8 WATER QUALITY IMPACT

8.1 Introduction

8.1.1 This section presents the assessment results of the potential hydrodynamic and water quality impact associated with the Kai Tak Development (KTD). Mitigation measures are also recommended to minimise potential adverse impacts and to ensure the acceptability of any residual impact (that is, after mitigation).

8.1.2 With reference to the EIA Study Brief, the Study Area for this water quality assessment shall cover all areas within and 300m beyond the Project boundary, plus the Victoria Harbour, the Eastern Buffer and the Western Buffer Water Control Zones (WCZ) (**Figure 8.1**).

8.2 Water Quality Sensitive Receivers

8.2.1 In order to evaluate the potential water quality impacts from the Project, water quality sensitive receivers (WSRs) in the Victoria Harbour and its adjacent waters were considered. Major WSRs identified include:

- WSD Flushing Water Intakes;
- Cooling Water Intakes;
- Corals; and
- Fish Culture Zones

8.2.2 Water quality and ecological sensitive receivers identified within the Victoria Harbour and its adjacent waters are shown in **Figure 8.2**. According to the recent dive surveys, some small and isolated patches of single species of hard coral (*Oulastrea crispate*) were found in the Kai Tak Development (KTD) area along the runway and the breakwaters of the To Kwa Wan Typhoon Shelter and this species is common in Hong Kong waters and known to tolerate more turbid and harsh environment. Most of the isolated colonies were attached on the surface of the boulders and rocks with very low coverage (<1%) and small size (~3 cm to 8 cm). Some of them were even less than 1 cm in diameter. The isolated coral colonies found in the KTD area are not considered as sensitive coral site and are therefore not covered in this water quality impact assessment. Details of the dive surveys and full description of the identified coral colonies are provided in **Section 14** of this EIA Report.

8.2.3 A District Cooling System (DCS) is planned by EMSD to be implemented in the KTD area. The associated seawater intake of DCS would be considered as a planned WSR. Based on the RODP, the seawater intake will be located along the waterfront of the former Kai Tak airport runway. The location of the seawater intake is included in **Figure 8.5**.

8.3 Environmental Legislation, Policies, Plans, Standards and Criteria

<u>Environmental Impact Assessment Ordinance (EIAO)</u>

8.3.1 The Technical Memorandum on Environmental Impact Assessment Process (Environmental Impact Assessment Ordinance) (EIAO-TM) was issued by EPD under Section 16 of the EIAO. It specifies the assessment method and criteria that are to be followed in this Study. Reference sections in the EIAO-TM provide the details of 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.

Water Quality Objectives

8.3.2 The Water Pollution Control Ordinance (WPCO) provides the major statutory framework for 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 (WCZs). Corresponding statements of Water Quality Objectives (WQOs) are stipulated for different water regimes (marine waters, inland waters, bathing beaches subzones, secondary contact recreation subzones and fish culture subzones) in the WCZs based on their beneficial uses. The WQOs for the Victoria Harbour, the Eastern Buffer and the Western Buffer WCZs are listed in **Table 8.1** to **Table 8.3** respectively.

Table 8.1 Summary of Water Quality Objectives for the Victoria Harbour 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 2m of the seabed	Not less than 2.0mg/l for 90% of samples	Marine waters
Depth-averaged DO	Not less than 4.0mg/l for 90% of samples	Marine waters
pH	To be in the range of 6.5 - 8.5, change due to human activity not to exceed 0.2	Marine waters
Salinity	Change due to human activity not to exceed 10% of ambient	Whole zone
Temperature	Change due to human activity not to exceed 2 ^{o}C	Whole zone
Suspended solids (SS)	Not to raise the ambient level by 30% caused by human activity	Marine waters
Unionised ammonia (UIA)	Annual mean not to exceed 0.021mg/l as unionised 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 0.4mg/l	Marine waters
Toxic substances	Should not attain such levels as to produce significant toxic, carcinogenic, mutagenic or teratogenic effects in humans, fish or any other aquatic organisms.	Whole zone
	Human activity should not cause a risk to any beneficial use of the aquatic environment.	Whole zone

Source: Statement of Water Quality Objectives (Victoria Harbour (Phases One, Two and Three) Water Control Zone).

Table 8.2 Summary of Water Quality Objectives for the Eastern Buffer 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 2m of the seabed	Not less than 2.0mg/l for 90% of samples	Marine waters
Depth-averaged DO	Not less than 4.0mg/l for 90% of samples	Marine waters excepting fish culture subzones
	Not less than 5.0mg/l for 90% of samples	Fish culture subzones
	Not less than 4.0mg/l	Water gathering ground subzone and other Inland waters
5-Day biochemical oxygen demand (BOD5)	Change due to waste discharges not to exceed 3mg/l	Water gathering ground subzones
	Change due to waste discharges not to exceed 5mg/l	Inland waters
Chemical oxygen demand (COD)	Change due to waste discharges not to exceed 15mg/l	Water gathering ground subzones
	Change due to waste discharges not to exceed 30mg/l	Inland waters
PH	To be in the range of 6.5 – 8.5, change due to waste discharges not to exceed 0.2	Marine waters
	To be in the range of 6.5 – 8.5	Water gathering ground subzones
	To be in the range of 6.0 – 9.0	Inland waters
Salinity	Change due to waste discharges not to exceed 10% of ambient	Whole zone
Temperature	Change due to waste discharges not to exceed 2 ^{o}C	Whole zone
Suspended solids (SS)	Not to raise the ambient level by 30% caused by waste discharges and shall not affect aquatic communities	Marine waters
	Change due to waste discharges not to exceed 20mg/l of annual median	Water gathering ground subzones
	Change due to waste discharges not to exceed 25mg/l of annual median	Inland waters
Unionized ammonia (UIA)	Annual mean not to exceed 0.021mg/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 0.4mg/l	Marine waters
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

Parameters	Objectives	Sub-Zone
Bacteria	Not exceed 610 per 100ml, calculated as the geometric mean of all samples collected in one calendar year	Fish culture subzones
	Less than 1 per 100ml, calculated as the geometric mean of the most recent 5 consecutive samples taken at intervals of between 7 and 21 days	Water gathering ground subzones
	Not exceed 1000 per 100ml, calculated as the geometric mean of the most recent 5 consecutive samples taken at intervals of between 7 and 21 days	Inland waters
Colour	Change due to waste discharges not to exceed 30 Hazen units	Water gathering ground
	Change due to waste discharges not to exceed 50 Hazen units	Inland waters

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

Table 8.3 Summary of Water Quality Objectives for the Western Buffer 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	Water gathering ground subzone and other Inland waters
5-Day biochemical oxygen demand (BOD_5)	Change due to waste discharges not to exceed 3 mg/l	Water gathering ground subzones
	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 15 mg/l	Water gathering ground subzones
	Change due to waste discharges not to exceed 30 mg/l	Inland waters
pH	To be in the range of 6.5 – 8.5, change due to waste discharges not to exceed 0.2	Marine waters
	To be in the range of 6.5 – 8.5	Water gathering ground subzones
	To be in the range of 6.0 – 9.0	Inland waters
Salinity	Change due to waste discharges not to exceed 10% of ambient	Whole zone
Temperature	Change due to waste discharges not to exceed 2 ^{o}C	Whole zone

Parameters	Objectives	Sub-Zone
Suspended solids (SS)	Not to raise the ambient level by 30% caused by waste discharges and shall not affect aquatic communities	Marine waters
	Change due to waste discharges not to exceed 20 mg/l of annual median	Water gathering ground subzones
	Change due to waste discharges not to exceed 25 mg/l of annual median	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 0.4 mg(N)/l	Marine waters
Toxic 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
Bacteria	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
	Less than 1 per 100 ml, calculated as the geometric mean of the most recent 5 consecutive samples taken at intervals of between 7 and 21 days	Water gathering ground subzones
	Not exceed 1000 per 100 ml, calculated as the geometric mean of the most recent 5 consecutive samples taken at intervals of between 7 and 21 days	Inland waters
Colour	Change due to waste discharges not to exceed 30 Hazen units	Water gathering round
	Change due to waste discharges not to exceed 50 Hazen units	Inland waters
Turbidity	Shall not reduce light transmission substantially from the normal level	Bathing beach subzones

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

Water Supplies Department (WSD) Water Quality Criteria

8.3.3 Besides the WQOs stipulated under the WPCO, the WSD has specified a set of objectives for water quality at flushing water intakes. The list is shown in **Table 8.4**. The target limit for suspended solids (SS) at these intakes is 10mg/l or less.

Table 8.4 WSD's Water Quality Criteria for Flushing Water at Sea Water Intakes

Parameter (in mg/l unless otherwise stated)	Target Limit
Colour (HU)	< 20
Turbidity (NTU)	< 10
Threshold Odour Number (odour unit)	< 100
Ammoniacal Nitrogen	< 1
Suspended Solids	< 10
Dissolved Oxygen	> 2
Biochemical Oxygen Demand	< 10
Synthetic Detergents	< 5
E. coli (no. per 100ml)	< 20,000

Cooling Water Intake Standards

8.3.4 Based on a questionnaire survey conducted under the approved Comprehensive Feasibility Study for Wan Chai Development Phase II (CFSWDII) EIA [(1)], a SS limit of 40mg/l was adopted as the assessment criterion for Admiralty Centre intake and MTRC South intake. No information on the SS limit is available for other cooling water intakes. These findings have been confirmed by a telephone survey conducted under the recent approved EIA for the Hong Kong Convention and Exhibition Centre (HKCEC) Atrium Link Extension (ALE) and further verified by a questionnaire survey conducted under another recent approved EIA for the Dredging Works for Proposed Cruise Terminal at Kai Tak. There are no water quality criteria available for the intake of the proposed DSC at Kai Tak.

Technical Memorandum

8.3.5 Discharges of effluents are subject to control under the WPCO. The Technical Memorandum on Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters (TM-DSS) gives guidance on the permissible effluent discharges based on the type of receiving waters (foul sewers, storm water drains, inland and coastal waters). The limits control the physical, chemical and microbial quality of effluents. Any effluent from the Project must comply with the standards for effluents discharged into the foul sewers, inshore waters or marine waters of the Victoria Harbour WCZ, as given in the TM-DSS.

Practice Note

8.3.6 A Practice Note for Professional Persons (ProPECC) was issued by the EPD to provide guidelines for handling and disposal of construction site discharges. The ProPECC PN 1/94 "Construction Site Drainage" provides good practice guidelines for dealing with ten types of discharge from a construction site. These include surface runoff, boring and drilling water, bentonite slurry, water for testing and sterilisation of water retaining structures and water pipes, wastewater from building constructions, acid cleaning, etching and pickling wastewater, and wastewater from site facilities. Practices given in the ProPECC PN 1/94 should be followed as far as possible during construction to minimise the water quality impact due to construction activities.

(1) Territory Development Department (July 2001). Agreement No. CE 74/98, Wan Chai Development Phase II, Comprehensive Feasibility Study, Environmental Impact Assessment Report, Volume I – Text.

Assessment Criteria for Coral

8.3.7 Potential impacts on benthic organisms, including corals, may arise through excessive sediment deposition. The magnitude of impacts on marine ecological sensitive receivers was assessed based on the predicted sedimentation rate.

8.3.8 According to Pastorok and Bilyard [(2)] and Hawker and Connell [(3)], a sedimentation rate higher than 0.1 kg/m^2/day would introduce moderate to severe impact upon corals. This criterion has been adopted for protecting the corals in Hong Kong under other approved EIAs such as Tai Po Sewage Treatment Works Stage 5 EIA [(4)], Further Development of Tseung Kwan O Feasibility Study EIA, Wan Chai Reclamation Phase II EIA, Eastern Waters MBA Study [(5)], West Po Toi MBA Study [(6)] and Tai Po Gas Pipeline Study [(7)]. This sedimentation rate criterion is considered to offer sufficient protection to marine ecological sensitive receivers and is anticipated to guard against unacceptable impacts. This protection has been confirmed by previous EM&A results which have indicated no adverse impacts to corals have occurred when this assessment criterion has been adopted.

8.3.9 The assessment criteria used in this Project for protection of corals identified at Green Island, Junk Bay and Cape Collinson is also based on the WQO for SS established under the WPCO, i.e. the SS elevations should be less than 30% of ambient baseline conditions. The WQO for SS has also been adopted under the approved Tai Po Sewage Treatment Works Stage 5 EIA as one of the assessment criteria for evaluating the water quality impact from the sewage effluent on corals identified at Tolo Harbour, Green Island and Junk Bay.

8.3.10 The above assessment criteria would be used to assess water quality impact to coral habitats (i.e. the far field ecological sensitive receivers) as identified and indicated in **Figure 8.2**. As discussed in **Section 8.2** above, the isolated coral colonies found in the KTD area are not considered as sensitive coral site and are therefore not covered in this water quality impact assessment.

Sediment Quality Assessment Criteria

8.3.11 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 minimises the loss of contaminants either into solution or by suspension.

(2) Pastorok, R.A. and Bilyard, G.R. (1985). “Effects of sewage pollution on coral-reef communities.” *Marine Ecology Progress Series* 21: 175-189.

(3) Hawker, D. W. and Connell, D. W. (1992). “Standards and Criteria for Pollution Control in Coral Reef Areas” in Connell, D. W and Hawker, D. W. (eds.), *Pollution in Tropical Aquatic Systems*, CRC Press, Inc.

(4) Maunsell Consultants Asia Limited (2003). Tai Po Sewage Treatment Works Stage 5, EIA Report, Drainage Services Department, 2003

(5) Hyder (1997). Sand Dredging and Backfilling of Borrow Pits at the Potential Eastern Waters Marine Borrow Area, EIA Report, CED, 1997.

(6) ERM-Hong Kong, Limited (2001). Focused Cumulative Water Quality Impact Assessment of Sand Dredging at the West Po Toi Marine Borrow Area Final Report.

(7) ERM-Hong Kong, Limited (2003). The Proposed Submarine Gas Pipelines from Cheng Tou Jiao Liquefied Natural Gas Receiving Terminal, Shenzhen to Tai Po Gas Production Plant, Hong Kong, EIA Report, The Hong Kong and China Gas Company Limited, 2003

- 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.

8.3.12 The sediment quality criteria for the classification of sediment are presented in **Table 8.5**.

Table 8.5 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	3160
PAHs (High Molecular Weight)	1700	9600
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

<u>Potential Water Quality Impacts Related to Cooling Water Discharges</u>

8.3.13 Thermal plumes associated with the outfalls for cooling water discharges will lead to a temperature rise in the receiving water. The WQO for the Victoria Harbour WCZ stipulated that the temperature rise in the water column due to human activity should not exceed 2 ^{o}C (**Table 8.1**).

8.3.14 Chlorine, in the form of sodium hypochlorite solution or produced through electrolysis of sea water, is commonly used as an anti-fouling agent or biocide for the treatment of cooling water within the cooling systems. Residual chlorine discharging to the receiving water is potentially harmful to marine organisms. A previous study (8) indicated that a residual chlorine level of 0.02 mg/l would have an adverse impact on marine organisms. EPD had commissioned an ecotoxicity study (9) on TRC using local species. The lowest No Observable Effect Concentration (NOEC) value from that study was 0.02 mg/L. The United States Environmental Protection Agency (USEPA) has a more stringent limit of 0.0075 mg L^{-1} for residual chlorine that has been adopted as the assessment criterion for this Study.

(8) Langford, T. E. (1983). Electricity Generation and the Ecology of Natural Waters.
(9) Tender Ref. WP 98-567 Provision of Service for Ecotoxicity Testing of Marine Antifoulant – Chlorine in Hong Kong Final Report January 2000. Submitted to Environmental Protection Department by the Centre for Coastal Pollution and Conservation, City University of Hong Kong.

8.3.15 C-Treat-6 is the trade name of a commercially available surfactant-based antifouling / anticorrosion chemical agent that is commonly used for the cooling water systems which contains the active ingredient '30% tallow 1,3-propylene diamine' at a typical concentration of 33% (measured as amine content). It is acutely toxic to aquatic life. Ma et al [10] considered an interim maximum permissible concentration (based on an ecotoxicity study on marine brown shrimp) of 0.1 mg C-Treat-6 per litre in the ambient water acceptable from an ecotoxicological standpoint.

8.4 Description of the Environment

Marine Water Quality in the Victoria Harbour

8.4.1 The marine water quality monitoring data routinely collected by EPD in the Victoria Harbour were used to establish the baseline condition. A summary of water quality data for selected EPD monitoring stations is presented in **Table 8.6** and **Table 8.7** for the Victoria Harbour WCZ (VM1 VM2, VM4-VM8, VM12 and VM15), the Eastern Buffer WCZ (EM1, EM2) and the Western Buffer WCZ (WM2 - WM4). Locations of the monitoring stations are shown in **Figure 8.2**. As the HATS Stage I was commissioned in late 2001, the data shown in **Table 8.6** and **Table 8.7** represent the situation after the commissioning of HATS Stage I. Descriptions of the baseline conditions for individual WCZ provided in the subsequent sections are extracted from the EPD's report "Marine Water Quality in Hong Kong 2006" (which is the latest version available at the time of preparing this Report).

Victoria Harbour

8.4.2 In 2006, the marked improvements in the eastern Victoria Harbour (VM1 and VM2) and moderate improvements in the mid harbour area (VM4 and VM5) since HATS Stage 1 was commissioned were generally sustained. Several monitoring stations in the WCZ are located close to sewage outfalls, including VM5 (Wan Chai East and Wan Chai West Preliminary Treatment Works (PTW) outfall), VM6 (Central PTW outfall), VM4 (North Point PTW outfall) and VM8 (Stonecutters Island STW – HATS Stage I outfall). The water quality at these stations was inevitably subject to the direct impact of sewage discharge from these outfalls.

8.4.3 Compliance with the WQO for TIN was 80% in 2006. The TIN level exceeded the WQO at two stations (VM7 and VM14) in the Harbour west and Rambler Channel respectively. Full compliance with WQOs for UIA and bottom DO was achieved in 2006 at all stations. The compliance with the WQO for depth-averaged DO was 90%. The depth-averaged DO level exceeded the WQO at VM12 in Rambler Channel.

Eastern Buffer

8.4.4 The water quality at the Eastern Buffer was stable and improvements since HATS Stage 1 were sustained. Full compliance with all the WQOs was achieved in 2006.

Western Buffer

8.4.5 Full compliance with all the WQOs was achieved in the Western Buffer in 2006 except for one station in the western-most station (WM4) where the depth-averaged DO level exceeded the WQO. This station (WM4) is closest to the Pearl River flow and was subject to water stratification during summer which caused the DO exceedance. The *E.coli* level in this zone was high due to the effluent from HATS Stage 1 which is yet to be equipped with disinfection facilities.

(10) Ma, S. W. Y., Kueh, C. S. W., Chiu, G. W. L., Wild, S. R. and Yip, J. Y. (1998). "Environmental Management of Coastal Cooling Water Discharges in Hong Kong" in *Wat. Sci. Tech.* Vol. 38, No. 8-9, pp. 267 – 274.

Table 8.6 Summary Statistics of 2006 Marine Water Quality in the Victoria Harbour

Parameter		Victoria Harbour East		Victoria Harbour Central		Victoria Harbour West		Stonecutters Island		Rambler Channel		WPCO WQO (in marine waters)
		VM1	VM2	VM4	VM5	VM6	VM7	VM8	VM15	VM12	VM14	
Temperature (^{o}C)		23.2 (17.4 – 26.7)	23.5 (17.4 – 27.5)	23.6 (17.4 – 27.6)	23.7 (17.4 – 27.5)	23.6 (17.5 – 27.4)	23.8 (16.9 – 27.9)	23.8 (16.9 – 27.9)	23.7 (17.6 – 27.7)	23.8 (17.2 – 27.1)	24.2 (17.4 – 27.8)	Not more than 2 ^{o}C in daily temperature range
Salinity		32.2 (29.5 – 33.4)	31.7 (27.8 – 33.0)	31.6 (27.4 – 33.0)	31.4 (27.3 – 32.8)	31.5 (27.3 – 32.8)	30.8 (24.1 – 33.0)	20.7 (23.3 – 33.0)	31.1 (26.2 – 32.8)	30.8 (25.4 – 32.9)	28.7 (16.8 – 33.0)	Not to cause more than 10% change
Dissolved Oxygen (DO) (% Saturation)	Depth average	82 (46 – 101)	81 (49 – 97)	80 (61 – 94)	77 (65 – 91)	78 (60 – 89)	80 (60 – 107)	85 (61 – 105)	80 (67 – 93)	77 (46 – 98)	84 (61 – 108)	Not available
	Bottom	80 (24 – 111)	81 (36 – 103)	79 (47 – 98)	76 (56 – 94)	75 (40 – 93)	77 (48 – 98)	82 (49 – 109)	78 (55 – 91)	75 (38 – 97)	83 (57 – 104)	Not available
Dissolved Oxygen (DO) (mg/l)	Depth average	5.9 (3.2 – 7.5)	5.8 (3.4 – 7.1)	5.7 (4.1 – 7.3)	5.5 (4.3 – 7.1)	5.5 (4.0 – 6.9)	5.7 (4.0 – 7.3)	6.0 (4.1 – 7.7)	5.7 (4.5 – 6.9)	5.5 (3.1 – 7.4)	6.0 (4.3 – 7.6)	Not less than 4 mg/l for 90% of the samples
	Bottom	5.7 (1.7 – 8.0)	5.8 (2.5 – 7.4)	5.6 (3.2 – 7.2)	5.4 (3.8 – 7.3)	5.4 (2.7 – 7.2)	5.5 (3.3 – 7.0)	5.8 (3.3 – 7.8)	5.5 (3.8 – 7.0)	5.3 (2.6 – 7.4)	5.9 (3.9 – 7.2)	Not less than 2 mg/l for 90% of the samples
pH		7.9 (7.7 – 8.2)	7.9 (7.7 – 8.1)	7.9 (7.7 – 8.1)	7.9 (7.7 – 8.1)	7.9 (7.7 – 8.1)	8.0 (7..7 – 8.3)	8.0 (7.8 – 8.3)	7.9 (7.7 – 8.0)	8.0 (7.8 – 8.3)	8.0 (7.8 – 8.4)	6.5 - 8.5 (± 0.2 from natural range)
Secchi disc Depth (m)		2.1 (1.2 – 3.0)	2.0 (1.4 – 3.1)	2.0 (1.4 – 3.0)	1.8 (1.4 – 2.7)	2.1 (1.5 – 2.7)	2.0 (1.2 – 2.5)	1.9 (1.0 – 2.5)	2.0 (1.3 – 2.5)	1.5 (0.5 – 2.1)	1.5 (1.0 – 2.0)	Not available
Turbidity (NTU)		12.6 (6.9 – 17.6)	11.2 (5.4 – 23.4)	12.1 (5.6 – 23.4)	11.6 (6.5 – 18.5)	11.1 (5.2 – 14.2)	11.5 (5.8 – 20.5)	11.9 (5.3 – 19.0)	12.4 (6.4 – 22.9)	15.6 (10.0 – 28.0)	12..6 (7.0 – 22.2)	Not available
Suspended Solids (SS) (mg/l)		5.5 (2.1 – 18.0)	4.2 (1.2 – 12.8)	4.9 (1.1 – 12.3)	4.6 (1.7 – 8.9)	4.5 (2.0 – 8.9)	5.5 (1.8 – 11.6)	5.9 (2.1 – 11.0)	6.1 (1.8 – 13.9)	11.0 (3.1 – 19.0)	5.9 (2.9 – 12.7)	Not more than 30% increase
5-day Biochemical Oxygen Demand (BOD_5) (mg/l)		0.6 (0.1 – 1.5)	0.6 (0.1 – 1.2)	0.7 (0.1 – 1.4)	1.0 (0.2 – 1.9)	0.8 (0.1 – 1.8)	0.8 (0.1 – 1.2)	0.7 (0.2 – 1.1)	0.7 (0.1 – 1.7)	0.7 (0.2 – 1.6)	0.7 (0.2 – 1.2)	Not available
Nitrite Nitrogen (NO_2-N) (mgN/l)		0.019 (0.004 – 0.067)	0.024 (0.004 – 0.084)	0.024 (0.006 – 0.079)	0.027 (0.009 – 0.093)	0.027 (0.009 – 0.095)	0.033 (0.014 – 0.053)	0.035 (0.009 – 0.060)	0.033 (0.010 – 0.120)	0.036 (0.011 – 0.053)	0.053 (0.010 – 0.100)	Not available
Nitrate Nitrogen (NO_3-N) (mgN/l)		0.08 (0.03 – 0.20)	0.10 (0.03 – 0.25)	0.11 (0.03 – 0.25)	0.12 (0.04 – 0.27)	0.13 (0.04 – 0.28)	0.16 (0.06 – 0.38)	0.16 (0.04 – 0.40)	0.15 (0.06 – 0.36)	0.17 (0.08 – 0.37)	0.27 (0.06 – 0.64)	Not available

Parameter	Victoria Harbour East		Victoria Harbour Central		Victoria Harbour West		Stonecutters Island		Rambler Channel		WPCO WQO (in marine waters)
	VM1	VM2	VM4	VM5	VM6	VM7	VM8	VM15	VM12	VM14	
Ammonia Nitrogen (NH_3-N) (mgN/l)	0.07 (0.04 – 0.13)	0.11 (0.04 – 0.20)	0.13 (0.05 – 0.23)	0.16 (0.09 – 0.30)	0.16 (0.11 – 0.25)	0.21 (0.07 – 0.52)	0.17 (0.13 – 0.26)	0.18 (0.12 – 0.29)	0.18 (0.05 – 0.28)	0.16 (0.04 – 0.23)	Not available
Unionised Ammonia (UIA) (mgN/l)	0.002 (0.001 – 0.004)	0.004 (0.001 – 0.007)	0.004 (0.002 – 0.007)	0.005 (0.003 – 0.008)	0.005 (0.003 – 0.007)	0.008 (0.003 – 0.018)	0.007 (0.004 – 0.016)	0.006 (0.003 – 0.009)	0.006 (0.003 – 0.011)	0.007 (0.003 – 0.014)	Not more than 0.021 mg/l for annual mean
Total Inorganic Nitrogen (TIN) (mgN/l)	0.18 (0.07 – 0.29)	0.23 (0.07 – 0.40)	0.26 (0.08 – 0.44)	0.31 (0.14 – 0.50)	0.32 (0.16 – 0.51)	0.40 (0.24 – 0.67)	0.37 (0.20 – 0.64)	0.36 (0.18 – 0.67)	0.39 (0.26 – 0.49)	0.48 (0.21 – 0.88)	Not more than 0.4 mg/l for annual mean
Total Nitrogen (TN) (mgN/l)	0.34 (0.22 – 0.49)	0.42 (0.20 – 0.64)	0.47 (0.22 – 0.69)	0.55 (0.30 – 0.83)	0.53 (0.34 – 0.73)	0.58 (0.45 – 0.75)	0.53 (0.38 – 0.86)	0.58 (0.35 – 0.86)	0.57 (0.39 – 0.75)	0.64 (0.31 – 1.06)	Not available
Orthophosphate Phosphorus (PO_4) (mgP/l)	0.02 (0.01 – 0.03)	0.03 (0.01 – 0.04)	0.03 (0.01 – 0.04)	0.03 (0.02 – 0.04)	0.03 (0.02 – 0.05)	0.03 (0.01 – 0.05)	0.03 (0.02 – 0.04)	0.03 (0.01 – 0.04)	0.03 (0.01 – 0.04)	0.03 (0.01 – 0.04)	Not available
Total Phosphorus (TP) (mgP/l)	0.04 (0.03 – 0.07)	0.05 (0.03 – 0.06)	0.05 (0.03 – 0.07)	0.06 (0.03 – 0.08)	0.06 (0.03 – 0.08)	0.05 (0.03 – 0.08)	0.04 (0.03 – 0.06)	0.06 (0.04 – 0.07)	0.05 (0.03 – 0.08)	0.04 (0.03 – 0.06)	Not available
Chlorophyll-*a* (µg/L)	2.6 (0.8 – 6.8)	3.0 (1.0 – 8.9)	2.9 (1.0 – 9.2)	2.8 (0.9 – 8.6)	2.9 (0.9 – 10.1)	2.6 (0.6 – 9.0)	2.7 (1.0 – 11.3)	3.5 (1.1 – 16.6)	2.1 (0.8 – 6.9)	3.4 (0.9 – 19.5)	Not available
E coli (cfu/100 ml)	440 (44 – 3400)	1100 (58 – 14000)	2600 (510 – 12000)	7700 (1900 – 22000)	5500 (650 – 33000)	9400 (2600 – 57000)	6100 (350 – 11000)	1800 (590 – 11000)	3400 (1500 – 6600)	1300 (320 – 5100)	Not available
Faecal Coliforms (cfu/100 ml)	940 (74 – 8600)	2600 (130 – 25000)	6500 (1800 – 40000)	19000 (3500 – 65000)	13000 (2500 – 100000)	23000 (5400 – 180000)	15000 (930 – 55000)	4800 (1300 – 23000)	8100 (4200 – 14000)	2800 (460 – 13000)	Not available

Notes:
1. Except as specified, data presented are depth-averaged values calculated by taking the means of three depths: Surface, mid-depth, bottom.
2. Data presented are annual arithmetic means of depth-averaged results except for *E.coli* and faecal coliforms that are annual geometric means.
3. Data in brackets indicate the ranges.

Table 8.7 Summary Statistics of 2006 Marine Water Quality in the Western and Eastern Buffer

Parameter		Western Buffer WCZ				Eastern Buffer WCZ		
		Hong Kong Island (West) WM2	Tsing Yi (South) WM3	Tsing Yi (West) WM4	WPCO WQO (in marine waters)	Chai Wan EM1	Tathong Channel EM2	WPCO WQO (in marine waters)
Temperature (°C)		23.8 (16.9 – 27.4)	23.6 (17.0 – 27.2)	23.6 (17.0 – 27.2)	Not more than 2 °C in daily temperature range	22.7 (15.8 – 28.0)	22.8 (15.7 – 27.9)	Not more than 2 °C in daily temperature range
Salinity		30.9 (23.9 – 33.2)	31.5 (27.2 – 33.0)	31.0 (26.6 – 33.0)	Not to cause more than 10% change	32.4 (29.7 – 33.8)	32.4 (29.2 – 33.8)	Not to cause more than 10% change
Dissolved Oxygen (DO) (% Saturation)	Depth average	86 (59 – 113)	82 (41 – 102)	80 (49 – 110)	Not available	80 (64 – 97)	84 (68 -109)	Not available
	Bottom	84 (52 – 114)	80 (37 – 111)	76 (20 – 109)	Not available	79 (51 – 98)	82 (51 – 101)	Not available
Dissolved Oxygen (DO) (mg/l)	Depth average	6.1 (4.0 – 8.1)	5.8 (2.8 – 7.8)	5.7 (3.3 – 7.9)	Not less than 4mg/l for 90% of the samples	5.7 (4.3 – 6.8)	6.0 (4.7 – 7.2)	Not less than 4mg/l for 90% of the samples
	Bottom	6.0 (3.5 – 8.2)	5.7 (2.5 – 8.0)	5.4 (1.4 – 7.8)	Not less than 2mg/l for 90% of the samples	5.7 (3.7 – 6.8)	5.9 (3.6 – 7.1)	Not less than 2mg/l for 90% of the samples
pH		8.0 (7.7 – 8.3)	8.0 (7.8 – 8.2)	8.0 (7.8 – 8.3)	6.5 - 8.5 (± 0.2 from natural range)	8.1 (7.8 – 8.4)	8.2 (7.8 – 8.5)	6.5 - 8.5 (± 0.2 from natural range)
Secchi disc Depth (m)		2.0 (1.3 – 2.5)	1.7 (1.0 – 2.3)	1.7 (0.8 – 2.5)	Not available	2.1 (1.5 – 2.7)	2.4 (1.5 – 3.7)	Not available
Turbidity (NTU)		12.0 (6.5 – 20.3)	13.8 (6.2 – 25.1)	14.3 (6.3 – 23.0)	Not available	10.0 (5.0 – 14.9)	9.7 (5.1 – 14.1)	Not available
Suspended Solids (SS) (mg/l)		4.8 (1.4 – 10.3)	7.7 (2.8 – 15.0)	7.6 (3.2 – 13.0)	Not more than 30% increase	3.2 (1.3 – 5.0)	3.2 (0.7 – 6.5)	Not more than 30% increase
5-day Biochemical Oxygen Demand (BOD_5) (mg/l)		0.6 (0.1 – 1.2)	0.7 (0.2 – 1.2)	0.6 (0.1 – 1.1)	Not available	0.6 (0.2 – 1.0)	0.5 (0.2 – 1.1)	Not available
Nitrite Nitrogen (NO_2-N) (mg/l)		0.034 (0.006 – 0.057)	0.032 (0.007 – 0.052)	0.037 (0.007 – 0.056)	Not available	0.02 (0.01 – 0.05)	0.01 (<0.01 – 0.05)	Not available
Nitrate Nitrogen (NO_3-N) (mg/l)		0.16 (0.03 – 0.43)	0.14 (0.04 – 0.32)	0.17 (0.05 – 0.38)	Not available	0.07 (0.03 – 0.17)	0.06 (0.02 – 0.18)	Not available
Ammonia Nitrogen (NH_3-N) (mg/l)		0.10 (0.05 – 0.21)	0.13 (0.04 – 0.23)	0.12 (0.02 – 0.22)	Not available	0.07 (0.03 – 0.12)	0.05 (0.02 – 0.09)	Not available

Parameter	Western Buffer WCZ				Eastern Buffer WCZ		
	Hong Kong Island (West)	Tsing Yi (South)	Tsing Yi (West)	WPCO WQO (in marine waters)	Chai Wan	Tathong Channel	WPCO WQO (in marine waters)
	WM2	WM3	WM4		EM1	EM2	
Unionised Ammonia (UIA) (mg/l)	0.004 (0.001 – 0.009)	0.005 (0.003 – 0.011)	0.005 (0.002 – 0.010)	Not more than 0.021mg/l for annual mean	0.004 (0.001–0.013)	0.003 (0.001 – 0.012)	Not more than 0.021mg/l for annual mean
Total Inorganic Nitrogen (TIN) (mg/l)	0.29 (0.12 – 0.55)	0.30 (0.15 – 0.45)	0.32 (0.17 – 0.48)	Not more than 0.3mg/l for annual mean	0.16 (0.07 – 0.25)	0.12 (0.05 – 0.25)	Not more than 0.4mg/l for annual mean
Total Nitrogen (TN) (mg/l)	0.43 (0.23 – 0.79)	0.45 (0.27 – 0.60)	0.47 (0.28 – 0.65)	Not available	0.27 (0.14 – 0.40)	0.23 (0.13 – 0.40)	Not available
Orthophosphate Phosphorus (PO_4) (mg/l)	0.02 (0.01 – 0.03)	0.02 (0.01 – 0.03)	0.02 (0.01 – 0.03)	Not available	0.02 (0.01 – 0.02)	0.01 (0.01 – 0.02)	Not available
Total Phosphorus (TP) (mg/l)	0.04 (0.02 – 0.06)	0.04 (0.02 – 0.07)	0.04 (0.02 – 0.07)	Not available	0.03 (0.02 – 0.05)	0.02 (0.02 – 0.04)	Not available
Chlorophyll-*a* (µg/l)	2.8 (0.9 – 10.9)	2.0 (0.8 – 6.0)	2.4 (1.0 – 9.9)	Not available	1.7 (0.8 – 5.1)	1.7 (0.5 – 5.1)	Not available
E. coli (cfu/100ml)	910 (16 – 5400)	3600 (1100 – 15000)	1400 (200 – 8700)	Not available	130 (29 – 1300)	36 (2 – 1800)	Not available
Faecal Coliforms (cfu/100ml)	2000 (42 – 11000)	8600 (2900 – 31000)	3000 (360 – 28000)	Not available	290 (41 – 4200)	86 (3 – 4400)	Not available

Notes:
1. Except as specified, data presented are depth-averaged values calculated by taking the means of three depths: Surface, mid-depth, bottom.
2. Data presented are annual arithmetic means of depth-averaged results except for *E.coli* and faecal coliforms that are annual geometric means.
3. Data in brackets indicate the ranges.

Marine Water Quality within Kwun Tong and To Kwa Wan Typhoon Shelter

8.4.6 A summary of the published EPD monitoring data (in 2006) collected from the monitoring stations in the Kwun Tong Typhoon Shelter (VT4) and To Kwa Wan Typhoon Shelter (VT11) is presented in **Table 8.8**. Marine water quality monitoring is conducted by EPD at the typhoon shelters on a monthly basis. Water samples are taken at three water depths, namely, 1 m below water surface, mid-depth and 1 m above sea bed, except where the water depth is less than 6 m, in which case the mid-depth station may be omitted. Locations of the monitoring stations are shown in **Figure 8.3**.

Table 8.8 Summary Statistics of 2006 Marine Water Quality at the Kwun Tong and To Kwa Wan Typhoon Shelter

Parameter		Kwun Tong VT4	To Kwa Wan VT11	WPCO WQO (in marine waters)
Temperature (^{o}C)		23.9 (17.5 – 28.8)	23.5 (17.2 – 28.6)	Not more than 2 ^{o}C in daily temperature range
Salinity (ppt)		29.3 (23.2 – 31.4)	30.5 (21.8 – 32.7)	Not to cause more than 10% change
Dissolved Oxygen (DO) (% saturation)	Depth average	68 (29 – 112)	83 (56 – 115)	Not available
	Bottom	66 (26 – 110)	84 (54 – 117)	Not available
Dissolved Oxygen (DO) (mg/l)	Depth average	4.9 (2.0 – 7.6)	6.0 (3.9 – 7.9)	Not less than 4 mg/L for 90% of the samples
	Bottom	4.7 (1.8 – 7.4)	6.0 (3.7 – 8.0)	Not less than 2 mg/L for 90% of the samples
pH value		7.7 (7.4 – 8.1)	8.0 (7.7 – 8.3)	6.5 - 8.5 ($\pm$ 0.2 from natural range)
Secchi disc (m)		1.4 (1.0 – 2.0)	1.7 (0.9 – 2.5)	Not available
Turbidity (NTU)		12.7 (4.1 – 30.1)	14.8 (9.0 – 22.1)	Not available
Suspended Solids (SS) (mg/l)		2.6 (1.2 – 3.5)	6.7 (2.4 – 20.6)	Not more than 30% increase
Silica (as SiO_2) (mg/l)		1.0 (0.4 – 1.8)	0.7 (0.2 – 1.6)	Not available
5-day Biochemical Oxygen Demand (BOD_5) (mg/l)		2.2 (1.1 – 3.5)	1.0 (0.6 – 1.6)	Not available
Nitrite Nitrogen (NO_2-N) (mg/l)		0.157 (0.082 – 0.227)	0.029 (0.012 – 0.059)	Not available
Nitrate Nitrogen (NO_3-N) (mg/l)		0.34 (0.22 – 0.64)	0.16 (0.05 – 0.42)	Not available
Ammoniacal Nitrogen (NH_3-N) (mg/l)		0.48 (0.29 – 0.65)	0.12 (0.06 – 0.21)	Not available
Unionised Ammonia (UIA) (mg/l)		0.011 (0.005 – 0.016)	0.004 (0.002 – 0.006)	Not more than 0.021 mg/L for annual mean
Total Inorganic Nitrogen (TIN) (mg/l)		0.97 (0.71 – 1.42)	0.31 (0.13 – 0.54)	Not more than 0.4 mg/L for annual mean
Total Nitrogen (TN) (mg/l)		1.33 (1.02 – 1.82)	0.53 (0.39 – 0.80)	Not available
Ortho-Phosphate (PO_4) (mg/l)		0.214 (0.153 – 0.295)	0.028 (0.007 – 0.050)	Not available
Total Phosphorus (TP) (mg/l)		0.26 (0.20 – 0.36)	0.05 (0.04 – 0.06)	Not available
Chlorophyll-*a* (µg L-1)		18.2 (1.0 – 35.0)	7.9 (1.0 – 20.5)	Not available
E. coli (cfu per 100 mL)		9,200 (2,800 – 29,000)	1,100 (340 – 4,400)	Not available
Faecal Coliforms (cfu per 100 mL)		22,000 (4,400 – 78,000)	2,600 (860 – 8,300)	Not available

Note: 1. Except as specified, data presented are depth-averaged data.
2. Data presented are annual arithmetic means except for *E. coli* and faecal coliforms that are geometric means.
3. Data enclosed in brackets indicate ranges.

8.4.7 Due to the embayment form and reduced flushing capacity of the typhoon shelter, marine water within the typhoon shelter is vulnerable to pollution. In 2006, high levels of *E.coli* were recorded at the Kwun Tong and To Kwa Wan Typhoon Shelters indicating faecal contamination. A high level of total inorganic nitrogen (TIN) was also recorded at the Kwun Tong Typhoon Shelter which breached the WQO.

Kai Tak Approach Channel

8.4.8 No long-term water quality data was collected at KTAC by EPD. Two baseline marine water quality surveys were carried out in October 2005 and January 2006 respectively under the KTPR. The survey locations include seven stations within the KTAC, namely AC1 - AC7, as shown in **Figure 8.3**. In each of the two baseline surveys, two monitoring events were carried out for typical spring and neap tides respectively. For each monitoring event, water quality measurements were taken once every three hours for a complete tidal cycle (roughly a 26-hour period). Water samples were taken at four water depths, namely water surface, 1 m below water surface, mid-depth, and 1 m from seabed respectively. For water depth of less than 6 m, the mid-depth measurement was omitted. For water depth of less than 3 m, only the mid-depth position was monitored.

8.4.9 The field survey results are tabulated in **Table 8.9** and **Table 8.10** for the two monitoring events respectively. The survey results are presented as averaged concentrations for suspended solids (SS), ammonia nitrogen (NH_3-N), total inorganic nitrogen (TIN) and biochemical oxygen demand (BOD) and 10th percentile values for bottom and depth-averaged dissolved oxygen (DO). The field data showed a gradient of water quality from the inner KTAC to the outer KTAC. The levels of nitrogen nutrients, ammonia and *E.coli* were found to be very high in the KTAC. The DO levels breached the WQO in October 2005 but complied well with the WQO in January 2006. The TIN levels exceeded the WQO in KTAC for both dry and wet seasons.

Table 8.9 Pollution Levels Measured at KTAC in October 2005

WQO	Mean Depth-averaged SS	Mean Depth-averaged NH_3-N	Geometric Mean Depth-averaged *E.coli*	Mean Depth-averaged TIN	Mean Depth-averaged BOD	10th Percentile Bottom DO	10th Percentile Depth-averaged DO
	mg/L	mg/L	cfu/100mL	mg/L	mg/L	mg/L	mg/L
	NA	NA	NA	0.4	NA	2	4
AC1	25	0.9	115519	**3.11**	11	**0.99**	**1.48**
AC2	28	1.0	17960	**3.21**	10	**0.74**	**1.18**
AC3	19	0.9	60517	**3.53**	9	**1.14**	**1.47**
AC4	20	1.2	37857	**3.15**	10	**0.93**	**1.33**
AC5	21	1.2	28832	**3.28**	8	**1.19**	**1.54**
AC6	26	1.4	34375	**2.76**	9	**0.86**	**1.41**
AC7	27	0.8	15863	**2.60**	7	2.06	**2.20**

Bolded and shaded – Exceedance of WQO
NA – WQO is not available

Table 8.10 Pollution Levels Measured at KTAC in January 2006

WQO	Mean Depth-averaged SS	Mean Depth-averaged NH_3-N	Geometric Mean Depth-averaged *E.coli*	Mean Depth-averaged TIN	Mean Depth-averaged BOD	10th Percentile Bottom DO	10th Percentile Depth-averaged DO
	mg/L	mg/L	cfu/100mL	mg/L	mg/L	mg/L	mg/L
	NA	NA	NA	0.4	NA	2	4
AC1	6	1.6	126945	**4.7**	10	3.0	5.4
AC2	4	1.5	72689	**4.1**	7	2.6	3.8
AC3	20	1.6	111217	**4.6**	11	3.1	5.1
AC4	4	1.3	81229	**3.7**	7	3.4	5.0
AC5	4	1.7	129380	**3.9**	10	4.4	6.6
AC6	4	2.2	132126	**3.4**	9	3.8	4.7
AC7	5	0.9	11833	**1.9**	5	6.2	5.5

Bolded and shaded – Exceedance of WQO
NA – WQO is not available

8.5 Identification of Environmental Impacts

8.5.1 Key water quality concerns associated with the Project are identified as follows:

<u>Operational Phase</u>

Use of KTAC and KTTS as an Area of General Amenity Value

<u>Background</u>

8.5.2 The Kai Tak Approach Channel (KTAC) and the Kwun Tong Typhoon Shelter (KTTS) receive storm water from the Kwun Tong, Kowloon Bay, Jordan Valley, San Po Kong and Wong Tai Sin areas. **Figure 8.4** shows the locations of storm outfalls in the Study Area and their respective catchments.

8.5.3 The KTAC is embayed by the former runway and the existing breakwaters of KTTS which results in poor water circulation. Therefore, the pollution loading discharged into the KTAC cannot be effectively dispersed which causes the pollution problem. The water pollution sources in KTAC and KTTS include:

- Secondary treated (un-disinfected) effluent of about 320,000 m^3 each day [(11)] from the Tai Po and Sha Tin sewage treatment works (STW) under the Tolo Harbour Effluent Export Scheme (THEES) discharged into the KTAC via the Kai Tak Nullah (KTN);
- Polluted storm runoff or street washing to the drainage system;
- Expedient connections from trade and residential premises, and integrity problems of aged drainage and sewerage systems in the catchment areas in North and East Kowloon; and
- Discharges and contamination from the marine and mooring activities in the Public Cargo Working Area (PCWA) and KTTS.

(11) The flow rate was based on the current design flow of the two STWs.

8.5.4 The pollution loading discharged into KTAC, KTTS and Kowloon Bay has been quantitatively assessed based on detailed field survey and desk-top calculations under the Kai Tak Planning Review (KTPR) [(12)]. It was found that the KTN and Jordan Valley Box Culvert (JVBC) contributed the largest amount of total pollution loading discharged into KTAC, KTTS and Kowloon Bay. The contribution of dry weather pollution loading from different storm outfalls under the existing condition is given in **Figure 8.4**.

8.5.5 THEES is one of the key pollution sources in terms of the nutrient levels. Amongst the loading discharged from the KTN outfall, it was estimated that during the dry season when the DWFI installed in the catchment of KTN are more effective, about 30% of the BOD and about half of the nutrient and SS loading would be contributed by the THEES effluent under the existing condition [(13)]. In terms of *E.coli*, the THEES effluent contributed only about 1% of the total loading discharged at the KTN outfall during the dry season under the existing condition. The Drainage Services Department (DSD) proposes to increase the capacity of the Tai Po and Sha Tin STWs (more effluent flows) but also to provide disinfection to reduce the *E.coli* concentrations to meet the new (more stringent) effluent quality standard. With the plan to provide disinfection to the THEES effluent in the future, the *E.coli* loading contribution from THEES would be even smaller. The discharges from PCWA and KTTS would only contribute a very minor portion of the overall pollution loading discharged into the KTAC and are therefore not included in **Figure 8.4**.

8.5.6 Without reclamation at the KTAC and KTTS, the water quality of these water bodies needs to be addressed as they may impose constraints to the future Kai Tak Development (KTD) on the land side.

Proposed Beneficial Use of KTAC and KTTS

8.5.7 The WPCO provides the major statutory framework for the protection and control of water quality in Hong Kong. Corresponding statements of WQO are stipulated for different water regimes (marine waters, inland waters, bathing beaches subzones, secondary contact recreation subzones and fish culture subzones) in the WCZ based on their beneficial uses.

8.5.8 The KTAC and KTTS are located within the Victoria Harbour (Phase 2) WCZ. There are currently no bathing beaches, secondary contact recreation and fish culture zone designated within the Victoria Harbour WCZ. No water quality objective is currently available for the non-contact activities such as boating and general waterfront usage. The WQO for the Victoria Harbour was established under the WPCO for the purpose of control of discharges into the water body but not for the purpose of planning individual developments. For a planned development with no human contact with the water and no polluted discharges, the minimum to be achieved under the EIAO would be no deterioration in the water quality (Annex 1.4 of Annex 6 of the EIAO-TM).

8.5.9 Under the KTPR, EPD have advised a set of specific water quality “compliance requirements” at KTAC and Kowloon Bay for the purpose of the water quality assessment of KTAC (which also applies to Kowloon Bay) which is shown in **Table 8.11** covering the following beneficial uses:

- BU1 - Bathing;
- BU2 - Secondary Contact Recreation; and
- BU3 - General Amenity

(12) South East Kowloon Comprehensive Planning and Engineering Review Stage 1: Planning Review
(13) The total pollution flows and loads discharged at the KTN outfall were measured under the dry season field surveys conducted in 2005/2006 under the KTPR. As the existing THEES flows and loads are known from DSD records, the loading contribution from THEES can be estimated.

Table 8.11 Summary of Water Quality Objectives for the Victoria Harbour WCZ

WQO	Description	WQOs applicable to water body with assigned beneficial use		
		BU 1 :Bathing	BU 2 : Secondary Contact Recreation	BU 3 : General Amenity
Aesthetic Appearance [a]	(i) There should be no objectionable odours or discolouration of the water. (ii) Tarry residues, floating wood, articles made of glass, plastic, rubber or of any other substance should be absent. (iii) Mineral oil should not be visible on the surface. Surfactants should not give rise to a lasting foam. (iv) There should be no recognizable sewage-derived debris. (v) Floating, submerged or semi-submerged objects of a size likely to interfere with the movement of free vessels, or cause damage to the vessels, should be absent. (vi) The water should not contain substances which settle to form objectionable deposits.	✔	✔	✔
Dissolved Oxygen [a]	The level of dissolved oxygen should not fall below 4 mg per litre for 90% of the sampling occasions during the whole year; values should be calculated as the annual water column average [d]. In addition, the concentration of dissolved oxygen should not be less than 2 mg per litre within 2 m of the seabed for 90% of the sampling occasions during the whole year.	✔	✔	✔
Temperature [a]	Human activity should not cause the daily temperature range to change by more than 2.0 °C.	✔	✔	✔
Salinity [a]	Human activity should not cause the salinity level to change by more than 10%.	✔	✔	✔
Suspended Solids [a]	Human activity should neither cause the suspended solids concentration to be raised more than 30% nor give rise to accumulation of suspended solids which may adversely affect aquatic communities.	✔	✔	✔
Ammonia [a]	The un-ionized ammonical nitrogen level should not be more than 0.021 mg per litre, calculated as the annual average (arithmetic mean).	✔	✔	✔
Nutrients [a]	(i) Nutrients should not be present in quantities sufficient to cause excessive or nuisance growth of algae or other aquatic plants. (ii) Without limiting the generality of objective (i) above, the level of inorganic nitrogen should not exceed 0.4 mg per litre, expressed as annual water column average [d].	✔	✔	✔

WQO	Description	WQOs applicable to water body with assigned beneficial use		
		BU 1 :Bathing	**BU 2 : Secondary Contact Recreation**	**BU 3 : General Amenity**
Toxic substances [a]	(i) Toxic substances in the water should not attain such levels as to produce significant toxic, carcinogenic, mutagenic or teratogenic effects in humans, fish or any other aquatic organisms, with due regard to biologically cumulative effects in food chains and to interactions of toxic substances with each other. (ii) Human activity should not cause a risk to any beneficial use of the aquatic environment.	✔	✔	✔
Bacterial *(E.coli)* (I) [b]	The level of Escherichia coli should not exceed 180 per 100mL, calculated as the geometric mean of all samples collected from March to October inclusive in one calendar year. Samples should be taken at least 3 times in a calendar month at intervals of between 3 and 14 days.	✔		
Bacterial (*E.coli.*) (II) [c]	The level of Escherichia coli should not exceed 610 per 100mL, calculated as the geometric mean of all samples collected in one calendar year.		✔	
pH [b]	The pH of the water should be within the range of 6.0 – 9.0 for 95% of samples. In addition, waste discharges shall not cause the natural pH range to be extended by more than 0.5 units.	✔		
Phenol [b]	Phenols shall not be present in such quantities as to produce a specific odour, or in concentrations greater than 0.05mg per litre as C_6H_5OH.	✔		
Turbidity [b]	No changes in turbidity or other factors arising from waste discharges shall reduce light transmission substantially from the normal level.	✔		

(a) WQOs assigned for general uses of marine water in Victoria Harbour WCZ.
(b) WQOs assigned for bathing use in other WCZs.
(c) WQOs assigned for secondary contact recreation use in other WCZs.
(d) Expressed normally as the arithmetic mean of at least 3 measurements at 1m below surface, mid depth and 1 m above the seabed. However, in water of a depth of 5 m or less the mean shall be that of 2 measurements (1 m below surface and 1 m above seabed), and in water of less than 3 m the 1 m below surface sample shall apply.

8.5.10 Major reviews received during the planning review from Stage 1 Public Participation were in favour of retaining KTAC with a view to preserving characteristics water body in the area and enhancing the contact between the people and the Victoria Harbour. There is also request for turning KTAC into a water sports area.

8.5.11 For beneficial uses such as bathing and secondary contact recreation, **Table 8.11** sets out the standard of the water quality requirements. The water quality in particular should meet the target level faecal pollution indicator (*E.coli*), 610 per 100mL for secondary contact activity (water recreation) and 180 per 100mL for primary contact activity (bathing).

8.5.12 The water quality of KTN, which discharges to KTAC, is monitored by EPD routinely. High annual geometric mean levels of *E.coli* were recorded along the KTN, which receives both natural stormwater runoff and THEES effluent, ranging from 39,000 to 53,000 per 100 mL in the upper and middle section of the KTN in 2006. Very high geometric mean concentration was recorded at the outfall of KTN of 580,000 per 100 mL in 2006. High level of *E.coli* of over 9,000 per 100 mL for annual geometric mean was also recorded in KTTS in 2006.

8.5.13 In the long term, the capacity of the Shatin and Tai Po Sewage Treatment Works (STWs) would be increased and there would be increase in effluent flow. EPD/DSD are planning to provide disinfection for both the Shatin and Tai Po STWs effluent (disinfection for Shatin STW scheduled for completion in 2008) and there is currently no plan to divert THEES away from KTAC.

8.5.14 Despite the plan for disinfection, the *E.coli* level of the THEES still cannot meet the standard for both primary and secondary contact activities. Coupled with the pollution discharges during the low flow condition from various stormwater systems into KTAC, improvement of the water quality standards of KTAC which is suitable for secondary contact activities is a far reaching task unless total diversion/removal of both these pollutant sources can be considered.

8.5.15 In view of the above, the target improvement of water quality of KTAC is first to demonstrate that there are practical mitigation measures that can improve the water quality standard to amenity use.

<u>Study History</u>

Preliminary Assessment

8.5.16 A preliminary technical analysis of the key environmental issues of KTAC was conducted under the KTPR based on information available from previous studies. The key issues of KTAC include poor water quality, contaminated sediment and odour impacts. As the previous development plan involves reclamation at KTAC, there was no detailed analysis of KTAC water quality available from the previous studies.

8.5.17 An assessment of the effectiveness of the possible mitigation measure to improve the water quality at KTAC is vital before it could be determined whether or not the "no reclamation" scenario would be a feasible solution to the observed environmental problems at KTAC.

8.5.18 Under the KTPR, various mitigation options were examined for improving the water quality and water circulation of KTAC including:

(1) Diversion of KTN flow into Kowloon Bay which involves construction of pumping station, pipe system and seawall outfall;

(2) Diversion at KTN flow into Victoria Harbour by discharging at the end of Runway which also involves construction of pumping station, pipe system and seawall outfall;

(3) Removal of breakwater of KTTS which necessitates the decommissioning of KTTS;

(4) Introduction of canal(s) or opening(s) in the runway; and

(5) Interception of Dry Weather Flow which involves provision of Dry Weather Flow Interceptors (DWFI) at the stormwater system to divert the low flows to the sewerage system.

(6) Installation of tide gate(s) at the KTAC to allow the discharge of flow in ebb tides only.

8.5.19 To minimise the level of uncertainty and provide a solid ground for testing feasibility of different mitigation options, preliminary water quality modelling was conducted under the KTPR to assess the broad acceptability and technical feasibility of a number of possible and practical mitigation options. Five different combinations of the mitigation measures as shown in **Table 8.12** were preliminarily assessed under the KTPR.

Table 8.12 Mitigation Proposals Considered under the KTPR

Mitigation Measures	Scenario 3	Scenario 4	Scenario 5	Scenario 6	Scenario 7	Scenario 8	Scenario 9
Partial Diversion of KTN	√						
Opening a 200 m Gap at the runway immediately south of the taxiway bridge	√						
Opening a Large Gap (600m) at the northern end of the runway (north of taxiway bridge)		√			√	√	
Opening two 200 m Gaps at the runway near the mouth of KTN and to the south of the taxiway bridge respectively			√	√			
Removal Breakwaters of To Kwa Wan Typhoon Shelter (TKWTS)		√		√			
Installation of two tide gates at the outfalls of KTN and JVBC respectively						√	
Installation of one tide gate at the downstream end of the KTAC							√

Remark: Scenario 1 is existing condition
Scenario 2 is 2016 condition without mitigation

8.5.20 Preliminary water quality modelling was conducted using an available model developed for the general Victoria Harbour area namely the VH model. The purpose of the preliminary water quality modelling was to determine the most preferred mitigation option for detailed analysis. The VH model has several limitations that may lead to some degrees of uncertainties on the effectiveness of mitigation scenarios assessed. The limitations are due to the fact that the purpose of the VH model was to assess the impacts on the overall water quality in the Victoria Harbour. The model prediction by the VH model would still be sufficient for comparison of the effectiveness of different mitigation options so identified for improving water quality of KTAC.

8.5.21 Based on the results of the initial preliminary modelling exercise, Scenario 7 (opening a 600 m gap at the runway) was considered to be the most practicable and effective option for improving the water quality and circulation at KTAC.

Detailed Assessment

8.5.22 The preferred mitigation scenario (opening a 600 m gap at northern end of the runway) as identified by preliminary water quality modelling was then further tested by a detailed water quality modelling exercise conducted under the KTPR. The primary objective of the detailed water quality modelling and assessment was to obtain reliable hydrodynamic and water quality data for the calibration of a new fine grid model, namely SEK model, to assess the impacts on water quality from the preferred mitigation measures and to confirm the findings of the preliminary water quality modelling.

8.5.23 Detailed modelling was carried out for 2 scenarios, namely Scenario I and Scenario II respectively. Scenario I represents the 2016 baseline situation without implementation of any mitigation measure. Scenario II represents the mitigated scenario in 2016 with a large gap (about 600m) at the northern end of the runway (north of taxiway bridge). The 600 m gap of the runway will be covered by a piled deck structure. The preliminary arrangement of the piled deck structure has been modelled under Scenario II. The results are compared between the two scenarios to assess the effectiveness of the proposed mitigation measures.

8.5.24 The SEK model predicted that the water circulation (in terms of flow velocity and flushing capacity) would be significantly improved due to the 600 m opening at the runway. The sedimentation rates were also found to be significantly reduced in the KTAC and KTTS due to the increase of the water circulation.

8.5.25 The model results showed that the 600 m opening would improve the water quality at KTAC and KTTS for all the selected parameters and reduce the overall extent of WQO exceedances within the Study Area. However, the water quality would still breach the water quality objective for water recreation use. The model results also indicated that the water quality at the WSD's Tai Wan flushing water intake in the outer Kowloon Bay would fully comply with the WSD's water standards with the 600 m opening at the runway.

Additional Assessment for this Study

8.5.26 Introduction of opening would require careful consideration of the location at runway. Different locations and width of the opening have been considered under the KTPR as follows:

- Opening a 200 m gap at the runway immediately south of the taxiway bridge
- Opening a large gap (600m) at the northern end of the runway (north of taxiway bridge)
- Opening two 200 m gaps at the runway near the mouth of KTN and to the south of the taxiway bridge respectively

8.5.27 Opening of a large gap (600m) at the runway has been demonstrated by water quality modelling conducted under the KTPR to be the preferred option to improve the water circulation of the KTAC.

8.5.28 Under the KTPR, water quality model simulations were performed for 15 days (excluding the spin-up time) each under typical wet and dry seasons for each assessment scenario. The Schedule 3 EIA Study Brief for the feasibility study of KTD however requires that the water quality model simulations shall be performed for at least one complete calendar year under operational phase. As such, the water quality effects from the 600 m runway opening have been re-examined under this Study based on a series of 1-year model simulations incorporating monthly variations in Pearl River discharges, solar radiation, water temperature and wind velocity to confirm the findings of the KTPR. Additional sensitivity modelling was also conducted under this Study to examine the feasibility of refining the size of the opening at the northern runway to 400 m.

8.5.29 In addition, the modelling conducted under the KTPR did not take account of the new manoeuvring basin of the proposed cruise terminal at Kai Tak. The hydrodynamic effects of the new manoeuvring basin together with the piled deck structure at the runway opening have been modelled under this Study for cumulative assessment.

Overflow or Emergency Discharge from the Sewerage System

8.5.30 The potential water quality concerns associated with the operation of the sewage pumping station (SPS) will include the following:

- Occasional overflow of sewage effluent during storm event under normal operation
- Emergency sewage effluent discharge as the consequences of pump failure or interruption of the electrical power supply

8.5.31 During the sewage effluent overflow or emergency discharge, it is likely that there would be a transient elevation of the water pollution level in the receiving water body.

Spent Cooling Water Discharge

8.5.32 The proposed DCS would require discharges of spent cooling water along the waterfront of the KTD area. Spent cooling water will be discharged through culverts / outfalls into the harbour causing a potential increase in water temperature. The associated impact would also be related to the discharge of residual chlorine and biocide which is potentially harmful to marine life. In general, sodium hypochlorite would be used for seawater treatment which would result in a certain amount of residual chlorine in the spent cooling water. Besides chlorine, C-Treat-6 would be the only other chemical injection to the cooling system to protect the pipework against corrosion and biofouling. The proposed locations of intake and discharges for the proposed DCS are shown in **Figure 8.5**.

Road Runoff

8.5.33 Surface runoff from new roads proposed under this Project may be contaminated by oils leaked from passing vehicles. It is considered that impacts upon water quality will be minimal provided that the road works are designed with adequate drainage systems and appropriate oil interceptors, as required.

Fuel Spillage

8.5.34 No marine fuelling facilities or fuel storage will be provided at the proposed cruise terminal at Kai Tak. Therefore, risks of marine spillage from transportation of fuel oil by oil tanker or fuel barge, fuel uploading operation and vessel refuelling activities are not anticipated at Kai Tak. Besides, as the fuel tanks of cruise ships are normally fully encased inside the outer steel structure of the vessel, fuel spillage from cruise ship operation is thus not expected. Based on the past record available from the Marine Department, there was only one oil pollution incident in relation to cruise vessel in Hong Kong since 1998 which involved a spillage of fuel oil of less than 1 m^3 recorded during the vessel refuelling operation. No spillage from normal cruise operation was recorded so far. Potential water quality impacts in case of oil spillage (e.g. caused by vessel in collision) is considered to be adequately addressed by the existing Maritime Oil Spill Response Plan (MOSRP) established by the Marine Department. No oil spill assessment and modelling is therefore conducted.

Construction Phase

Marine-based Construction Works

Dredging and Filling Activities

8.5.35 The proposed marine works for KTD involving dredging or filling activities include:

- Dredging works for the proposed cruise terminal at Kai Tak
- Opening a 600m wide gap at the northern section of the former Kai Tak Airport runway and construction of a pile deck to cover the runway opening (which will involve some localised dredging along the gap opening)
- Re-construction of a section of the existing seawall at the former Kai Tak Airport runway for the proposed public landing steps cum fireboat berth
- Construction of Trunk Road T2 Immersed Tunnel which involves the reconstruction of a section of the existing Kwun Tong submarine outfall

8.5.36 Reconstruction of a section of the existing Kwun Tong submarine outfall would be needed for the construction of the Road T2 Immersed Tunnel and the outfall discharge location would not be altered after completion of the tunnel construction. No dredging would be required for decommissioning of the disused fuel dolphin at inner Kowloon Bay and its connecting fuel pipelines which forms part of the fuelling facilities of the former Kai Tak Airport. **Appendix 8.1** shows the proposed marine works within the KTD.

8.5.37 Fine particles released from dredging or filling operations could cause an increase in SS concentrations in the water column. The SS will be transported by currents to form sediment plumes along the tidal flows, which will gradually resettle.

8.5.38 Potential impacts on water quality from dredging also include the following:

- Increased suspension of solids in the water column during dredging activities, with possible consequence of reducing DO levels and increasing nutrient levels.
- Release of previously bound organic and inorganic constituents such as heavy metals, polynuclear aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs) into the water column, either via suspension or by disturbance as a result of dredging activities.
- Release of the same contaminants due to leakage and spillage as a result of poor handling and overflow from barges during dredging and transport.

8.5.39 Detailed descriptions for each of the above KTD marine works and detailed assessment of their potential cumulative construction phase impacts (in terms of SS elevation) are provided in the recent approved EIA Report for Dredging Works for the Proposed Cruise Terminal at Kai Tak (CT Dredging EIA) and are therefore not repeated in this Report. The assessment conducted under the CT Dredging EIA has covered the cumulative impacts from other concurrent marine works, including:

- Submarine Gas Main Relocation
- Trunk Road T2 Immersed Tunnel and Central Kowloon Route (CKR)
- Runway Opening
- Wan Chai Reclamation Phase II (WDII)
- Western Cross Harbour Main
- Further Development of Tseung Kwan O (TKO FS)

8.5.40 Methodologies for the assessment of the sediment plume generated from the proposed dredging and filling activities and the relevant assessment results for cumulative SS elevation can also be referred to the approved CT Dredging EIA. It should be highlighted that the dredging rates assumed for the Road T2 construction as presented in the CT Dredging EIA represent a worst case scenario with incorporation of the reconstruction of a section of the existing Kwun Tong submarine outfall. Based on the model results available from the CT Dredging EIA, assessment is provided under this EIA to evaluate the water quality impacts on the proposed DCS intake due to the marine construction activities.

8.5.41 With regard to the contaminant release from dredging, the CT Dredging EIA only focused on the impact from the dredging works for the proposed cruise terminal at Kai Tak alone. Therefore, further assessment on the potential contaminant release from other KTD works such as the dredging works for the proposed public landing steps cum fireboat berth, the runway opening (including some localized dredging at KTAC) and Trunk Road T2 has been conducted under this EIA with reference to the recent marine site investigation (SI) conducted for the proposed public landing steps cum fireboat berth as well as the elutriate testing collected under the approved EIA of the Comprehensive Feasibility Study for the Revised Scheme of South East Kowloon Development (SEKDCFS EIA).

Maintenance Dredging

8.5.42 Maintenance dredging is required during operation of the proposed cruise terminal at Kai Tak to maintain space needed for safe manoeuvring of cruise vessels clear of the fairway and cruise berth. It is assumed that a dredged volume of approximately 350,000 m^3 would be needed for manoeuvring of vessels every 5 to 10 years. This would take one grab dredger approximately 8 months to dredge the whole site assuming a maximum rate of 2,000m^3 per day and limited access. Maintenance dredging will not be conducted concurrently with the capital dredging for the cruise terminal. Detailed descriptions for the maintenance dredging and detailed assessment of its potential water quality impacts (including the model scenario and results) are provided in the recent approved CT Dredging EIA.

Localized Dredging at KTAC and alongside the Runway Opening

8.5.43 In addition, the potential odour emissions from KTAC and KTTS would be mitigated by a series of odour reduction measures including some localized maintenance dredging at KTAC to provide a sufficient water depth as capping layer for the sediment (details refer to Section 6). It is assumed that localised maintenance dredging will involve a maximum dredging volume of about 120,000 m^3 at KTAC. With the use of one closed grab dredger of 8m^3 capacity and a daily dredging rate of about 1,000 m^3, the localized maintenance dredging would be finished within a total dredging period of about 120 days. The proposed localized maintenance dredging will be implemented prior to the occupation of the future development in the immediate vicinity of the concerned section of KTAC. It should be highlighted that the maximum dredging rate of 2,000m^3 per day assumed for dredging alongside the runway opening as presented in the CT Dredging EIA already represents a worst case scenario with incorporation of the proposed localized maintenance dredging at KTAC required for odour mitigation. This worst-case scenario also covered the cumulative impact from the dredging of contaminated sediment near the KTTS (at 8,000m^3 per day) for construction of Road T2; in inner Kowloon Bay (at 1,000m^3 per day) for construction of CKR; and near the proposed cruise terminal (at 4,000m^3 per day) for construction of the manoeuvring area. Based on the model predictions as presented in the approved CT Dredging EIA, with the implementation of proper control measures including the use of closed grab dredger and deployment of silt curtain around the grab dredger during the localized maintenance dredging, adverse impact upon the water quality in Victoria Harbour is not expected. Details of the model results and assessment can be referred to the approved CT Dredging EIA.

Release of the Contaminants due to Leakage and Spillage

8.5.44 Release of the contaminants due to leakage and spillage as a result of poor handling and overflow from barges during dredging and transport can be addressed by proper implementation of recommended mitigation measures in CT Dredging EIA. Details of the mitigation measures are provided in **Section 8.8**.

Land-based Construction Works

Stormwater Discharges

8.5.45 Stormwater and drainage discharges from the construction sites may contain considerable loads of SS and contaminants during construction activities. Potential water quality impact includes run-off and erosion of exposed bare soil and earth, drainage channels, earth working area and stockpiles. Minimum distances of 100 m shall be maintained between the existing or planned stormwater discharges and the existing or planned seawater intakes during construction and operational phases.

8.5.46 Local and coastal water pollution impact may be substantial if the construction site run-off is allowed to discharge into the storm drains or natural drainage without mitigation.

Construction Runoff and Drainage

8.5.47 Surface runoff generated from the construction site may contain increased loads of SS and contaminants. Potential water quality impacts from site run-off may come from:

- release of any bentonite slurries and other grouting materials with construction run-off, storm water or ground water dewatering process;
- wash water from dust suppression sprays and wheel washing facilities; and
- fuel, oil and lubricants from maintenance of construction vehicles and equipment.

8.5.48 Land and groundwater contamination identified in the Project site will be cleaned up before commencement of any construction work (refer to Section 10). No groundwater extraction would be required during the decontamination process.

General Construction Activities

8.5.49 The general construction works that will be undertaken for the roads and infrastructure including the proposed drainage and sewerage construction works will be primarily land-based and may have the potential to cause water pollution. These could result from the accumulation of solid waste such as packaging and construction materials, and liquid waste such as sewage effluent from the construction work force, discharge of bilge water and spillage of oil, diesel or solvents by vessels and vehicles involved with the construction. If uncontrolled, any of these could lead to deterioration in water quality. Increased nutrient levels result from contaminated discharges and sewage effluent could also lead to a number of secondary water quality impacts including decreases in DO concentrations and localised increase in NH_3-N concentrations which could stimulate algal growth and reduction in oxygen levels.

8.5.50 Sewage will arise from sanitary facilities provided for the on-site construction work force. It is characterised by high level of BOD, NH_3-N and *E.coli* counts. For some of the works areas, there will be no public sewers available for domestic sewage discharge on-site.

Drainage Diversion Work

8.5.51 Any culvert realignment works or storm diversion works within the KTD works may pollute the storm water due to potential release of construction wastes. Construction wastes are generally characterized by high concentration of SS and elevated pH. Adoption of good house keeping and mitigation measures would reduce the generation of construction wastes and potential water pollution. The implementation of measures to control runoff and drainage will be important for the construction works at or adjacent to the stormwater system in order to prevent runoff and drainage water with high levels of SS from entering the water environment. With the implementation of adequate construction site drainage and the provision of mitigation measures as described in **Section 8.8**, it is anticipated that unacceptable water quality impacts would not arise.

Sediment Treatment

8.5.52 I*n-situ* bioremediation is being considered to suppress odour generated from the contaminated sediment along the seabed of KTAC. The bioremediation work is currently scheduled to commence in 2010 for completion by 2012 before commencement of other proposed marine works in the KTAC and KTTS (such as the Road T2 and runway opening construction). Also, the bioremediation work would be completed before the implementation of pollution load reduction measures described in Section 8 of **Annex A**. Sediment treatment is proposed to cover all areas within the KTAC and KTTS. The sustainability of the proposed sediment treatment process is discussed in detail in Section 6 of **Annex A**.

8.5.53 In comparison to *ex-situ* treatment, *in-situ* bioremediation is likely to cause far less environmental impacts as there would be minimal disturbance to the seabed due to dredging. In addition, *in-situ* bioremediation has the environmental benefits to remove odorous compounds and organic contaminants and has the capability to restore the original seabed and to promote recolonization of benthic organisms. The major environmental concerns associated with *in-situ* bioremediation are the potential release of nitrate-nitrogen, ammonia and heavy metals from the sediments into the surrounding water bodies during the bioremediation activities.

8.6 Assessment Methodology

Operational Phase

Modelling Tools

8.6.1 The hydrodynamic and water quality modelling platforms were developed by Delft Hydraulics, namely the Delft3D-FLOW and Delft3D-WAQ respectively.

8.6.2 Delft3D-FLOW is a 3-dimensional hydrodynamic simulation programme with applications for coastal, river and estuarine areas. This model calculates non-steady flow and transport phenomena that result from tidal and meteorological forcing on a curvilinear, boundary fitted grid.

8.6.3 Delft3D-WAQ is a water quality model framework for numerical simulation of various physical, biological and chemical processes in 3 dimensions. It solves the advection-diffusion-reaction equation for a predefined computational grid and for a wide range of model substances.

8.6.4 The detailed SEK model developed using Delft3D-FLOW and Delft3D-WAQ has been employed to assess the hydrodynamic and water quality impacts for the Project. The SEK model was developed under the KTPR and is a cut out from the Update Model. The Update Model is a regional model covering the whole HKSAR waters and the adjacent Mainland waters, which was constructed, calibrated and verified under the EPD Cumulative Effect Study (14). The SEK Model was refined in KTD area to give a better representation of the hydrodynamic and water quality conditions. The grid layout of the SEK model has a high resolution of less than 75m by 75m at the KTAC and Kowloon Bay area. There are a total 4 grid cells across the KTAC to resolve transverse variations of the KTAC.

8.6.5 The performance of SEK model has been checked against that of the Update Model. The model was also extensively calibrated by comparing computational results with the field measurements collected in the KTAC, Kowloon Bay and Victoria Harbour Channel as part of the KTPR. Details of the model setup and verification are described in the "Water Quality Model Calibration and Assessment Final Model Calibration Report" prepared under the KTPR.

8.6.6 The detailed SEK Model is linked to the regional Update Model. Computations were first carried out using the Update Model to provide open boundary conditions to the SEK Model. The Update Model covers the whole Hong Kong and the adjacent Mainland waters including the discharges from Pearl River. The influence on hydrodynamics and water quality in these outer regions would be fully incorporated into the SEK Model.

Use of KTAC and KTTS as an Area of General Amenity Value

8.6.7 Major factors that would affect the water quality simulated would be (i) the change in background pollution loading discharged from storm and sewage outfalls; and (ii) the change in coastline configurations in different time horizons.

8.6.8 The regional Update Model, which covers the whole Hong Kong and the adjacent Mainland waters including the discharges from Pearl River, has been used to provide open boundary conditions to the nested SEK Model. The set up of both the regional Update Model and the nested SEK Model (including pollution loading and coastline configurations) would need to be updated to mimic the envisaged conditions for the assessment years.

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

Pollution Loading

8.6.9 Sewage effluent discharged from the Harbour Area Treatment Scheme (HATS) would be the key background pollution source affecting the water quality in the Victoria Harbour. Stage 1 of HATS, comprising the Stonecutters Island Sewage Treatment Works (SCISTW) and the deep tunnels, was commissioned in late 2001, which collects sewage from Kwai Chung, Tsing Yi, Tseung Kwan O, parts of eastern Hong Kong Island and all of Kowloon and deliver it to SCISTW for chemically enhanced primary treatment (CEPT). Stage 2 of HATS would be implemented in two phases, namely Stage 2A and Stage 2B. Under Stage 2A, deep tunnels would be built to bring sewage from the northern and western areas of Hong Kong Island to SCISTW and the design capacity of the SCISTW would be expanded to meet the future demands. Stage 2A is currently scheduled for implementation by 2014. Stage 2B of HATS involves the provision of biological treatment at the SCISTW to improve the effluent quality. Stage 2B is tentatively scheduled for implementation by 2021. It should however be highlighted that the way forward of the HATS is still being studied and the timing for implementation of Stage 2B is still subject to review. The pollution loading was compiled for two scenarios:

- Year 2013 (or Worst Case) Scenario
- Ultimate Scenario

Year 2013 (or Worst Case) Scenario

8.6.10 Year 2013 scenario is selected as the time horizon for worst case assessment as it represents the late phase of HATS Stage 1 condition before commissioning of HATS Stage 2A. The treatment process of HATS Stage 1 would be CEPT plus disinfection which involves a discharge of effluent at the existing SCISTW. The assumed flow and effluent quality for SCISTW are given in **Table 8.13** below. Year 2013 is a worst-case in terms of the Harbour water quality because the Harbour water would still be impacted by sewage discharged from the outfalls of North Point Preliminary Treatment Works (PTW) (close to our Study Area), Wan Chai East PTW, Wan Chai West PTW and Central PTW under Stage 1. Stage 2A would involve decommissioning of these sewage outfalls and diversion of the sewage effluents to the SCISTW for treatment.

8.6.11 The dry weather load discharged within the KTD areas (including KTAC, KTTS and Kowloon Bay) such as expedient connections / cross connections were quantified based on the actual field measurements collected under the KTPR in 2005/2006 assuming that there would be no further load reduction in the future. In actuality, the EPD and DSD will continue to remove the pollution sources based on the expedient connection survey results. Thus, it is expected that the storm pollution situations in 2013 would not be worse than the existing conditions. Adopting the 2005/2006 loading survey data for model input under the 2013 scenario would be a conservative approach. It should be noted that the loading measured at KTN outfall during the 2005/2006 field surveys included both the dry weather load and the THEES loading. The dry weather load for KTN was calculated by subtracting the average THEES loading measured during the survey period (obtained from DSD) from the total loading measured at KTN outfall. The worst-case THEES loading was calculated separately (refer to Section 8.6.13 below) and added on top of the measured dry weather load. As the 2005/2006 field surveys were carried out during dry periods, loading from rainwater runoff was also calculated separately and included in the modelling. Details of the runoff loading calculation are given in **Appendix 8.2**.

8.6.12 It is expected that adequate sewerage will be provided for the planned developments at Kai Tak and the wastewater generated from the new developments at Kai Tak will be diverted to the HATS for treatment and disposal in the western Harbour via a submarine outfall to the south of Tsing Yi Island. The pollution loading inventory did not take account of any new interception facilities or load reduction measures for KTN and JVBC for conservative assessment.

8.6.13 The estimated 2013 effluent flow for THEES is based on the information provided in the approved EIA report for "Tai Po Sewage Treatment Works Stage 5". The THEES loading was compiled based on the projected effluent flow and the effluent quality standards at 95 percentile value, which is a conservative assumption. The assumed flow and effluent quality of THEES are provided in **Table 8.14** below. The worst case pollution loading was used only for the purpose of providing an indication of the maximum possible extent of the water quality impact.

Ultimate Scenario

8.6.14 Pollution loading inventory for the KTD area in ultimate year was compiled with reference to the latest population and employment statistics, assuming that only 5% of the residual pollution loading (from domestic, commercial and industrial activities) would remain in the storm system taken account of the continuous efforts by the government to rectify expedient connections and improve the sewerage and drainage systems. Planned improvement projects in the hinterland include Upgrading of Central and East Kowloon Sewerage, Sewage Interception Scheme in Kowloon City, Improvement of Kai Tak Nullah (WTS Police Station and Tung Kwong Road section), Control of Water Pollution at Jordan Valley Box Culvert and Improvement of Kai Tak Nullah (Tung Kwong Road and Prince Edward Road East Section). The ultimate scenario aims to provide a more optimistic pollution loading inventory for model prediction to reflect the probable level of water quality under the ultimate condition after completion of all the sewerage and drainage improvement works and water pollution control measures within the catchments.

8.6.15 Under the ultimate scenario, all the outfalls of the PTW in the Victoria Harbour would be decommissioned and the sewage would be diverted to the SCISTW under HATS Stage 2B for secondary treatment and disinfection. The assumed HATS flow and effluent quality under the ultimate scenario are given in **Table 8.13** below. It should be noted that the need and timing of the Stage 2B implementation would still be subject to detailed investigation. However, as the HATS outfall is located in the Western Buffer to the south of Tsing Yi Island away from the KTD area, the possible change in the HATS effluent quality (between secondary treatment plus disinfection under Stage 2B and CEPT plus disinfection under Stage 2A) would unlikely have a significant effect on the assessment conclusion and water quality in the KTD area.

8.6.16 It is assumed that the THEES effluent flow of 130,000 m^3 per day and 340,000 m^3 per day for Tai Po STW and Sha Tin STW, respectively, would be discharged via the KTN into the KTAC in the ultimate scenario. **Table 8.14** shows the averaged loading of THEES effluent for input to the water quality model to provide a more realistic water quality impact assessment. Pollution loading from rainwater runoff was also calculated separately and included in the ultimate scenario. Details of the runoff loading calculation are given in **Appendix 8.2**.

Table 8.13 Pollution Loading from Stonecutters Island Sewage Treatment Works under HATS

Parameters	Assumed Flow Rate and Effluent Concentration	
	2013 Scenario	Ultimate Scenario
Flow (m^3 per day)	1,540,000 (1)	2,450,000 (1)
BOD_5 (mg/l)	68 (2)	24 (2)
SS (mg/l)	42 (2)	16 (2)
Organic Nitrogen (mg/l)	9.93 (2)	3.5(2)
NH_3-N (mg/l)	17.43 (2)	7 (2)
E.coli (no./100ml)	200,000 (3)	20,000 (3)
Total Phosphorus (mg/l)	3 (2)	2 (2)
Orthophosphate (mg/l)	1.8 (2)	1.3 (2)
Silicate ($mgSiO_2$/l)	8.6 (2)	8.6 (2)
Total nitrite and nitrate (mg/l)	0 (2)	23(2)

Notes: (1) Based on the latest flow projections adopted under the recent EIA study for HATS Stage 2.
(2) Based on the "Environmental and Engineering Feasibility Assessment Studies in Relation to the Way Forward of the Harbour Area Treatment Scheme (EEFS) Final Study Report".
(3) Based on the findings of the approved EIA Study for the Provision of Disinfection Facilities at Stonecutters Island STW.

Table 8.14 Assumed Effluent Flow and Concentrations for THEES

Scenario	Flow (m^3/day)	BOD_5 (mg/L)	TSS (mg/L)	Org-N (mg/L)	NH_3-N (mg/L)	Ortho-P (mg/L)	TP (mg/L)	*E.coli* (no/100 mL)	Silicate (mg/L)
2013	426,397 (1)	20 (2)	30 (2)	8.85 (2)	7.66 (2)	1.70 (3)	1.93 (3)	15,000 (2)	9 (4)
Ultimate	470000 (1)	5 (3)	8 (3)	1.50 (3)	1.15 (3)	1.70 (3)	1.93 (3)	1,000 (5)	9 (4)

(1) Based on the approved EIA report for Tai Po Sewage Treatment Works Stage 5.
(2) Based on discharge license of Sha Tin STW (secondary treatment) at 95 percentile.
(3) Average concentration from actual measurement of effluent at STSTW.
(4) Average concentration from actual measurements of raw sewage at Sha Tin STW.
(5) Based on geometric mean value of effluent discharge standards (disinfection is currently not available for THEES effluent)

8.6.17 The background pollution loading outside the KTD area was estimated for the whole HKSAR waters by desk-top method and was input to the regional Update Model and the detailed SEK Model for cumulative impact assessment. The inventory incorporates all possible pollution sources within the HKSAR waters including those from landfill sites, marine culture zones, beach facilities and typhoon shelters, non-point source surface run-off and sewage from cross connections etc. The inventory has taken into account the removal of pollutants due to wastewater treatment facilities and the possible redistribution of pollution loads due to different sewage disposal plans and sewage export schemes. The methodologies for compiling the background pollution loading are given in **Appendix 8.2**.

Coastline configurations

8.6.18 Based on the information on the planned developments from the EIA Reports registered under the EIAO, there would not be any major change in the coastline configuration within the Victoria Harbour. The WDII reclamation is currently scheduled to commence in 2009 for completion by 2016. Based on the latest information available from the WDII Planning and Engineering Review, seawall construction for most of the WDII reclamation stages will be completed in 2013. Although there would be some changes at the coastlines of Wan Chai, and North Point as the WDII reclamation proceeds, the change is relatively small and is unlikely to have a major effect on the flow regime at the KTD area. Similarly, construction of most of the seawalls for reclamation under Further Development of Tseung Kwan O (TKO) would be completed by 2013. As such, year 2013, with WDII and TKO reclamations, represents a worst case in terms of both background pollution discharges and impact on tidal flushing within the Victoria Harbour.

8.6.19 The reclamation for Yau Tong Bay Reclamation (YTBR) was excluded as their concept plans were not yet confirmed. **Table 8.15** indicates the reclamation projects to be included in the model at different time horizons.

Table 8.15 Coastal Developments to be Incorporated in the 2013 and ultimate Coastline Configuration

Coastal Development	Information Source	Included in 2013 Scenario	Included in Ultimate Scenario
Sunny Bay Reclamation	EIA Report for "Northshore Lantau Development Feasibility Study" (Register No.: AEIAR-031/2000).	Yes	Yes
Lantau Logistic Park Reclamation	EIA Report for "Northshore Lantau Development Feasibility Study" (Register No.: AEIAR-031/2000).	No	Yes
Penny's Bay Reclamation	EIA Report for "Construction of an International Theme Park in Penny's Bay of North Lantau together with its Essential Associated Infrastructures" (EIAO Register No.: AEIAR-032/2000).	Yes	Yes
Lamma Power Station Extension	EIA Report for "1,800 MW Gas-fired Power Station at Lamma Extension" (EIAO Register No.: AEIAR-010/1999).	Yes	Yes
Further Development of Tseung Kwan O	EIA Report for "Further Development of Tseung Kwan O Feasibility Study" (EIAO Register No.: AEIAR-092/2005)	Yes	Yes
Wan Chai Reclamation Phase II	EIA Study Brief for "Wan Chai Development Phase II and Central-Wan Chai Bypass" (Study Brief No.: ESB-153/2006)	Yes	Yes
Tuen Mun Siu Lang Shui Reclamation	HATS EEFS	No	Yes
Hei Ling Chau Reclamation	HATS EEFS	No	Yes
Tai O Reclamation	HATS EEFS	No	Yes

Modelling Scenarios

8.6.20 Based on the above considerations, year 2013 is selected as the time horizon for modelling the possible worst case water quality condition in KTAC to address the uncertainties about the implementation programme of the sewerage and drainage improvement works including rectifications of expedient connections or cross connections in the urbanized area. The ultimate year is also selected to simulate the probable level of water quality after implementation of all the water pollution control measures within the catchments. Four modelling scenarios as listed below were simulated.

- *Scenario 1A* - 2013 Baseline Scenario without any opening at the runway
- *Scenario 1B* - *2*013 Development Scenario with a 400 m opening at the northern end of the runway
- *Scenario 1C* - 2013 Development Scenario with a 600 m opening at the northern end of the runway
- *Scenario 1D* - Ultimate Development Scenario (UDS) with a 600 m opening at the northern end of the runway

8.6.21 The model results were compared between Scenario 1A and Scenario 1B (as well as between Scenario 1A and Scenario 1C) to evaluate the effectiveness of the proposed runway opening for improving the water circulation and water quality in the KTAC. Year 2013 is selected as the time horizon for all the three scenarios, i.e. Scenario 1A, Scenario 1B and Scenario 1C (using the pollution loading inventory) to facilitate the identification of the net effect from the runway opening. Scenario 1D would reflect the likely situation within the Study Area under the Ultimate Development Scenario (UDS).

Pile Frictions

8.6.22 Marine piles would be installed at the opening under the Development Scenarios, namely Scenario 1B, Scenario 1C and Scenario 1D. The preliminary arrangement of the piled deck structure adopted under the KTPR is also assumed in this modelling exercise.

8.6.23 The presence of the marine piles may reduce the flushing of the water channel and thus impact upon the water quality. As the dimensions of the marine piles are much smaller than the grid size, the exact pier configurations cannot be adopted in the model simulation. Instead, only the overall influence of the piles on the flow was taken account. This overall influence was modelled by a special feature of the Delft3D-FLOW model, namely porous plate. Porous plates represent transparent structures in the model and are placed along the model gridline where momentum can still be exchanged across the plates. The porosity of the plates is controlled by a quadratic friction term in the momentum to simulate the energy losses due to the presence of the piles. The forces on the flow due to a vertical pile or series of piles are used to determine the magnitude of the energy loss terms. The mathematical expressions for representation of piles friction were based on the Cross Border Link Study [(15)] and the Delft 3D-FLOW module developed by Delft Hydraulics.

Simulation Periods

8.6.24 For each assessment scenario, the simulation period of the hydrodynamic model covers two 15-day full spring-neap cycles (excluding the spin-up period) for dry and wet seasons respectively. The simulation period of the water quality model covers one complete calendar year (excluding the spin-up period) which has incorporated the monthly variations in Pearl River discharges, solar radiation, water temperature and wind velocity in accordance with the EIA Study Brief. A spin-up period of 23 days and 45 days is provided for hydrodynamic simulation and water quality simulation respectively. These spin-up periods were tested under the KTPR to be sufficient.

Overflow or Emergency Discharge from the Sewerage System

8.6.25 During the sewage effluent overflow or emergency discharge, it is likely that there would be a transient elevation of the water pollution level in the receiving water body. The degree of impact would depend on the quantity and level of pollutants in the sewage discharge, the assimilation capacity of pollutants in the receiving water as well as the nature and location of the WSR. **Table 8.16** summarises the preliminary design information for the proposed SPSs.

(15) Planning Department Agreement No. CE48/97 Feasibility Study for Additional Cross-border Links Stage 2: Investigations on Environment, Ecology, Land Use Planning, Land Acquisition, Economic/Financial Viability and Preliminary Project Feasibility/Preliminary Design Final Water Quality Impact Assessment Working Paper WP2 Volume 1 1999.

Table 8.16 Design Information for Sewage Pumping Station

SPS ID (refer to Figure 1.3)	Preliminary Design Peak Flow (m^3/sec)	Preliminary Design Average Flow (m^3/day)	Sewage Overflow or Emergency Discharge Route (refer to Figure 8.4)
PS1	0.44	7,682	Discharge at storm outfall N via KTN
PS1A	0.95	11,739	
PS2	0.11	3,130	
PS3	1.68	16,634	Discharge at the inner corner of Kowloon Bay via storm outfall 5
Site 5A1	0.46	36,603	
PS6	1.2	12,933	Discharge to the open harbour via the southern tip of the former airport runway

8.6.26 Provision of standby pump facilities and dual power supply would minimize the occurrence of such effluent discharge. With the implementation of suitable design measure, there should not be any insurmountable water quality impacts associated with the SPS operation.

8.6.27 Water quality modelling was undertaken to address the effect of the proposed runway opening on the dispersion of emergency sewage overflow from the HATS catchments. One modelling scenario, namely Scenario 2A, was simulated to cover the worst-case water quality impact as a result of total power failure at SCISTW under the condition with the 600m runway opening. The same modelling scenario (i.e. emergency discharge at all the PTWs within the HATS catchments due to total power failure at SCISTW) has also been simulated under the EIA for HATS Stage 2A to assess in detail the regional water quality impacts in the Victoria Harbour without the 600 m opening at the runway. When power failure occurs at SCISTW, the screened sewage will be discharged directly to the Harbour via seawall bypass at the PTWs within the HATS catchments. It is assumed that the screened sewage would be discharged from all the PTWs at the same time for a period of 6 hours in the ultimate year. The ultimate design daily flows of the PTWs (including Kwun Tong PTW of about 390,000 m^3 per day and To Kwa Wan PTW of about 300,000 m^3 per day) were used to calculate the pollution loading of the emergency discharge for 6 hours for worst case assessment. The total volume of overflow discharge assumed in the modelling exercise was about 612,000 m^3 including 98,000 m^3 from Kwun Tong PTW and 75,000 m^3 from To Kwa Wan PTW. No power failure has been occurred at SCISTW since its commissioning and the occurrence of such scenario is remote. Discharge duration of 6 hours is only assumed for EIA purpose based on the experience of other sewage treatment works e.g. Tai Po STW.

Spent Cooling Water Discharge

8.6.28 Based on the latest design information obtained from the EMSD, the design seawater flow rate for the whole DCS would be 14,100 l/s (including the discharge of spent cooling water at the northern DCS outfall and the southern DCS outfall at a rate of 8,040 l/s and 6,060 l/s respectively). The design temperature elevation of 6°C is assumed at the DCS outfalls. Chlorination dosing is assumed to be 24 hours per day with a continuous discharge of chlorine at 0.5 mg/L in the effluent. Mathematical modelling was carried out to simulate the residual chlorine and thermal discharges from the DCS.

8.6.29 Besides chlorine, C-Treat-6 would be the only other chemical injection to the cooling system. Based on the assumption that C-Treat-6 is injected only for one hour per week to achieve 2 mg/L 30% tallow 1,3-propylene diamine (as amine content) at the outfall. This small amount and intermittent releases of biocide into Victoria Harbour would be readily diluted by strong tidal current along the harbour such that the potential impact from the biocide would be minimal.

Thermal Plume Modelling Tools

8.6.30 In the present Study, the basis for modelling of the harbour waters is the fine grid SEK Model as discussed in previous sections. The Excess Temperature Model within Delft3D-FLOW model was employed to simulate the thermal plume dispersion in the Victoria Harbour and to assess the impact upon the proposed DCS intake in relation to the potential short circuit problem. The model allows for the excess temperature distribution and decay of the thermal plume, and addresses heat transferred from the water surface to the atmosphere. While the total heat flux is proportional to the excess temperature at the surface, the heat transfer coefficient of the formulation depends mainly on water temperature and wind speed. The parameters adopted for the thermal plume modelling are summarized in **Table 8.17**.

Table 8.17 Summary of Parameters for Thermal Plume Model (Delft3D-FLOW)

Delft3D-FLOW Excess Temperature Model Parameters		
Background (Air) Temperature (°C)	18 28	Dry Season Wet Season
Temperature of spent cooling water (°C)	24 32 (1)	Dry Season Wet Season
Wind Speed (m s^{-1})	5	Dry Season and Wet Season
Ambient Water Temperature (°C)	18 To be computed by model (1)	Dry Season Wet Season

(1) The predicted temperature at the intake location under the baseline scenario (without any cooling water discharges) have been checked and confirmed to be lower than 26°C for the entire simulation period, the discharge temperature of 32°C for wet season should provide a good approximation of the temperature of spent cooling water for thermal plume modelling and assessment.

8.6.31 The simulation periods for the hydrodynamic FLOW model will cover a complete spring-neap tidal cycle (about 15 days), preceded by a spin-up period. A spin-up period of about 1.5 tidal cycles was provided for the simulations and has been tested. One-minute time step was used in the thermal plume modelling. In order to determine whether the time step of 1 minute is acceptable, a sensitivity hydrodynamic run was conducted using a smaller time step of 30 seconds. Comparison of the flow results for the 1-minute time step and the 30-second time step showed that there is no significant deviation between the 2 sets of results. The time step of 1 minute is therefore considered acceptable.

8.6.32 The excess temperature of 6°C in the spent cooling water is assumed for modelling based on the latest design of the proposed DCS. Results of the predicted temperature elevation at the intakes were factored up by [1(1-E/k)] to take into account the potential short circuit problem of the re-circulation of heated water to the cooling water intake.

Where:

E = maximum of the mean temperature elevations predicted at the intakes

k = excess temperature of the cooling system = 6°C

8.6.33 The derivation of the heat re-circulation factor [1(1-E/k)] is given in **Appendix 8.3**.

Residual Chlorine and Biocide

8.6.34 The 3-dimensional particle tracking model (Delft3D-PART) developed by Delft Hydraulics was employed to model the residual chlorine discharged from the cooling water. The discharge of residual chlorine is represented by discrete particles released into the surface layer of the model. These discrete particles are transported with flow fields determined from the hydrodynamic simulation using the refined Delft3D-FLOW SEK Model, and turbulent diffusion and dispersion, based on a random walk technique. The residual chlorine elevation over the ambient level is then evaluated from the particle density in each cell of the curvilinear grid of SEK model. As chlorine would be subject to decay in marine waters, the ambient level of chlorine would be assumed to be negligible.

8.6.35 The flow data adopted in Delft3D-PART model were obtained from the Delft3D-FLOW hydrodynamic model results. Each Delft3D-FLOW simulation covered a complete spring-neap tidal cycle for both dry and wet seasons. The actual simulation period for Delft3D-FLOW was preceded by a spin-up period of 8 days.

8.6.36 For Delft3D-PART, each simulation covered a complete spring-neap tidal cycle, preceded by a spin-up period of 15 days. The spin-up period for Delft3D-PART was tested to be sufficient. The 15-day Delft3D-FLOW simulation results were used repeatedly for the simulation period for Delft3D-PART (i.e. the actual period of 15 days plus the spin-up period).

8.6.37 It should be noted that the residual chlorine concentration represents total residual chlorine as there is no mechanism in the Delft model to partition the chlorine into free chlorine or various compound species. The decay value (T90 = 8289s) will be used under this Study. The T90 factor adopted in this Study is based on the assumption used under the approved EIA for Tai Po Sewage Treatment Works Stage V. Upon our review of relevant past EIA studies, this T90 factor is the most conservative value and therefore applied to the model for conservative assessment.

Construction Phase

Marine-based Construction Works

8.6.38 Assessment of the SS impact generated from the proposed dredging and filling activities as well as the impact due to the potential contaminant release from the cruise terminal dredging has been fully addressed under the approved CT Dredging EIA. This EIA only covers the assessment on the potential SS elevations at the proposed DCS intake at Kai Tak as well as the potential contaminant release from the dredging works for the proposed public landing steps cum fireboat berth, the runway opening (including some localized dredging at KTAC) and Trunk Road T2 with reference to the recent marine site investigation (SI) conducted for the proposed public landing steps cum fireboat berth as well as the elutriate testing collected under the approved SEKDCFS EIA.

Land-Based Construction Works

8.6.39 Assessment of the potential impact of land-based construction activities on water quality has been undertaken in a qualitative manner. Proposed construction activities were reviewed to assess the land-based water quality impact upon the nearby water bodies. Practical water pollution control measures / mitigation proposals (**Section 8.8**) have been subsequently recommended to prevent local flooding and to ensure that effluent discharged from the construction site will comply with the WPCO criteria. Consideration has been given to control potentially harmful impacts from site works and to the use of 'best' practice measures to minimise the potential for discharges of pollutants to the nearby waters of the Victoria Harbour.

Sediment Treatment

8.6.40 Assessment of the potential water quality impact of the proposed sediment treatment at KTAC has been undertaken in a qualitative manner. The water quality monitoring results for the pilot scale field tests conducted at the KTAC in 2006 under the KTPR were used to assess the potential impacts. Water quality monitoring has been recommended to ensure that the proposed treatment operation would not result in unacceptable impact.

8.7 Prediction and Evaluation of Potential Environmental Impacts

Operational Phase

Use of KTAC and KTTS as an Area of General Amenity Value

Hydrodynamics

8.7.1 The hydrodynamic modelling results are presented in **Appendix 8.4** as vector plots for flood and ebb tides for both dry season and wet season. The time-series plots for current magnitudes are presented in **Appendix 8.5** for KTAC (Stations AC2, AC4, AC6 and AC7), KTTS (Station VT4) and TKWTS (Station VT11). The model plots show that opening a large gap at the runway would cause an increase in the flow velocity in the approach channel and KTTS. The flow pattern at the approach channel and KTTS is similar between Scenario 1B (with 400 m opening at the runway) and Scenario 1C (with 600 m opening at the runway). The runway opening would not change the overall flow regime in the Victoria Harbour. There are no assessment criteria available for current velocity and hydrodynamic impact.

Water Quality

8.7.2 The model results are also presented in **Appendix 8.6** and **Appendix 8.7** as contour plots for DO, TIN, UIA, NH_3-N, *E.coli*, BOD, SS and sedimentation rate. The contour plots are presented as annual arithmetic averages for TIN, NH_3-N, SS and BOD and annual geometric means for *E.coli*. The contour plots for DO are presented as 10^{th} percentile depth-averaged values and 10^{th} percentile bottom values for comparison with the WQO. The results for sedimentation rate are presented as both maximum and mean values over the simulation period.

8.7.3 Each figure attached in **Appendix 8.6** contains three plots. The upper plot shows the model output for 2013 baseline scenario without any opening at the runway whereas the middle and the lower plots show the model output for 2013 mitigated scenarios with 400m opening and 600m opening at the runway respectively.

8.7.4 Each figure attached in **Appendix 8.7** contains two plots. The upper plot shows the model output for 2013 mitigated scenario with the proposed 600m runway opening. The 2013 mitigated scenario represents the possible worst case condition to address the uncertainties about the programme for implementing sewerage improvement and water pollution control measures in the catchments. The lower plot shows the Ultimate Development Scenario (UDS) with the 600m runway opening for comparison. The UDS represents the ultimate condition in the KTD area assuming that all the water pollution control measures within the catchments would be completed. **Table 8.18** tabulates the predicted water quality at selected indicator points in KTAC, KTTS and TKWTS.

Table 8.18 Predicted Water Quality at Indicator Points

Parameters	Scenario	Upper KTAC	Middle KTAC		Lower KTAC	KTTS	TKWTS	WPCO WQO
		AC2	AC4	AC6	AC7	KT1	IB2	
10%ile Bottom DO (mg/L)	1A – 2013 Baseline Condition	**<0.01**	**<0.01**	**<0.01**	**<0.01**	**0.89**	4.68	2
	1B – 2013 with 400m Opening at the Runway	2.38	2.64	2.45	2.35	2.61	4.15	
	1C - 2013 with 600m Opening at the Runway	2.28	2.73	2.80	2.78	3.08	4.06	
	1D – UDS with 600 m Opening at the Runway	5.57	5.88	5.89	5.89	5.79	5.88	
10%ile Depth-averaged DO (mg/L)	1A – 2013 Baseline Condition	**<0.01**	**<0.01**	**<0.01**	**<0.01**	**0.76**	4.84	4
	1B – 2013 with 400m Opening at the Runway	**2.63**	**2.65**	**2.50**	**2.46**	**2.73**	4.03	
	1C - 2013 with 600m Opening at the Runway	**2.63**	**2.84**	**2.87**	**2.88**	**3.15**	4.11	
	1D – UDS with 600 m Opening at the Runway	5.99	6.10	6.11	6.12	6.06	6.04	
Depth-averaged *E.coli* (no per 100mL)	1A – 2013 Baseline Condition	589021	371147	245688	176498	15141	1005	N/A
	1B – 2013 with 400m Opening at the Runway	224326	78171	31053	21225	5395	16067	
	1C - 2013 with 600m Opening at the Runway	228107	76315	23039	14994	4587	16911	
	1D – UDS with 600 m Opening at the Runway	2693	2475	1909	940	677	538	
Depth-averaged UIA (mg/L)	1A – 2013 Baseline Condition	**0.064**	**0.068**	**0.070**	**0.069**	**0.045**	0.006	0.021
	1B – 2013 with 400m Opening at the Runway	**0.032**	**0.027**	**0.025**	**0.024**	0.016	0.014	
	1C - 2013 with 600m Opening at the Runway	**0.031**	**0.024**	0.020	0.019	0.013	0.014	
	1D – UDS with 600 m Opening at the Runway	0.004	0.003	0.003	0.003	0.002	0.003	
Depth-averaged TIN(mg/L)	1A – 2013 Baseline Condition	**8.691**	**7.883**	**7.033**	**6.528**	**3.096**	**0.432**	0.4
	1B – 2013 with 400m Opening at the Runway	**2.839**	**2.003**	**1.757**	**1.679**	**1.068**	**1.117**	
	1C - 2013 with 600m Opening at the Runway	**2.813**	**1.826**	**1.423**	**1.357**	**0.896**	**1.128**	
	1D – UDS with 600 m Opening at the Runway	0.340	0.287	0.262	0.254	0.224	0.253	
Depth-averaged SS (mg/L)	1A – 2013 Baseline Condition	86	71	59	52	21	6	N/A
	1B – 2013 with 400m Opening at the Runway	24	18	16	15	10	10	
	1C - 2013 with 600m Opening at the Runway	25	17	14	13	9	10	
	1D – UDS with 600 m Opening at the Runway	10	8	7	7	6	6	
Mean Sedimentation Flux ($g/m^2/day$)	1A – 2013 Baseline Condition	0.400	0.069	1.530	60.324	4.107	1.298	N/A
	1B – 2013 with 400m Opening at the Runway	0.045	0.011	0.336	0.066	2.206	2.331	
	1C - 2013 with 600m Opening at the Runway	0.049	0.013	0.229	0.050	1.822	2.495	
	1D – UDS with 600 m Opening at the Runway	0.020	0.006	0.082	0.020	0.828	1.251	
Maximum Sedimentation Flux ($g/m^2/day$)	1A – 2013 Baseline Condition	32.642	16.796	36.544	18.370	46.090	5.492	N/A
	1B – 2013 with 400m Opening at the Runway	6.856	4.141	14.033	7.157	23.347	14.747	
	1C - 2013 with 600m Opening at the Runway	6.330	3.037	10.028	5.612	17.317	18.476	
	1D – UDS with 600 m Opening at the Runway	1.930	1.178	3.153	2.060	3.720	3.998	

8.7.5 The 2013 model results for Scenarios 1A, 1B and 1C showed that opening a large gap at the northern end of the runway would substantially improve the water quality at KTAC and KTTS for all the selected parameters. However, WQO exceedances are still predicted in KTAC and KTTS even with the implementation of the proposed runway opening under the possible worst case condition in 2013. The approximate sizes of mixing zones are presented in **Table 8.19** for different assessment scenarios. The degree of impact was found to be more significant under Scenario 1B with the 400 m opening as compared to Scenario 1C with the 600 m opening.

Table 8.19 Approximate Dimension of Mixing Zones in KTAC and KTTS under 2013 Worst Case Scenario

Parameter	Approximate Dimension of Mixing Zone (km^2)		
	Scenario 1A – 2013 Baseline without any Opening	Scenario 1B – 2013 with 400m Opening at the Runway	Scenario 1C – 2013 with 600m Opening at the Runway
10^{th} Percentile Depth-averaged DO	0.9	0.9	0.9
10^{th} Percentile Bottom DO	0.8	0.2	0
Unionized Ammonia (Annual Mean)	0.9	0.4	0.2
Total Inorganic Nitrogen (Annual Mean)	0.9	0.9	0.9

8.7.6 With a 400 m opening at the runway (Scenario 1B), some exceedances of bottom DO are still predicted in the inner half of the KTTS. With the 600 m opening (Scenario 1C), the exceedances for bottom DO would be totally eliminated and the predicted bottom DO would fully comply with the WQO in all areas of KTAC and KTTS. The predicted UIA exceeded the WQO in the KTAC under Scenario 1C (with 600 m opening at the runway) but the extent of impact area would be reduced by one half as compared to the case with the 400 m opening under Scenario 1B. Exceedances for depth-averaged DO and TIN are predicted in both KTAC and KTTS under Scenario 1B (with 400 m opening) and Scenario 1C (with 600 m opening). Although the area of exceedance for these 2 parameters is predicted to be the same under Scenario 1B and Scenario 1C, the level of exceedance was found to be lower under Scenario 1C (with 600 m opening). The depth-averaged DO and TIN predicted under Scenario 1C (with 600 m opening) would be improved by 10-15% at the middle portion of the KTAC and 15% at the outer part of the KTTS as compared to Scenario 1B with the 400 m opening as shown in **Table 8.18**.

8.7.7 The UDS (Scenario 1D) assumes that all the planned water pollution control measures would be completed including the implementation of HATS Stage 2 to remove pollution sources from all the local PTW in the central and western Victoria Harbour. As shown in **Table 8.18** and **Appendix 8.7**, all the exeedances in the KTD area would be eliminated in the ultimate year.

Water Quality in Victoria Harbour

The water quality modelling results for Victoria Harbour are presented as contour plots in **Appendix 8.8**. Comparing the model outputs for the 2013 baseline scenario and the 2013 mitigated scenario as shown in **Appendix 8.8** indicated that there would be no significant change in the overall harbour water quality between the two scenarios for all the selected water quality parameters. Based on the model results, the proposed 600 m opening would not adversely affect the overall water quality in the Victoria Harbour

Likelihood of Algal Bloom

Past Record on Red Tide Occurrence

Algal blooms (more often called red tides) are natural phenomena which occur seasonally in both polluted and unpolluted waters. **Table 8.20** shows the occurrence and distribution of red tides in Hong Kong extracted from the EPD’s report “Marine Water Quality Monitoring in Hong Kong 2006”. From the past records (1980 – 2006), majority (over 90%) of the red tides happened in the eastern waters (Port Shelter, Mirs Bay and Tolo Harbour) and southern waters where the nutrient level was lower than that of the western waters (Victoria Harbour, Western Buffer, North Western and Deep Bay).

Table 8.20 Occurrence and Distribution of Red Tides in Hong Kong

WQC	Occurrence of Red Tide (1980 – 2006) **		Occurrence of Red Tide in 2006 **		Occurrence of Red Tide Species (1980 – 2006) **			Pollution Levels in 2006 (Annual Mean)					
	No.	% Contribution	No.	% Contribution	Diatom	Dinoflagellates	Other Species	TIN (mg/l)	PO_4 (mg/l)	SiO_2 (mg/l)	SS (mg/l)	Chlorophyll-a (µg/l)
Western Buffer	20	3%	1	8%	12	7	0	0.19 – 0.32	0.01 – 0.02	0.9 – 1.2	4.7 – 7.7	2.0 – 2.8
Victoria Harbour	14	2%	0	0%	11	2	0	0.18 – 0.48	0.02 - 0.03	0.7 – 1.6	4.2 – 11.0	2.1 – 3.5
Junk Bay	6	1%	0	0%	5	0	2	0.15 – 0.18	0.01	0.6	3.2 – 4.5	3.6 – 4.8
Eastern Buffer	1	0%	0	0%	1	0	0	0.12 – 0.15	0.01 – 0.02	0.6 – 0.7	3.9 – 5.0	3.0 – 3.3
Southern	126	17%	3	23%	26	67	29	0.11 – 0.34	<0.01 – 0.02	0.6 – 1.1	3.4 – 13.4	2.5 – 9.1
North Western	25	3%	1	8%	4	12	9	0.43 – 0.67	0.02 – 0.03	1.4 – 2.4	6.4 – 15.8	2.8 – 4.2
Deep Bay	9	1%	0	0%	3	2	4	0.83 – 3.86	0.04 – 0.35	2.4 – 4.9	8.3 – 58.5	2.13 – 25.5
Port Shelter	108	14%	5	38%	3	89	17	0.03 – 0.05	<0.01	0.5 – 0.6	2.2 – 4.5	2.3 – 3.3
Mirs Bay	139	18%	1	8%	10	106	24	0.04 – 0.13	<0.01	0.5 – 0.6	1.5 – 5.0	2.0 – 7.7
Tolo Harbour & Channel	315	41%	2	15%	75	241	60	0.06 – 0.18	<0.01 – 0.01	0.6 – 1.2	1.7 – 5.3	2.3 – 9.5
Total	763	100%	13	100%	150	526	145	-	-	-	-	-

Note: ** A red tide incident may involve more than one causative species.

8.7.8 Inorganic nutrients such as TIN (N) and PO_4 (P) are essential to algal formation. However, from the 2006 records for Port Shelter, Mirs Bay and Tolo Harbour, it can be concluded that algal bloom could readily take off at a low N and P level provided that other environmental conditions were suitable. Past research studies on long-term water quality data in Hong Kong suggested that, under favourable environmental conditions, there would be a sharp increase in red tide occurrence whenever the level of N and P rose above 0.1 mg/l and 0.02 mg/l respectively [16]. Another recent report also indicated that the threshold nutrient level for algal bloom in Hong Kong would be 0.12 mg/l and 0.018 mg/l for N and P respectively [17]. In the western waters (Victoria Harbour, Western Buffer, North Western and Deep Bay), the background nutrient levels are considered high enough to trigger algal bloom but the red tide occurrence was limited by light and / or other hydrodynamic factors (such as the degree of water circulation and vertical mixing).

8.7.9 Recent research studies on algal blooms indicated that red tides would be optimized in poorly flushed coastal water under calm wind condition. In the open water environment in the Victoria Harbour, the effect of tidal flushing was high. As the water was frequently diluted by horizontal advection or vertical mixing, the accumulation of algal biomass and hence the chance of algal bloom were more effectively minimized.

8.7.10 Species of algae differ greatly in their nutrient requirements and efficiency in solar energy fixation (photosynthesis). A bloom of a species would depend on a combination of different environmental factors such as the flow condition, light penetration, salinity distribution, nutrient concentrations, nutrient ratios and species competition. Inorganic nitrogen could exist in water in two different forms, namely ammonia and nitrate both of which can support algae growth. As ammonia is the preferred nitrogen nutrients over nitrate for phytoplankton growth, the presence of a certain level of algae in water may in fact be beneficial to the environment by consuming the ammonia which could be toxic to marine life. It should therefore be highlighted that the presence of algae in water is generally not harmful. Only their uncontrolled growth as algal bloom would be a potential concern.

8.7.11 In Hong Kong, the most common red tide species was the dinoflagellate *Noctiluca scintillans*, which accounted for ~30% of the reported red tides since the 1980s. In 2006, 13 red tides were recorded in Hong Kong waters, involving 6 species (i.e. *Noctiluca scintillans*, *Skeletonema costatum*, *Ceratium furca*, *Dictyocha speculum*, *Phaeocystis globosa* and *Cochlodinium sp.*) 3 of which were dinoflagellates. Of the remaining 3 species, 1 was diatom and the other 2 were minor algal species.

Potential Impact at KTD

<u>Likelihood of Algal Bloom</u>

8.7.12 The KTD water is subject to the direct influence of the background water quality in the open Victoria Harbour where the nutrient levels are affected by point and non-point sources such as the polluted runoff generated from the old urbanized areas on both sides of the Victoria Harbour as well as the influences from other background nutrient sources such as the Pearl River discharges. The existing N and P levels measured in the open water in central harbour channel are over 0.3 mg/l and 0.03 mg/l respectively. Due to the influence of the background water quality in the open harbour, it is considered realistic to assume that the overall nutrient level in the KTD water would not be lower than the threshold level for algal bloom (0.1 mg/l and 0.018 mg/l for N and P respectively) even after completion of all the planned local pollution control measures within the KTD catchments. However, opening a large gap at the runway would enhance the tidal circulation and current velocities in the KTD area which could reduce the potential of red tide formation in the KTD area.

[16] Hodgkiss, I. J., Ho, K. C., 1997. Are changes in N:P ratios in coastal waters the key to increased red tide blooms. Hydrobiologia 352, 141 – 147.

[17] Ken T. M. Wong, Joseph H. W. Lee, I. J. Hodgkiss, 2007. A simple model for forecast of coastal algal blooms. Estuarine, Coastal and Shelf Science 74, 175 – 196.

8.7.13 From the above, it can be concluded that nutrient level would not be a critical factor for triggering algal bloom in the KTD area. Given that the current nutrient level in Kowloon Bay is already abundant (more than enough to trigger algal bloom), the potential increase or redistribution of nutrients due to the proposed runway opening would unlikely cause any further effect on the algal bloom formation. As shown in **Appendix 8.8**, there would be no significant change in the overall harbour water quality due to the proposed runway opening. On the other hand, the proposed runway opening would further enhance the tidal flushing in the Study Area (as demonstrated by the modelling assessment) to minimize the red tide occurrence. Further water pollution control measures will also be implemented to reduce the pollution entering KTAC and KTTS in order to improve the water quality and aesthetic quality of the KTD water (refer to Section 8 of **Annex A**). Hence, the Project would unlikely increase the risk of algal bloom as compared to the existing condition. However, it cannot be ruled out that algal bloom could occur in the KTD waters under the worst-case scenario.

<u>Acceptability of the Potential Impact at KTD due to Algal Bloom</u>

Oxygen Depletion

Algal bloom may adversely affect marine life because the water can become completely deprived of oxygen when a bloom declines rapidly, since the biological degradation of dead algal material consumes large amounts of oxygen. Marine water in hypoxic condition (DO < 2 mg/l) is often considered as one of the signals for excess algal formation. The water quality model used in this EIA incorporates various physical / biochemical processes. Biochemical processes such as nitrification, algal growth and decay and the decay of organic matter, were all taken into account in the modelling exercise. Review of the model prediction indicated that oxygen depletion would not occur in the KTD area and the adjacent Victoria Harbour as a result of adoption of a 600 m gap at the northern part of the former Kai Tak runway. As shown in **Appendix 8.6**, with the improvement in water circulation as a result of the 600 m runway opening, the 10 percentile bottom dissolved oxygen (DO) level in the entire Study Area would be increased to 2 – 4 mg/l and fully complied with the WQO of no less than 2 mg/l. Based on the model results, adverse impact associated with oxygen depletion is not anticipated.

Toxic Effect

Some species of phytoplankton may also produce toxins and induce toxic effect on marine life and cultured fish. However, only a minority of blooms consist of species that synthesize toxins. In actuality, most algal blooms would be non-toxic. There are no marine cultural sites and other ecological sensitive receiver of great importance identified in and near the KTD site. No sensitive beneficial uses such as secondary contact recreation subzones, bathing subzones and fish culture site are proposed in KTD under this Project. Any potential toxic effect of algal bloom at KTD water would be transient and would dissipate quickly when reaching the Victoria Harbour and therefore would unlikely cause any adverse effect on public health and health of biota or risk to life. The potential impact is expected to be acceptable.

Discoloration

Although the primary concern would be oxygen depletion, algal bloom could also cause other side effect such as discoloration of marine water, which may deteriorate the aesthetic quality of the KTD water. However, as an algal bloom would usually subside within a rather short period, the associated discoloration effect is considered minor and transient. No significant water quality nuisance would be generated from the short-term discoloration effect as a result of algal bloom. The potential effect is also expected to dissipate quickly after the flushing in KTD area is enhanced with the proposed 600 m runway opening.

WSD Flushing Water Intake

8.7.14 Based on the model results (refer to **Appendix 8.8**), the pollution level predicted at the WSD intake points including Quarry Bay, Tai Wan and Cha Kwo Ling intakes would fully comply with the relevant WSD water quality standards for all the parameters of concern under both 2013 mitigated scenario (Scenario 1C) and the UDS (Scenario 1D).

Acceptability of Mixing Zone

8.7.15 Non-compliance with the numeric WQO is predicted under the 2013 mitigated scenario (Scenario 1C) for depth-averaged DO, UIA and TIN. It should be highlighted that these exceedances were not caused by the Project. As predicted by the model, the Project (with the adoption of the proposed runway opening) would improve the overall pollution level in the Study Area as compared to the existing baseline condition. The predicted non-compliance is considered acceptable due to the following:

- The exceedance would be confined in the KTD area and would not impair the integrity of the water body and the ecosystem in the Victoria Harbour as a whole.
- The mixing zone would not endanger sensitive uses e.g. beaches, breeding grounds, or diminish existing beneficial uses and therefore would not cause any adverse effects in human or aquatic organism.
- The Project would improve the local water circulation and flushing and also eliminate all the bottom DO exceedances in the KTD area and therefore would improve the aesthetic quality (such as entrapment of floating debris and other nuisances such as odour and turbidity) and probably reduce the chance of red tide occurrence.

8.7.16 As predicted by the model, all the exceedances would be totally eliminated in the long term after all the planned sewerage works and water pollution control measures are implemented.

Overflow or Emergency Discharge from the Sewerage System

8.7.17 The modelling results for emergency discharge from HATS due to total power failure (namely Scenario 2A) are tabulated in **Appendix 8.9**. It should be noted that, under Scenario 2A, several model runs were conducted to cover different discharge start times. The key purpose of this modelling exercise is to investigate the effect of the proposed runway opening on the dispersion of the emergency discharge near the KTD area. The same modelling scenario (i.e. emergency discharge at all the PTWs within the HATS catchments due to total power failure at SCISTW) has also been simulated under the EIA for HATS Stage 2A to assess in detail the regional water quality impacts in the Victoria Harbour without the 600 m opening at the runway. The emergency discharge volume and duration assumed under the EIA for HATS Stage 2A are the same as those assumed under this EIA. As discussed previously, the proposed runway would not change the overall flow regime and water quality in the Victoria Harbour. Therefore, the results presented in **Appendix 8.9** include only three water sensitive receivers (namely WSD flushing water intakes at Quarry Bay, Tai Wan and Cha Kwo Ling) which are closest to the emergency discharge from Kwun Tong PTW and To Kwa Wan PTW within the KTD area to identify the effect from the runway opening.

8.7.18 The target *E.coli* limit specified by WSD at the flushing water intake points is 20,000 no. per 100 ml, expressed as a maximum value. The model predicted that the worst-case emergency discharge would cause *E.coli* exceedances at two flushing water intakes (Cha Kwo Ling and Tai Wan) in both dry and wet seasons. Elevations of *E.coli* levels were predicted immediately after the start of temporary discharge. The normal water quality conditions (i.e. the conditions under normal operation of the HATS Stage 2A) were predicted to recover within 1 day after the end of the emergency discharge. These are similar to the findings of the EIA for HATS Stage 2A where the *E.coli* level would also exceed at these two intake points during the emergency discharge period.

8.7.19 As shown in **Appendix 8.9**, the pollution level predicted at the WSD Quarry Bay, Tai Wan and Cha Kwo Ling intakes would fully comply with the relevant WSD water quality standards for all other parameters of concern (including DO, SS, NH_3-N and BOD_5) during the worst-case emergency discharge period. These are also in line with the findings of the EIA for HATS Stage 2A. In summary, the proposed runway opening would not cause any significant effect on the water quality under the emergency situations.

8.7.20 It should be noted that there are some differences between the model adopted in this EIA and the model used under the EIA for HATS Stage 2A. They are: (1) The EIA for HATS Stage 2A adopted a slower decay rate for *E.coli* to suit its specific purpose; and (2) the grid adopted under this EIA has a more refined grid in Kowloon Bay, KTAC and KTTS areas. Therefore, the numerical values predicted by the model may not necessarily be consistent between the two EIA studies. Despite the model differences identified above, the results predicted under this EIA are generally in line with the findings of the EIA for HATS Stage 2A (i.e. *E.coli* exceedances predicted at the WSD intakes and full compliance with other parameters of concern including SS). In summary, the proposed runway opening would not cause any significant effect on the water quality impacts under the emergency situations.

8.7.21 Short-term exceedances of *E.coli* would occur at the WSD intakes in the Victoria Harbour under the worst case emergency discharge scenario. Historical EPD monitoring data indicated that the *E.coli* levels measured in the Victoria Harbour during the pre-HATS period would be similar or even higher than these predicted exceedance values. It is understood that the seawater abstracted from all the WSD flushing water intakes would normally be treated by disinfection before it is distributed to the users for flushing purpose. Given that the *E.coli* exceedances predicted at the intakes occurred only for a very short period (maximum 8 hours). No unacceptable water quality and public health effect would be expected. A water quality monitoring and audit programme will be implemented before and after opening a 600 m gap at the runway to ascertain the runway opening would not result in unacceptable impact on the WSD flushing water intakes. Based on the review and analysis of the monitoring data, the need for further water quality control or mitigation measures to the Project operation will be identified to minimize the potential impact on the WSD flushing water intakes.

Spent Cooling Water Discharge

8.7.22 Modelling was conducted for the DCS discharges based on the design temperature elevation of 6°C at the DCS outfalls. The WQO for the Victoria Harbour stipulated that the temperature rise in the water column due to human activity should not exceed 2 ^{o}C. **Appendix 8.10a** and **Appendix 8.10b** show the surface temperature elevations over the ambient temperature at different tidal conditions for dry and wet seasons. The model results indicated that temperature rise of more than 2 ^{o}C would occur in vicinity of the spent cooling water outfalls but the overall thermal plume impact would be localised. The temperature elevations predicted at the DCS intake point which is located about 100 m away from the southern DCS outfall are given **Table 8.21**.

Table 8.21 Operation Scenario – Temperature Elevations at DCS Intake

Dry season			Wet season		
Mean	**90 percentile**	**Maximum**	**Mean**	**90 percentile**	**Maximum**
0.19	0.34	1.47	0.15	0.46	1.58

8.7.23 Chlorination dosing is assumed under the modelling exercise to be 24 hours per day with a continuous discharge of chlorine at 0.5 mg/L in the effluent for worst case assessment. The model results indicated that the chlorine concentrations in the Victoria Harbour would generally comply with the assessment criterion of 0.0075 mg/l and, thus, unacceptable chlorine impact on the marine organism is not anticipated. The model outputs showing the predicted tidal and depth-averaged chlorine concentrations in the dry and wet seasons are attached in **Appendix 8.11**.

8.7.24 Besides chlorine, C-Treat-6 would be the only other chemical injection to the cooling system. Based on the assumption that C-Treat-6 is injected only for one hour per week to achieve 2 mg/L 30% tallow 1,3-propylene diamine (as amine content) at the outfall. Based on the biocide content of 2 mg/L at the outfall, the required dilution rate to meet the water quality standard was calculated to be 20 times. Based on the inert tracer modelling assuming a discharge of C-Treat-6 at 2 mg/L continuously (for 24 hours a day; 7 days a week) at the DCS outfall, the dilution rate of 20 times would be achieved at a point about 300 m away from the DCS outfalls. The associated plume of C-Treat-6 is considered localized and confined within the KTD area and would not encroach on any water sensitive receivers. In actuality, the biocide would be released into the marine water intermittently (for only 1 hour per week). The actual plume size is therefore expected to be much smaller. The small amount and intermittent releases of biocide into Victoria Harbour would be readily diluted by strong tidal current along the harbour and would not cause any adverse water quality impact.

Acceptability of Mixing Zone

Non-compliance with the assessment criteria for temperature and chlorine/biocide is predicted in the vicinity of the proposed DCS outfalls. The approximate sizes of mixing zones are presented in **Table 8.21a**.

Table 8.21a Approximate Dimension of Mixing Zones of Thermal and Chlorine Discharges from the DCS

Parameter	**Approximate Dimension of Mixing Zone (km^2)**
Temperature	0.2
Chlorine / Biocide	0.2

The predicted non-compliance is considered acceptable due to the following:

- The exceedance would be confined in the KTD area and would not impair the integrity of the water body and the ecosystem in the Victoria Harbour as a whole.
- The mixing zone would not endanger sensitive uses e.g. beaches, breeding grounds, or diminish existing beneficial uses and therefore would not cause any adverse effects in human or aquatic organism.

As shown in **Appendix 8.11**, non-compliance with the assessment criterion for chlorine of 0.0075 mg/L is predicted at the DCS intake point due to the spent cooling water discharge from the southern DCS outfall. The assessment criterion for chlorine of 0.0075 mg/L was established under the USEPA for protection of aquatic life. No adverse impact on the DCS operation would be caused by the chlorine or biocide exceedance at the DCS intake.

Road Runoff

8.7.25 Surface runoff from new roads proposed under this Project may be contaminated by oils leaked from passing vehicles. It is considered that impacts upon water quality will be minimal provided that the road works are designed with adequate drainage systems and appropriate oil interceptors, as required.

Construction Phase

Marine-based Construction Works

8.7.26 As discussed in **Section 8.5**, this EIA focused on the assessment on the potential SS elevations at the proposed DCS intake at Kai Tak as well as the contaminant release during dredging for the construction of the fireboat berth, Road T2 and the runway opening (including the localized dredging at KTAC for odour mitigation).

SS Elevations at the Proposed DCS Intake

The SS elevations arising from the marine-based construction works including all the potential concurrent dredging and filing activities have been modelled and assessed under the CT Dredging EIA. Based on the model results, the maximum SS elevations caused by the concurrent dredging and filling activities at the DCS intake point were predicted to be lower than 8 mg/L under all the mitigated scenarios with deployment of silt curtains at appropriate locations as recommended under the CT Dredging EIA. Taking into account the background ambient SS level of about less than 6 mg/L, the maximum SS level predicted at the DCS intake point would be about 14 mg/L. Based on the consultation with EMSD, there will not be any SS standard available for the DCS water intake. Potential SS impact on the DCS intake is not expected. No further mitigation measure such as deployment of silt screen at the DCS intake would be required.

Public Landing Steps cum Fireboat Berth

8.7.27 In accordance with the ETWB TCW No. 34/2002, Management of Dredged / Excavated Sediment, sediments are classified into Category L, M and H according to the concentration of the contaminants. With reference to the marine site investigation (SI) recently conducted for the proposed public landing steps cum fireboat berth (sampling locations VC1 and VC2), all the two sediments samples collected from proximity of the proposed marine works area were classified as Category L material or uncontaminated (see also Section 9 of this report). Potential contaminate release from dredging due to the construction of the proposed public landing steps cum fireboat berth would not be expected.

Runway Opening and Road T2

8.7.28 Construction of the runway opening (including some localized dredging alongside the KTAC for odour mitigation) and Road T2 would be carried out after completion of the sediment treatment works proposed in KTAC and KTTS. Review of the historical sediment quality data collected at or near the runway opening and the Road T2 (including the EPD routine sediment quality data at TKWTS and KTTS as well as the sediment sampling data available from the SEKDCFS EIA) indicated that the sediment to be dredged at these Project sites would be contaminated. An indication of the likelihood of release of contaminants from the sediment during dredging alongside the runway opening and Road T2 is given by the results of the elutriation tests conducted under the SEKDCFS EIA. Sediment samples mixed with a solution, i.e. the ambient seawater collected from the same site, were vigorously agitated during the tests to simulate the strong disturbance to the seabed sediment during dredging. Pollutants absorbed onto the sediment particles would be released and increasing the pollutant concentrations in the solution. The laboratory testing was to analyse the pollutant concentrations in the solution (elutriate). **Table 8.22** summarizes the elutriate test results extracted from the approved SEKDCFS EIA for the sampling stations at or close to these Project sites. Locations of the sampling stations are given in **Appendix 8.12**.

Table 8.22 Comparison of Site Investigation Sediment Elutriate Test Results with the Water Quality Standards

Sampling Stations (refer to **Appendix 8.12**)	Metal content (μg/L)									Organic Compounds Content (μg/L)
	Ag	**Cd**	**Cu**	**Ni**	**Pb**	**Zn**	**Cr**	**As**	**Hg**	**TBT**
Stations at KTAC and Kowloon Bay on both sides of the Runway Opening										
SEKD - AC1	<1	<0.2	<2	20	1	**50**	<10	8	0.029	0.015
SEKD - KB7	<1	<0.2	<2	2	<1	<10	<10	10	0.025	<0.015
Stations at or near the Road T2 site										
SEKD - KT1	<1	0.2	<2	3	<1	20	<10	6	0.052	5.6
SEKD - KT2	<1	<0.2	<2	7	<1	<10	<10	6	0.042	1.96
SEKD - KT4	<1	<0.2	<2	3	<1	<10	<10	8	0.021	0.083
Water Quality Standards	2.3 (2)	2.5 (2)	5 (2)	30 (2)	25 (2)	40 (2)	15 (2)	25 (2)	0.3 (2)	0.1 (3)

(Source: Drawing Number 22936/EN/021, Table 4.29 and Table 4.30 of the approved EIA for SEKD CFS)
Notes:
(1) Value in bold indicates exceedance of the Water Quality Standard.
(2) UK Water Quality Standard.
(3) Michael H. Salazar and Sandra M. Salazar (1996). "Mussels as Bioindicators: Effects of TBT on Survival, Bioaccumulation, and Growth under Natural Conditions" in *Organotin*, edited by M. A. Champ and P. F. Seligman. Chapman & Hall, London.

8.7.29 The levels of metals in the elutriate samples complied well with the relevant water quality criteria except only for the levels of zinc measured at the KTAC near the runway opening which only marginally exceeded the water quality criterion. However, the laboratory tests do not take into account the dilution factor after the contaminants are released into the water column. Based on the detected concentration (50 μg/L), the required dilution rate to meet the water quality standard for zinc (40 μg/L) were calculated to be very low (less than 1 time), which can be naturally achieved once the contaminants are released into the water column. Thus, full compliance with the water quality criteria for zinc is expected in the receiving water environment.

8.7.30 The levels of PCBs and PAHs in the elutriate samples were all below the detection limit. The TBT levels, which exceeded the detection limit, were all well below the water quality criterion. It is therefore concluded that adverse water quality impacts due to the potential release of organic compounds from the sediment would not be expected during the dredging activities.

Sediment Treatment

8.7.31 The bioremediation work is currently scheduled to commence in 2010 for completion by 2012 before commencement of other proposed marine works in the KTAC and KTTS (such as the Road T2 and runway opening construction). Also, the bioremediation work would be completed before the implementation of pollution load reduction measures described in Section 8 of **Annex A**. Sediment treatment is proposed to cover all areas within the KTAC and KTTS. The sustainability of the proposed sediment treatment process is discussed in detail in Section 6 of **Annex A**.

8.7.32 The major environmental concerns associated with *in-situ* bioremediation are the potential release of nitrate-nitrogen, ammonia and heavy metals from the sediments into the surrounding water bodies during the bioremediation activities. There is the possibility that the sediment disturbance during injections would increase mobilization of heavy metals and release nitrate-nitrogen. An *in-situ* bioremediation pilot scale field test using calcium nitrate was performed at KTAC in 2006. Based on the EM&A results conducted for the pilot scale field tests during and after-injection, there were no significant water quality impacts noted as a result of the bioremediation activities. There were some transient elevated nitrate-nitrogen levels identified in the collected water samples. However, the potential elevation in the nitrate-nitrogen level is expected to be transient and confined within the breakwaters of KTTS. Outside the breakwaters of KTTS in the Victoria Harbour, the pollutants would easily be dispersed by the fast moving tidal currents. Significant elevation of the nitrate in the open water environment in the Victoria Harbour is not expected. As the ecological value of the existing water bodies in KTAC and KTTS would be low and there are no biological water sensitive receivers, areas of conservation value, ecological importance or mariculture activities identified in KTAC and KTTS, the potential water quality impact associated with the transient and localized increase of nitrate-nitrogen would be limited.

8.7.33 Water quality monitoring and audit is recommended to be carried out to ensure that the proposed sediment treatment operation would not result in unacceptable impact. If the water quality monitoring data indicate that the proposed works result in unacceptable water quality impacts in the receiving water, appropriate actions should be taken to review the treatment works and additional measures such as slowing down, or rescheduling of works should be implemented as necessary.

8.8 Mitigation of Environmental Impacts

<u>Operational Phase</u>

Use of KTAC and KTTS as an Area of General Amenity Value

8.8.1 No unacceptable water quality impact is predicted for the proposed general amenity use at the KTAC and KTTS provided that a 600 m wide opening will be provided at the northern end of the runway (north of taxiway bridge) to improve the water circulation and flushing effect at the KTAC and KTTS. Cleansing contractor provides scavenging service (floating refuse) in the waters surrounding the ex-Kai Tak Airport runway except the inaccessible water area located to the northwest of the footbridge connecting the runway and Kwun Tong Typhoon Shelter (**Figure 8.6**). Mitigation measures to control pollution entering KTAC and KTTS will also be implemented to further improve the water quality and aesthetic quality of the KTAC and KTTS as detailed in Section 8 of **Annex A**. Odour control measures for KTAC and KTTS are described in **Section 6** of this Report and would also improve the aesthetic quality in the Study Area. No further water quality mitigation is considered necessary.

Overflow or Emergency Discharge of the Sewerage System

8.8.2 The following mitigation measures are proposed to be incorporated in the design of the proposed SPS, including:

- Dual power supply or emergency generator should be provided at all the SPSs to secure electrical power supply;
- Standby pumps should be provided at all SPSs to ensure smooth operation of the SPS during maintenance of the duty pumps;
- An alarm should be installed to signal emergency high water level in the wet well at all SPSs; and
- For all unmanned SPSs, a remote monitor system connecting SPSs with the control station through telemetry system should be provided so that swift actions could be taken in case of malfunction of unmanned facilities.

8.8.3 With the above mitigation measures, the possibility of sewage overflow due to the event of pump failure or power failure would be minimized. The occurrence of emergency overflow of SPSs was envisaged to be minimal.

Spent Cooling Water Discharge

8.8.4 The thermal impact from the DCS discharge on the harbour water is predicted to be localized and minor as the general flushing capacity in the Victoria Harbour is high. As chlorine would be subject to decay, the impact from any residual chlorine discharge from the DCS is also predicted to be localized and confined in area close to the outfall. No mitigation measures would be required.

Road Runoff

8.8.5 For the operation of road works, a surface water drainage system would be provided to collect road runoff. It is recommended that the road drainage should be provided with adequately designed silt trap and oil interceptors, as necessary. The design of the operational stage mitigation measures for the road works shall take into account the guidelines published in ProPECC PN 5/93 "Drainage Plans subject to Comment by the EPD".

Construction Phase

Marine-based Construction Works

8.8.6 Details of the mitigation measures recommended for the proposed dredging activities for construction of the cruise terminal are given in the approved CT Dredging EIA. In addition, based on the sediment plume modelling results available from the approved CT Dredging EIA, the following measures are recommended to be implemented in the design of dredging works for the proposed runway opening (including the localized dredging at KTAC for odour mitigation), fireboat berth and Road T2:

- Silt curtains should be deployed around the close grab dredger to minimize release of sediment and other contaminants for any dredging and filling activities in open water.
- Dredging at and near the seawall area for construction of the public landing steps cum fireboat berth should be carried out at a maximum production rate of 1,000m^3 per day using one grab dredger.
- The proposed construction method for runway opening should adopt an approach where the existing seawall at the runway will not be removed until completion of all excavation and dredging works for demolition of the runway. Thus, excavation of bulk fill and majority of the dredging works will be carried out behind the existing seawall, and the sediment plume can be effectively contained within the works area. As there is likely some accumulation of sediments alongside the runway, there will be a need to dredge the existing seabed on both sides of the runway after completion of all the demolition works. Dredging near the 600m opening (with incorporation of the localized maintenance dredging at KTAC required for odour mitigation) should be carried out at a maximum production rate of 2,000m^3 per day using one grab dredger.
- Dredging for Road T2 should be conducted at a maximum rate of 8,000m^3 per day (using four grab dredgers) whereas the sand filling should be conducted at a maximum rate of 2,000m^3 per day (using two grab dredgers).

8.8.7 Based on approved CT Dredging EIA, silt screens are recommended to be deployed at six selected WSD flushing water intakes during the marine construction work including the intake at Cha Kwo Ling, Sai Wan Ho, Quarry Bay, Sheung Wan, Wan Chai and Tai Wan. The operation of the flushing water intakes would not be adversely affected by the silt screens provided that the silt screens are properly designed and maintained. Installation of silt screens at the selected flushing water intake points shall be implemented by the contractor. The contractor for shall demonstrate and ensure that the design of the silt screen will not affect the normal operation of flushing water intake. The contractor shall obtain consensus from all relevant parties, including WSD and Marine Department, on the design of the silt screen at each of the six selected flushing water intake points before installation of the silt screen and commencement of the proposed dredging works. A water quality monitoring and audit programme and an Event and Action Plan as stipulated in the Environmental Monitoring and Audit (EM&A) Manual of the CT Dredging EIA shall be implemented by the contractor to ensure that the proposed works do not result in unacceptable impacts at the WSD flushing water intakes. As a mitigation measure to avoid the pollutant and refuse entrapment problems and to ensure that the impact monitoring results are representative, regular maintenance of the silt screens and refuse collection should be performed by the contractor at the silt screens at regular intervals on a daily basis. The Contractor should be responsible for keeping the water behind the silt screen free from floating rubbish and debris during the impact monitoring period.

8.8.8 Details of the water quality model assumptions, modelling scenarios, modelling results and mitigation measures for the potential dredging and filling impacts from all the concurrent marine activities are given in the approved CT Dredging EIA.

Land-based Construction Works

8.8.9 It is important that appropriate measures are implemented to control runoff and drainage and prevent high loading of SS from entering the marine environment. Proper site management is essential to minimise surface water runoff, soil erosion and sewage effluents.

8.8.10 Any practical options for the diversion and re-alignment of drainage should comply with both engineering and environmental requirements in order to ensure adequate hydraulic capacity of all drains.

8.8.11 8.8.11 Construction site runoff and drainage should be prevented or minimised in accordance with the guidelines stipulated in the EPD's Practice Note for Professional Persons, Construction Site Drainage (ProPECC PN 1/94). Good housekeeping and stormwater best management practices as detailed below should be implemented to ensure that all construction runoff complies with WPCO standards and that no unacceptable impact on the WSRs arises due to construction of the Project. All discharges from the construction site should be controlled to comply with the standards for effluents discharged into the Victoria Harbour WCZ under the TM-DSS.

Construction Runoff

8.8.12 Exposed soil areas should be minimised to reduce the potential for increased siltation, contamination of runoff, and erosion. Construction runoff related impacts associated with the above ground construction activities can be readily controlled through the use of appropriate mitigation measures which include:

- use of sediment traps; and
- adequate maintenance of drainage systems to prevent flooding and overflow.

8.8.13 Construction site should be provided with adequately designed perimeter channel and pre-treatment facilities and proper maintenance. The boundaries of critical areas of earthworks should be marked and surrounded by dykes or embankments for flood protection. Temporary ditches should be provided to facilitate runoff discharge into the appropriate watercourses, via a silt retention pond. Permanent drainage channels should incorporate sediment basins or traps and baffles to enhance deposition rates. The design of efficient silt removal facilities should be based on the guidelines in Appendix A1 of ProPECC PN 1/94.

8.8.14 Ideally, construction works should be programmed to minimise surface excavation works during the rainy season (April to September). All exposed earth areas should be completed as soon as possible after earthworks have been completed, or alternatively, within 14 days of the cessation of earthworks where practicable. If excavation of soil cannot be avoided during the rainy season, or at any time of year when rainstorms are likely, exposed slope surfaces should be covered by tarpaulin or other means.

8.8.15 Sedimentation tanks of sufficient capacity, constructed from pre-formed individual cells of approximately 6 to 8 m^3 capacity, are recommended as a general mitigation measure which can be used for settling surface runoff prior to disposal. The system capacity is flexible and able to handle multiple inputs from a variety of sources and particularly suited to applications where the influent is pumped.

8.8.16 Open stockpiles of construction materials (for examples, aggregates, sand and fill material) of more than 50 m^3 should be covered with tarpaulin or similar fabric during rainstorms. Measures should be taken to prevent the washing away of construction materials, soil, silt or debris into any drainage system.

8.8.17 Manholes (including newly constructed ones) should always be adequately covered and temporarily sealed so as to prevent silt, construction materials or debris being washed into the drainage system and storm runoff being directed into foul sewers.

8.8.18 Precautions to be taken at any time of year when rainstorms are likely, actions to be taken when a rainstorm is imminent or forecast, and actions to be taken during or after rainstorms are summarised in Appendix A2 of ProPECC PN 1/94. Particular attention should be paid to the control of silty surface runoff during storm events.

8.8.19 Oil interceptors should be provided in the drainage system and regularly cleaned to prevent the release of oils and grease into the storm water drainage system after accidental spillages. The interceptor should have a bypass to prevent flushing during periods of heavy rain.

8.8.20 All vehicles and plant should be cleaned before leaving a construction site to ensure no earth, mud, debris and the like is deposited by them on roads. An adequately designed and located wheel washing bay should be provided at every site exit, and wash-water should have sand and silt settled out and removed at least on a weekly basis to ensure the continued efficiency of the process. The section of access road leading to, and exiting from, the wheel-wash bay to the public road should be paved with sufficient backfall toward the wheel-wash bay to prevent vehicle tracking of soil and silty water to public roads and drains.

Drainage

8.8.21 It is recommended that on-site drainage system should be installed prior to the commencement of other construction activities. Sediment traps should be installed in order to minimise the sediment loading of the effluent prior to discharge into foul sewers. There shall be no direct discharge of effluent from the site into the sea.

8.8.22 All temporary and permanent drainage pipes and culverts provided to facilitate runoff discharge should be adequately designed for the controlled release of storm flows. All sediment control measures should be regularly inspected and maintained to ensure proper and efficient operation at all times and particularly following rain storms. The temporarily diverted drainage should be reinstated to its original condition when the construction work has finished or the temporary diversion is no longer required.

8.8.23 All fuel tanks and storage areas should be provided with locks and be located on sealed areas, within bunds of a capacity equal to 110% of the storage capacity of the largest tank, to prevent spilled fuel oils from reaching the coastal waters of the Victoria Harbour WCZ.

Sewage Effluent

8.8.24 Construction work force sewage discharges on site are expected to be connected to the existing trunk sewer or sewage treatment facilities. The construction sewage may need to be handled by portable chemical toilets prior to the commission of the on-site sewer system. Appropriate numbers of portable toilets shall be provided by a licensed contractor to serve the large number of construction workers over the construction site. The Contractor shall also be responsible for waste disposal and maintenance practices.

Floating Refuse and Debris

8.8.25 It is recommended that collection and removal of floating refuse should be performed at regular intervals on a daily basis. The contractor should be responsible for keeping the water within the site boundary and the neighbouring water free from rubbish during the KTD construction. On-site waste management requirements are described further in Section 9 of this Report.

Stormwater Discharges

8.8.26 Minimum distances of 100 m shall be maintained between the existing or planned stormwater discharges and the existing or planned seawater intakes.

Construction Works at or in Close Proximity of Storm Culvert or Seafront

8.8.27 To minimize the potential water quality impacts from the construction works located at or near any storm culvert, drainage channels, nullah or seafront, the good practices as listed below should be adopted where applicable:

- The proposed works should preferably be carried out within the dry season where the flow in the drainage channel /storm culvert/ nullah is low.
- The use of less or smaller construction plants may be specified to reduce the disturbance to the bottom sediment at the drainage channel /storm culvert / nullah.
- Temporary storage of materials (e.g. equipment, filling materials, chemicals and fuel) and temporary stockpile of construction materials should be located well away from any water courses during carrying out of the construction works.
- Stockpiling of construction materials and dusty materials should be covered and located away from any water courses.
- Construction debris and spoil should be covered up and/or disposed of as soon as possible to avoid being washed into the nearby water receivers.
- Construction activities, which generate large amount of wastewater, should be carried out in a distance away from the waterfront, where practicable.
- Mitigation measures to control site runoff from entering the nearby water environment should be implemented to minimize water quality impacts. Surface channels should be provided along the edge of the waterfront within the work sites to intercept the runoff.
- Construction effluent, site run-off and sewage should be properly collected and/or treated.
- Any works site inside the storm water courses should be temporarily isolated, such as by placing of sandbags or silt curtains with lead edge at bottom and properly supported props to prevent adverse impact on the storm water quality.
- Silt curtain may be installed around the construction activities at the seafront to minimize the potential impacts due to accidental spillage of construction materials.
- Proper shoring may need to be erected in order to prevent soil/mud from slipping into the storm culvert/drainage channel/sea.
- Supervisory staff should be assigned to station on site to closely supervise and monitor the works.

Sediment Treatment

8.8.28 No unacceptable impact would be expected from the proposed *in-situ* bioremediation. Water quality monitoring and audit is recommended to be carried out during and after the treatment operation to ensure that the proposed works would not result in unacceptable impact.

8.9 Environmental Monitoring and Audit

Operational Phase

8.9.1 No unacceptable water quality impacts would be expected from the Project. Cleansing contractor will provide scavenging service (floating refuse) in the accessible water area surrounding the ex-Kai Tak Airport runway. A water quality monitoring and audit programme will be implemented before and after opening a 600 m gap at the runway to ascertain the runway opening would not result in unacceptable impact marine water quality as well as the WSD flushing water intakes and to confirm the water quality impacts predicted under operational phase of the Project. The potential impacts from red tide or harmful algal blooms (HABs) that may arise in the KTD area during operational phase will be managed and responded under the routine red tide monitoring and management protocol and response plan currently adopted by AFCD for the Hong Kong SAR waters to ascertain the runway opening and bioremediation for the sediment at KTAC and KTTS would not result in unacceptable impact.

8.9.2 With regards to the proposed bioremediation for the sediment at KTAC and KTTS, water quality monitoring and audit is also recommended to be carried out during and for a period of one year after the bioremediation treatment operation to ensure that the proposed treatment operation would not result in unacceptable impact.

Construction Phase

8.9.3 There would be potential impacts of suspended solids upon the flushing water intakes due to the marine construction works proposed under the KTD. Water quality monitoring and audit will need to be carried out for the proposed dredging and filling works to ensure that all the recommended mitigation measures are properly implemented.

8.9.4 Water quality monitoring and audit is also recommended to be carried out during and after the sediment treatment operation to ensure that the proposed treatment work would not result in unacceptable impact.

8.9.5 Details of the water quality monitoring programme and the Event and Action Plan are provided the EM&A Manual.

8.10 Summary

Operational Phase

Use of KTAC and KTTS as an Area of General Amenity Value

8.10.1 No unacceptable water quality impact is predicted for the proposed general amenity use at the KTAC and KTTS provided that a 600 m wide opening will be provided at the northern end of the runway (north of taxiway bridge) to improve the water circulation and flushing effect at the KTAC and KTTS. Cleansing contractor will provide scavenging service (floating refuse) in the accessible water area surrounding the ex-Kai Tak Airport runway Further mitigation measures will be implemented to control pollution entering KTAC and KTTS in order to improve the water quality and aesthetic quality of the KTD water. The assessment results also indicated that the proposed 600 m opening at the runway would not adversely affect the overall water quality impact in the Victoria Harbour and its adjacent water.

Overflow or Emergency Discharge from the Sewerage System

8.10.2 Provision of standby pump facilities and dual power supply would minimize the occurrence of emergency discharge event. With the implementation of suitable design measure, there would not be any insurmountable water quality impacts associated with the proposed SPS operation.

Spent Cooling Water Discharge

8.10.3 The thermal impact from the DCS discharge on the harbour water is predicted to be localized and minor as the general flushing capacity in Victoria Harbour is high. As the chlorine would be subject to decay, the impact from any residual chlorine discharge from the DCS is also predicted to be localized and confined in area close to the outfall.

Road Runoff

8.10.4 Surface runoff from new roads proposed under this Project may be contaminated by oils leaked from passing vehicles. It is considered that impacts upon water quality will be acceptable provided that the road works are designed with adequate drainage systems and appropriate oil interceptors, as required.

Construction Phase

Marine-based Impact

8.10.5 The cumulative water quality impact from the marine construction works proposed under the KTD has been quantitatively assessed using the Delft3D Model under the approved CT Dredging EIA. Suspended sediment is identified as the most significant water quality parameter during the marine works. However, the water quality impacts could be effectively minimized with the implementation of the proposed mitigation measures. There would be no unacceptable residual water quality impact due to the proposed marine works. An environmental monitoring and audit programme is required to ensure the effectiveness of the proposed water quality mitigation measures.

Land-based Impact

8.10.6 Water quality impacts from land-based construction, including road works, waterfront facilities and public utilities, are associated with the surface runoff, effluent discharge from the site, and sewage from on-site construction workers. Impacts can be controlled to comply with the WPCO standards by implementing the recommended mitigation measures. No unacceptable residual impacts on water quality are anticipated.

Sediment Treatment

8.10.7 No unacceptable impact would be expected from the proposed *in-situ* bioremediation. Water quality monitoring and audit is recommended to be carried out during and after the treatment operation to ensure that the proposed sediment treatment work would not result in unacceptable impact.