discharge licence. All the run-off and wastewater generated from the works areas should be treated so that it satisfies all the standards listed in the TM-DSS. The beneficial uses of the treated effluent for other on-site activities such as dust suppression and general cleaning etc., can minimise water consumption and reduce the effluent discharge volume. If monitoring of the treated effluent quality from the works areas is required during the construction phase of the Project, the monitoring should be carried out in accordance with the relevant environmental legislation.

Accidental Spillage

5b.8.1.4 Contractor must register as a chemical waste producer if chemical wastes would be produced from construction activities. The Waste Disposal Ordinance (Cap 354) and its subsidiary regulations in particular the Waste Disposal (Chemical Waste) (General) Regulation should be observed and complied with for control of chemical wastes.

5b.8.1.5 Maintenance of vehicles and equipments involving activities with potential for leakage and spillage should only be undertaken within the areas which appropriately equipped to control these discharges.

5b.8.1.6 Oils and fuels should only be used and stored in designated areas which have pollution prevention facilities. All fuel tanks and storage areas should be sited on sealed areas in order to prevent spillage of fuels and solvents to the nearby watercourses. All waste oils and fuels should be collected in designated tanks prior to disposal.

5b.8.1.7 Disposal of chemical wastes should be carried out in compliance with the Waste Disposal Ordinance. The Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes published under the Waste Disposal Ordinance details the requirements to deal with chemical wastes. General requirements are given as follows:

- Suitable containers should be used to hold the chemical wastes to avoid leakage or spillage during storage, handling and transport.
- Chemical waste containers should be suitably labelled, to notify and warn the personnel who are handling the wastes, to avoid accidents.
- Storage area should be selected at a safe location on site and adequate space should be allocated to the storage area.

Sewage Effluent

5b.8.1.8 Temporary sanitary facilities, such as portable chemical toilets, should be employed on-site where necessary to handle sewage from the workforce. A licensed contractor would be responsible for appropriate disposal and maintenance of these facilities.

Reclamation, Construction of Breakwaters and Localized Dredging for Anti-Scouring Protection Layer

5b.8.1.9 The following mitigation measures are recommended to minimize the loss of fine sediment to suspension:

- The proposed dredging and reclamation should be commenced in phases. The breakwaters and seawalls should be constructed using cofferdam method and the reclamation should be started within the enclosed breakwaters after the completion of the breakwater. Silt curtain should be used to surround the circular cell during the filling of the cell to prevent the loss of fine in the filling material
- Water trapped inside the cofferdam, if any, would be pumped out for treatment before discharge.
- The maximum production rate for dredging for the anti-scouring protection layer shall not exceed 380 m^3 per day. It is recommended to employ closed grab with small capacity of 2 m^3 to control the dredging rate. No dredging works would be carried out within 100 m from the nearest coral community.
- Any gap that may need to be provided for marine access will be located at the middle of the North Western seawall, away from the identified coral communities and will be shielded by silt curtains systems to control sediment plume dispersion.
- The silt curtain system at marine access opening should be closed as soon as the barges passes through the marine access opening in order to minimize the period of curtain opening. Filling should only be carried out behind the silt curtain when the silt curtain is completely closed.
- To enhance the effectiveness of the silt curtain at the marine access, the northern breakwater would be built before the commencement of the reclamation to reduce the current velocity towards the marine access opening.
- The silt curtain system at marine access opening should be regularly checked and maintained to ensure proper functioning.
- 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;
- The filling for reclamation should be carried out behind the seawall. The filling material should only consist of public fill, rock and sand. The production rate for each composition at each filling area should follow those delineated in **Table 5b.9** and **0**. The filling above high watermark is not restricted;
- For dredging for anti-scouring protection layer, the contractor should follow the production rate stated in **Table 5b.12** and the maximum number of grab per hour stated in **Table 5b.13**;
- No dredging should be carried out within 100 m to the nearest non-translocatable coral community;
- Daily site audit including full-time on-site monitoring by the ET is recommended during the dredging for anti-scouring protection layer for checking the compliance with the permitted no. of grab to be performed per hour by the dredging contractor as specified in **Table 5b.13**;

- Closed grab dredger should be used to minimize the loss of sediment during the raising of the loaded grabs through the water column;
- Frame-type silt curtains should be deployed around the dredging operations;
- Floating-type silt curtains should be used to surround the circular cell during the sheetpiling work;
- The descent speed of grabs should be controlled to minimize the seabed impact speed;
- Barges should be loaded carefully to avoid splashing of material;
- All barges used for the transport of dredged materials should be fitted with tight bottom seals in order to prevent leakage of material during loading and transport;
- No concurrence works between laying of submarine cables and dredging/reclamation works within the same location is allowed. For works close to each other, the construction program should be arranged so that the dredging/reclamation works within area bounded by the breakwaters and the laying of cables would not operate within a distance of 80m from each other to avoid any accumulative impact on the environment (in case if such tight schedule is necessary).
- All barges should be filled to a level which ensures that material does not spill over during loading and transport to the disposal site and that adequate freeboard is maintained to ensure that the decks are not washed by wave action.
- Coral which are directly affected should be translocated as much as practicable. (Please refer to **Section 7** for the details on coral translocation)

5b.8.2 Operation Phase

Site Effluent

5b.8.2.1 The Project Site will be equipped with an adequately sized wastewater treatment plant to provide treatment to some wastewater generated from the IWMF (mainly human sewage) for reuse in the incineration plant and mechanical treatment plant or for washdown and landscape irrigation in the IWMF site. A “net zero discharge” scheme will be adopted during the operation of the IWMF.

5b.8.2.2 A small amount of brine water will be discharged into the marine water from the proposed desalination plant via a seawall discharge outfall at the southern boundary of the artificial island near SKC (outside the proposed breakwaters). The potential water quality impact from the brine water discharge has been assessed to be negligible and therefore no mitigation measure specific to the brine water discharge is required.

Surface Runoff

5b.8.2.3 A pipeline drainage system will serve the development area collecting surface runoff from paved areas, roof, etc. Sustainable drainage principle would be adopted in the drainage system design to minimize peak surface runoff, maximize permeable surface and maximize beneficial use of rainwater.

5b.8.2.4 Oil interceptors should be provided in the drainage system of any potentially contaminated areas (such as truck parking area and maintenance workshop) and regularly cleaned to prevent the release of oil products into the storm water drainage system in case of accidental spillages. Accidental spillage should be cleaned up as soon as practicable and all waste oils and fuels should be collected and handled in compliance with the Waste Disposal Ordinance.

Refuse Entrapment

5b.8.2.5 Collection and removal of floating refuse should be performed at regular intervals for keeping the water within the Project site boundary and the neighbouring water free from rubbish.

Transportation of bottom ash, fly ash and APC residues to WENT Landfill for disposal

5b.8.2.6 Mitigation measures for minimizing the risk of spillage during transportation of bottom ash, fly ash and APC residues are given in Section 6b.5 and Section 6b.6 under the Waste Management Implementation section. Covered container should be used in the shipping of the incineration waste to limit the contact between the incineration waste and the marine water. A comprehensive emergency response plan for any accidental spillage should be submitted by the operation contractor to the EPD for agreement before the operation of the facilities. Salvage and cleanup action to recover the spilled incineration waste containers following the spillage should be carried out according to the emergency response plan to mitigate the environmental impact in case of spillage.

Maintenance Dredging

5b.8.2.7 The precautions stated in **Section 5b.8.1.9** should be followed to avoid any adverse water quality impact. The dredging extent shown in **Figure 5b.8** for the maintenance dredging should be followed to avoid dredging too close to the coral communities.

5b.9 Evaluation of Residual Impacts

5b.9.1.1 With the implementation of the recommended mitigation measures, no unacceptable residual impacts on water quality are expected.

5b.10 Environmental Monitoring and Audit

5b.10.1.1 Water quality monitoring and audit is recommended to be carried out during the proposed marine construction works at SKC to ensure that the recommended mitigation measures are implemented properly. During submarine cable laying works, dredging, installation of cofferdam, reclamation, a water quality monitoring programme should be conducted to ensure no unacceptable water quality impacts will occur at the nearby WSRs. If the water quality monitoring data indicate that the proposed marine works result in unacceptable water quality impacts in the receiving water, appropriate actions should be taken to review the construction method and additional measures such as slowing down, or rescheduling of works should be implemented as necessary. During the reclamation, the opening for marine access would be shielded by silt curtains system to control the dispersion of filling material from the reclamation area. To ensure the actual efficiency of the silt curtains system would be at least as high as the level assumed in the assessment, a field trial to verify the reduction effect of the silt curtain during the EM&A stage is recommended. Daily site audit should be performed during the dredging for anti-scouring protection layer to ensure compliance with the recommended dredging rates as shown in **Table 5b.11**. Water quality monitoring and audit is also recommended to be carried out during the first four weeks of the commission of brine water discharge at SKC to ensure that no adverse water quality impact would occur due to the discharge of brine. Details of the water quality monitoring programme and the Event and Action Plan will be provided in the stand-alone EM&A Manual. Monitoring of effluent quality is also recommended for operation stage and under the perspective of the WPCO.

5b.11 Conclusion

5b.11.1.1 The water quality impact during the dredging works for the proposed breakwater construction will not be anticipated due to the phasing and construction method adopted while the water quality impact during the reclamation and dredging for anti-scouring protection layer has been quantitatively assessed using the near field sediment dispersion model. The model results indicated that the water quality impact generated from the reclamation and dredging works under mitigated scenario would be localized and minor and would unlikely contribute any significant water quality impact. Mitigation measures are proposed to ensure that no unacceptable water quality impact would be resulted from the reclamation and dredging works.

5b.11.1.2 During the operation phase of the Project, wastewater will be generated from the proposed incineration plant and mechanical treatment plant. An on-site wastewater treatment plant will be provided. All generated wastewater will be discharged to the on-site wastewater treatment plant and treated. The treated effluent from the wastewater treatment plant will be reused in the incineration plant and mechanical treatment plant or washdown and landscape irrigation in the IWMF site. There would be no wastewater effluent discharged to the coastal waters of Southern WCZ.

5b.11.1.3 The water quality impact for any potential maintenance dredging has been quantitatively assessed using the near field sediment dispersion model. The model results indicated that the water quality impact generated from the dredging works under mitigated scenario would be localized and minor and would unlikely contribute any significant water quality impact.

5b.11.1.4 Saline water would be discharged from the proposed desalination plant in a low discharge rate. The saline water has been quantitatively assessed to be minor and acceptable. Adverse impacts on water quality due to the proposed saline water discharge would not be expected.