SECTION 5

5 WATER QUALITY

5.1 Introduction

5.1.1 The construction and operation of the Western Coast Road (WCR) has the potential to have an impact on the marine water quality of the Study Area. A number of marine-based water quality sensitive activities, in particular dredging and filling activities, for the two reclamations will be conducted. Although the extent of the proposed reclamations are relatively small, any proposed reclamation for the alignment will need to be considered carefully. A comprehensive assessment of the potential impacts arising from all the water quality sensitive activities has been undertaken to ensure that no local effects and far field effects on harbour water velocities will result from the implementation of the WCR.

5.1.2 The objective of this assessment is to evaluate the potential environmental impacts to water quality from the construction and operation of the WCR, to formulate recommendations for their mitigation and to assess the likely residual acceptability of water quality impacts.

5.1.3 The marine sediment contamination assessment is presented in *Annex F*.

5.2 Government Legislation and Standards

Construction and Operational Phase

5.2.1 The criteria for evaluating water quality impacts are laid out in the *Technical Memorandum on Environmental Impact Assessment Process* (EIAO-TM). The relevant criteria to this EIA Study are given below.

Water Pollution Control Ordinance

5.2.2 *The Water Pollution Control Ordinance* (WPCO) is the legislation for the control of water pollution and water quality in Hong Kong. Under the WPCO, Hong Kong waters are divided into 10 Water Control Zones (WCZ). Each WCZ has a designated set of statutory Water Quality Objectives (WQO). The proposed WCR Study Area falls within three WCZ: the Junk Bay WCZ; the Eastern Buffer WCZ; and the Victoria Harbour WCZ, which has been subdivided into three phases of implementation. Phase I and Phase II of Victoria Harbour WCZ were declared in November 1994 and September 1995 respectively. Victoria Harbour WCZ Phase III was gazetted in April 1996. These three WCZs are shown in *Figure 5.2a*.

Water Quality Objectives

5.2.3 The WQOs for each of these WCZs, are presented in *Annex C*, will be applicable as evaluation criteria for assessing compliance of the WCR against statutory requirements. The WQOs have been defined in Annex 6: *Criteria for Evaluating Water Pollution of the Technical Memorandum for the EIA Ordinance*.

Project Specific Criteria

5.2.4 There are no water quality objectives for cooling water intakes specified by the Hong Kong SAR. The Dairy Farm Ice Factory has advised that a maximum level of suspended solids (SS) of 30 mg L^{-1} would not have a significant impact to the operations of their Yau Tong Bay Ice Plant's condensing system operation. Therefore, this level is considered to be the recommended threshold level for this sensitive receiver.

5.2.5 For the salt water used for flushing, the Water Supplies Department (WSD) have their own WQO standard in which the SS concentration should not exceed 10 mg L^{-1} (with an upper tolerance level of 20 mg L^{-1}). The nearest sensitive receivers identified are the Cha Kwo Ling and Yau Tong Bay Salt Water Pumping Stations. Taking a conservative approach, the SS content at the flushing water intake should be kept below the upper tolerance level of 20 mg L^{-1}, preferably within the WSD operating standard of 10 mg L^{-1}.

5.2.6 The Agriculture and Fisheries Department (AFD) have set specific water quality criterion for SS in the Tung Lung Chau FCZ, beyond which damage to fish stocks may occur. Presently, mariculturists will be eligible for exgratia allowance when the SS at the fish culture zone, as a result of dredging or dumping works of a project, achieves 50 mg L^{-1} or 100% more than the highest level recorded at the zone during the 5 years before commencement of the works in the vicinity. When such criteria are exceeded, appropriate mitigatory measures, including ceasing of works, if necessary, should be adopted to keep the impact to within acceptable levels.

5.2.7 The highest SS level detected by EPD during five years of water quality monitoring at Tung Lung Chau, prior to October 1992, when sand borrowing commenced in the Tathong Channel, was 11 mg L^{-1}. Therefore, the exgratia payment would be initiated when levels of suspended solids at Tung Lung Chau FCZ, resulting from dredging and dumping activities, reach 22 mg L^{-1} which is 11 mg L^{-1} (100%) above background conditions at the FCZ.

5.2.8 The WQO for SS concentrations allow a maximum increase of 30% above the background concentrations. The background concentration is defined as being the 90th percentile of measured concentrations. An analysis of data at the EPD routine monitoring Station VM1 for 1996 found that the depth averaged 90th percentile was 15.9 mg L^{-1}. The allowable elevation from the dredging and filling works would therefore be 4.8 mg L^{-1}. It should be noted that without any additional contribution of SS from the WCR works that the WSD operating standard of 10 mg L^{-1} would still be exceeded, while the upper tolerance limit of 20 mg L^{-1} would be satisfied.

5.3 Baseline Conditions

Marine Waters

5.3.1 The EPD marine water quality monitoring data routinely collected in the vicinity of the site in the WCZs of Victoria Harbour, Eastern Buffer and Junk Bay have been used for determining background conditions. The EPD monitoring stations of most relevance are: VM1 for Victoria Harbour WCZ; EM1 for the Eastern Buffer WCZ and JM4 for the Junk Bay WCZ as shown in *Figure 5.3a*. A summary of the most recently published EPD monitoring data (for the year 1995) collected at these stations are presented in *Table 5.3a*.

Table 5.3a Summary Statistics of 1996 Marine Water Quality in the Vicinity of the Proposed WCR

Parameter		VM1	EM1	JM4
Temperature (°C)	Surface	23.3 (18.9-27.9)	23.2 (17.4-28.1)	23.0 (17.3-28.1)
	Bottom	22.7 (18.7-27.9)	22.5 (17.3-28.0)	22.3 (17.3-27.9)
Salinity (ppt)	Surface	32.1 (28.8-34.1)	32.2 (27.9-34.2)	32.5 (28.6-34.4)
	Bottom	33.0 (30.6-34.2)	33.1 (32.0-34.3)	33.5 (31.8-34.3)
DO (% saturation)	Surface	74.2 (50.6-98.0)	67.4 (40.6-86.2)	76.6 (52.8-96.4)
	Bottom	65.4 (39.3-79.1)	66.5 (40.4-83.5)	74.5 (54.4-92.9)
DO (mg L^{-1})	Surface	5.2 (3.8-6.6)	4.8 (2.7-6.1)	5.5 (3.5-7.0)
	Bottom	4.7 (2.7-5.6)	4.8 (2.7-5.7)	5.3 (3.6-6.8)
pH value		8.0 (7.8-8.2)	8.0 (7.7-8.4)	8.0 (7.8-8.4)
Secchi disc (m)		1.9 (1.5-2.7)	2.1 (1.4-3.0)	2.8 (2.0-3.7)
Turbidity (NTU)		4.5 (1.7-9.8)	3.6 (1.5-5.6)	3.7 (1.5-7.1)
Suspended solids (mg L^{-1})		8.6 (3.9-17.1)	5.6 (2.1-11.6)	4.1 (1.8-7.0)
Silica (as SiO_2) (mg L^{-1})		0.7 (0.4-1.5)	0.9 (0.4-1.4)	0.8 (0.4-1.3)
BOD_5 (mg L^{-1})		0.9 (0.5-1.4)	1.1 (0.6-2.4)	0.5 (0.1-0.9)
Nitrite Nitrogen (mg L^{-1})		0.02 (0.01-0.03)	0.02 (0.01-0.04)	0.02 (<0.01-0.03)
Nitrate Nitrogen (mg L^{-1})		0.05 (0.03-0.13)	0.07 (0.02-0.19)	0.06 (0.01-0.22)

Parameter		VM1	EM1	JM4
Ammoniacal Nitrogen (mg L^{-1})		0.20 (0.04-0.33)	0.22 (0.07-0.47)	0.15 (0.02-0.31)
Total Inorganic Nitrogen (mg L^{-1})		0.26 (0.12-0.40)	0.31 (0.16-0.57)	0.23 (0.07-0.39)
Total N (mg L^{-1})		0.55 (0.21-0.96)	0.57 (0.28-1.14)	0.48 (0.26-0.80)
Ortho-Phosphate (mg L^{-1})		0.04 (0.02-0.06)	0.05 (0.02-0.10)	0.03 (0.01-0.06)
Total P (mg L^{-1})		0.14 (0.09-0.22)	0.14 (0.09-0.23)	0.12 (0.07-0.19)
Phaeo-pigment (μg L^{-1})		1.94 (0.23-10.50)	1.70 (0.20-8.20)	1.80 (0.20-8.90)
Chlorophyll-a (μg/l)		1.95 (0.47-6.33)	2.35 (0.53-8.07)	3.92 (0.50-23.67)
E. coli (cfu/100 ml)		9,401 (1,767-38,000)	11,109 (673-90,600)	927 (133-6,867)
Faecal Coliform (cfu/100 ml)		13,878 (3,500-68,000)	15,956 (1,173-132,667)	1,442 (217-11,567)

Note: 1. Except as specified, data presented are depth-averaged data.
2. Data presented are annual arithmetic means except for *E. coli* data which are geometric means.
3. Data enclosed in parentheses indicate the range.

Victoria Harbour

5.3.2 The summary data for VM1 indicates that the eastern part of Victoria Harbour is heavily influenced by freshwater discharge from stormwater drains and sewers, which contains high levels of organic material and bacterial counts (*E. coli* levels range from 1,767 to 38,000 cfu/100 ml). These factors also serve to create prominent seasonal and vertical variations in dissolved oxygen (DO), and may be responsible for fluctuations in temperature and salinity.

5.3.3 In the summer, the DO concentration in the bottom water layer decreases due to the large quantity of organic matter with high biochemical oxygen demand (BOD) entering the water column and the sediment oxygen demand being exerted, while the surface layer can become supersaturated with oxygen as a result of algal growth. Oxygen depletion in the bottom layer is compounded by the lack of vertical mixing during the summer months as opposed to the well mixed winter conditions. DO and BOD at VM1 range from 2.7 to 6.6 mg L^{-1} and from 0.5 to 1.4 mg L^{-1} respectively. The DO saturation was calculated to range from 39% to 98%, with a depth averaged BOD at 0.9 mg L^{-1}. The SS concentrations range from 3.9 to 17.1 mg L^{-1}, with the depth averaged value at approximately 8.6 mg L^{-1}.

Eastern Buffer

5.3.4 The summary data for EM1 indicate that the western portion of the Eastern Buffer at the mouth to Victoria Harbour is also heavily influenced by freshwater discharge from stormwater drains and sewers, which contains high levels of organic material and bacterial counts (*E. coli* levels range from 673 to 90,600 cfu/100 ml). These factors also serve to create prominent seasonal and vertical variations in dissolved oxygen (DO), and may be responsible for fluctuations in temperature and salinity. For DO and BOD at EM1, concentrations are similar to VM1 with a range from 2.7 to 6.1 mg L^{-1} and from 0.6 to 2.4 mg L^{-1} respectively. The DO saturation was calculated to be 40% to 86 %, with depth averaged BOD of 1.1 mg L^{-1}. The SS concentrations range from 2.1 to 11.6 mg L^{-1}, with the depth averaged value at approximately 5.6 mg L^{-1}.

Junk Bay

5.3.5 The summary data for JM4 indicates that Junk Bay is less influenced by discharge from stormwater drains and sewers, with lower levels of *E. coli* compared with VM1 and EM1 which range from 133 to 6,867 cfu/100 ml. For DO and BOD at JM4, concentrations are similar to VM1 with a range from 3.5 to 7.0 mg L^{-1} and from 0.1 to 0.9 mg L^{-1} respectively. The DO saturation was calculated to be 53% to 96 %, with depth averaged BOD of 0.5 mg L^{-1}. The SS concentrations range from 1.8 to 7.0 mg L^{-1}, with the depth averaged value at approximately 4.1 mg L^{-1} which is lower than both VM1 and EM1.

5.4 Water Quality Sensitive Receivers

5.4.1 In order to evaluate the water quality impacts during the construction phase, the proximity of Water Sensitive Receivers (WSR) to the reclamation site must be considered. These have been identified in accordance with the *Hong Kong Planning Standards and Guidelines* (HKPSG), which provide guidance for including environmental considerations in the planning of both public and private developments.

5.4.2 A review of available information(6) determined that major biological sensitive receivers such as mariculture zones, commercial fisheries, or shell fisheries are not found in the vicinity of the Study Area. However the nearest fish culture zone is located at Tung Lung Chau (W5) which is outside the Study Area. The Tung Lung Chau Fish Culture Zone (FCZ) has an area of 80,000 m². The FCZ relevant assessment criteria are described in *Section 5.2.6* and *5.2.7*.

5.4.3 Within the WCR Study Area there are two WSD saltwater intake pumping stations located at Cha Kwo Ling (W2) and Yau Tong Bay (W3). There is also the Dairy Farm Ice Factory Seawater Cooling Intake (W1) within close proximity to the Study Area. The locations of the saltwater pumping stations are indicated in *Figure 5.4a*. The pump equipment and filters may be susceptible to clogging, or even damage caused by excessive loads of suspended solids, silt or floating debris and the relevant assessment criteria are described in *Section 5.2.5*. The WSD salt water pumping station in Tseung Kwan O is also considered to be a

(6) Feasibility Study for South East Kowloon Development, Environmental Impact Assessment Report, Hong Kong Government Territory Development Department, Agreement No. CE 49/94, May 1997.

WSR however this station is further from the construction works.

5.5 Construction Phase

Potential Sources of Impact

5.5.1 Based upon the findings of previous studies on reclamation projects within Victoria Harbour and the presently envisaged construction activities, the primary water quality impacts which may arise during the construction of WCR would result from disturbance of sediment and accumulation of organic pollutants within the water column associated with the dredging and reclamation filling activities.

Reclamation Activities

5.5.2 The proposed reclamation activities for the TKO Section and Yau Tong Areas are expected to be the major source of impact to water quality during the construction phase. A brief description of each reclamation is provided in the following section.

5.5.3 For the TKO Section, it was expected that the WCR would be built on the reclamation formed as part of the Area 131 Study and thus water quality assessment in the TKO section were previously excluded. However, following a request by TDD in 20 March 1998 (ref (37) in NTEJB2/584TH/41 IX), a comparative assessment of the TKO section of the reclamation was included as part of the EIA.

5.5.4 For the Yau Tong Bay Section, any temporary embayment formed due to the phasing of the reclamation in Yau Tong Bay could lead to a temporary reduction in flushing and accumulation of pollutants within the water column. However, following the endorsement of the preferred alignment Option 2D2 in the 4th Project Steering Group Meeting held on 17 November 1997, the following refinements have been incorporated into the preferred alignment as described in *Section* 5.5.5. The movement of plant for the reclamation works is not expected to impact the Sam Ka Tsuen Typhoon Shelter and would be outside the existing breakwater. The Sam Ka Tsuen storm drain outfall will be re-diverted prior to the WCR reclamation works.

5.5.5 The preferred alignment Option 2D2 will be built on piled structures in the Yau Tong Area with a thin strip of reclamation 80 m wide between Sam Ka Tsuen Typhoon Shelter and Yau Tong Bay which will avoid any far field tidal flows of Victoria Harbour.

5.5.6 After discussion with EPD Water Policy Group on 10 September 1997, the configuration and phasing of the thin reclamation strip between Yau Tong Bay and Sam Ka Tsuen Typhoon Shelter has been further reviewed by the Engineering Team to minimise any key adverse water quality impacts identified. It was proposed that an evaluation of the potential transport of sediment and impacts on the nearby WSR water intakes identified in *Section 5.4* be undertaken for the thin strip of reclamation, using dispersion modelling.

Cumulative Impacts During Reclamation Construction

5.5.7 There are a number of other potential projects which may overlap with the construction of the WCR reclamation which will also be sources of SS. Such projects may include the SEKR and the Yau Tong Bay CDA reclamation. However, there is no confirmed construction programme for either of these projects and as such it would not be reasonable to consider these projects as cumulative impacts without confirmation that they would overlap with the construction of the WCR. If, at a later date, information on the construction programmes of the SEKR and Yau Tong Bay CDA reclamation become available and show overlaps with the construction of the WCR reclamation then it will be necessary to consider cumulative impacts. It is likely that such information will not become available until the later stages of this Project, possibly during the detailed design stage.

Marine Sediment Impacts

5.5.8 According to information provided by the WCR Engineering Team, marine sediments will only be removed from locations where permanent seawalls and other critical foundation items such as piles are to be constructed to minimise dredging. Further minimisation of dredging may be achieved by installing vertical drains through soft alluvial mud and surcharging throughout the site to encourage expeditious settlement of the main body of reclamation.

5.5.9 For the TKO Section, estimates of the volume of marine muds and spoils generated by dredging activities that will be undertaken as part of the Area 131 Study are provided in the Final Laboratory Testing Report and are presented in *Section 6*.

5.5.10 For the Yau Tong Bay Section, estimates of the volume of marine muds and spoils generated by dredging activities are undertaken in the Dredging of Contaminated Material Report and are presented in *Section 6*.

5.5.11 Results for both reclamations, show that a portion of the dredged material will be moderately (Class B) to seriously contaminated (Class C), and which will require special handling and disposal according to EPD's *Technical Circular TC 11/92* and *WBTC 6/92* and *22/92*. The potential impacts to water quality from dredging and disposal of marine muds will vary according to the quantities and level of contamination, as well as the sensitive receivers at the dredging and disposal sites. These impacts may include:

- release of previously bound organic and inorganic constituents such as nutrients, PAHs, PCBs, ammonia sulphides, and heavy metals into the water column, either via suspension or by disturbance from turbulent flow or mud waves as a result of dredging activities, disposal of muds, or depositing fill materials;

- release of contaminants from pore water and leachate forced out of sediments as a result of accelerated draining, compaction or settlement during site formation;

- release of the same contaminants due to leakages and spillage as a result of poor handling and overflow from barges during dredging and transport;

- disturbance and release of previously deposited contaminant material from the sea bed in the disposal pits from introduction of new dredged spoil; and

- suspension of solids in the water column during dredging activities and marine sediment dumping activities, with the likely consequence of reducing dissolved oxygen levels and increasing nutrient levels.

5.5.12 All of the above can result in a deterioration in the receiving marine water quality and may have adverse effects on marine sensitive receivers.

Cooling Water Discharge

5.5.13 Through discussions with the Engineering Team and through review of previous studies, a cooling water discharge point at the Dairy Farm Ice Factory Seawater Cooling Discharge has been identified within the Study Area. Water at a raised temperature from cooling systems is discharged via the above outfall into Victoria Harbour. Temperature elevations could impact on the efficiency of the cooling water from the local water body within the Study Area. However, due to the shape and relatively small size of the reclamation proposed, it is unlikely that any cooling water impacts will result due to the proposed reclamation.

Sewage Outfalls

5.5.14 At present there are four sewage screening plants discharging into the Study Area. The flow inventory of the outfalls from these plants are listed in *Table 5.5a* and the locations shown in *Figure 5.5a*. It is assumed that by the time the WCR is constructed, the SSPs will be connected to the Strategic Sewage Disposal Scheme (SSDS) and treated at the Stonecutters Sewage Treatment Works (STW).

Table 5.5a Flow and Estimated Loading of Existing Sewage Outfalls in the Study Area

Plant	Sewage Treatment Plant	Average Daily Sewage Flow (1)	Loading (kg day^{-1})(2)					
			Suspended Solids	BOD^5	COD	Total Nitrogen	Nitrogen (Free Ammonia)	Total Coliform
1	To Kwa Wan Sewage Treatment Plant	51,920	11,422.2	11,422. 2	25,960	2,076.8	1,298	$5.19x10^{15}$ $5.19x10^{16}$
2	Kwun Tong SSP	341,372	75,101.84	75,101.84	170,686	13,654.88	8,534.3	$3.41x10^{16}$ $3.41x10^{17}$
3	Shau Kei Wan SSP	44,727	9,839.94	9,839.94	22,363.5	1,789.08	1,118.18	$4.47x10^{15}$ $4.47x10^{16}$
4	Chai Wan SSP	46,197	10,163.34	10,163.34	23,098.5	1,847.88	1,154.93	$8.61x10^{16}$ $8.61x10^{17}$

Note:
(1) Sewage flow values presented are daily averages in November 1995.
(2) All loading values are calculated by multiplying the medium strength of each parameter by the average daily sewage flow in November 1995.
Source:
Drainage Services Department, Hong Kong Government.
Feasibility Study for South East Kowloon Development EIA, Initial Assessment Report (March 1996).

Stormwater Discharge

5.5.15 At least seven stormwater outfalls have been identified within the Study Area. Dry weather flow discharge from these stormwater outfalls may be contaminated with organic matters from illegal and expedient sewage connections into the stormwater drainage systems. A review of the *Development of a Master Plan for Sewage Disposal for East Kowloon Study* (Pypun, 1989) shows the presence of polluted flows in the stormwater drainage systems that serve the Study Area. Data for the drainage sub-catchments in the area, namely subcatchments 1 to 3 (shown *Figure 5.5b*) are particularly relevant for assessment and are presented in *Table 5.5b*.

Table 5.5b Dry Weather Flow (DWF) and Pollutant Strength

Subcatchment	Monitored DWF (m^3/day)	BOD Load (tonne day^{-1})
1	0.080 to 0.110	0.9 to 1.2
2	0.027 to 0.037	0.6 to 0.9
3	0.150 to 0.200	0.9 to 1.3
Source: Development of a Master Plan for Sewage Disposal for East Kowloon Study (Pypun, 1989)		

5.5.16 Any temporary embayment, if subject to discharge from existing stormwater outfalls, particularly in Yau Tong Bay and Sam Ka Tsuen Typhoon Shelter, may result in impacts associated with increases in oxygen demand such as reductions in DO concentrations, or even anoxia in extreme cases. Increases in nutrients may promote algal growth within the surface layer of the water column, leading to potential eutrophication. However, due to the shape and relatively small size of the proposed reclamation and expected absence of discharge in the area, embayment problems are not expected to occur.

General Construction Activities

5.5.17 The reclamation works will be primarily marine based and could, if uncontrolled, have the potential to cause water pollution. These could result from the accumulation of solid and liquid waste such as packaging and construction materials, sewage effluent from the construction workforce, discharge of bilge water and spillage of oil, diesel or solvents by vessels and vehicles involved with the construction, as described in *Section 6*. Any of these could lead to deterioration in water quality and potential impacts upon the efficacy of seawater intake in the vicinity of the works. Increased nutrient levels resulting from contaminated discharges and sewage effluent could also lead to a number of secondary water quality impacts including decreases in DO concentrations and localised increases in unionised ammonia concentrations which would stimulate algal growth, and reductions in oxygen levels.

Construction Runoff and Drainage

5.5.18 Runoff and drainage from construction sites may contain increased loads of suspended solids and other contaminants. Potential sources of pollution from site drainage include:

- runoff and erosion from site surfaces, drainage channels, earthworks and stockpiles;
- drainage from dust suppression sprays;
- discharge from wheel washing facilities;
- fuel and lubricants from construction vehicles and machinery;
- cement derived materials used for road pavement; and
- waste material and litter.

5.5.19 Construction runoff and drainage may cause both physical and biological effects. The physical effects which, may arise, include blockage of drainage channels, increased SS concentrations in receiving waters and accretion of SS with high pH from cement derived materials. Possible biological effects which may affect aquatic life include localised reduction in dissolved oxygen levels caused by elevated SS concentrations.

5.5.20 However, with good site management and the observation of proper site practices to prevent runoff water and drainage water with high levels of SS from entering the surrounding waters, significant impacts on water quality are not expected. It is also expected that stabilisation of cut and fill slopes, will also minimise increased SS from erosion of exposed slope surfaces.

Evaluation of Water Quality Impacts

Potential Dredging and Filling Impacts

5.5.21 The impacts from the generation and disposal of dredged material are a key concern for the reclamation, particularly with regard to dredging of contaminated material. In general, when contaminated sediments are disturbed by dredging, the potential exists for toxic metals previously bound to the sediment particles to be mobilised into the water column. To minimise the potential impacts on water quality, firstly the volumes of marine sediments to be dredged should be reduced to the minimum and then during implementation, Class C contaminated sediments must be dredged with great care.

Disposal of Dredged Materials

5.5.22 For the TKO Section reclamation, the impacts from the generation and disposal of dredged material are a key concern for the Project, particularly with regard to contaminated marine dredged material. A review of the Area 131 EIA Report shows that a portion of the upper layer of sediment will be contaminated as described in *Section 6.*

5.5.23 For the Yau Tong Bay reclamation the impacts from the generation and disposal of dredged material are a key concern for the Project, particularly with regard to contaminated marine dredged material. A review of the *Dredging of Contaminated Material Report* shows that the sediment will be contaminated as described in *Section 6*.

5.5.24 In general, when contaminated sediments are disturbed by dredging, the potential exists for toxic metals previously bound to the sediment particles to be mobilised into the water column. To minimise the potential impacts on water quality, seriously contaminated sediments must be dredged with great care. Details of recommended mitigation measures are discussed in *Section 5.5.47 to 53*.

5.5.25 The disposal of dredged material also has the potential for water quality impacts. For example, in the case of marine disposal, the potential environmental effects of the disposal of sediments to marine disposal sites will vary according to their level of contamination and physical and chemical nature. Other factors that may have a bearing on the significance of the impact may include:

- actual rate of construction activity i.e. volumes of material dredged and dumped per day, and the types of dredging methods employed;
- the phasing of the construction schedule and time required to complete each phase;
- quantity of pollutants discharged into the Study Area from nullahs and stormwater drains;
- dispersion, currents, and flushing characteristics of the receiving water body; and
- the number, nature, and proximity of sensitive receivers.

Filling Activities

5.5.26 The placement of fill during the WCR may lead to impacts associated with increase in SS within the water column. It is presently envisaged that and filling will occur behind constructed seawalls and therefore no impacts to nearby sensitive receivers is expected to arise during these activities.

5.5.27 For the TKO Section Reclamation, the proposed preliminary reclamation construction sequence will proceed with the following volumes of dredging given in *Table 5.5c*. The WCR TKO Section reclamation would be approximately 7.52 ha in area, 940 m in length and 80 m in width. The WCR TKO Section reclamation is expected to proceed in one stage and take 39 weeks for seawall construction and 42 weeks for the filling activities.

Table 5.5c Estimated Volumes of Dredging and Fill Materials for TKO Section Reclamation

Activity	Volume of Dredging (m^3)(1)	Volume of Fill Materials (m^3)(2)
Sloping Seawall	299,150	594,440
General Reclamation	0	536,145
Total	299,150	1,130,585

Note :
(1) Assumed seabed level at -10.0 mPD with the bottom of Marine Deposit at -15.0 mPD
(2) General fill to replace dredged material. Top of reclamation level to be at +4.5 mPD

5.5.28 The rationale to adopt the use of a comparative assessment for the TKO Section reclamation is provided in *Para. D1.1.1* in *Annex D*. A qualitative comparative assessment as shown in *Para D2.1.1 Annex D* has been undertaken to comparatively assess the difference in dredging and filling rates and loss rates between the Area 131 reclamation and the WCR TKO Section reclamation. The comparative assessment has been based on the assumptions for dry density and loss rates used in the Area 131 Study.

Table 5.5d Comparison of Area 131 and WCR Worst Case Scenario

Activity	Rate (m^3 per day)	Loss Rate of dredged/fill material (%)	Loss Rate of dredged/fill material ($kg\ s^{-1}$)
Area 131			
Dredging contaminated marine mud at seawall trench (1)	2,747	5%	0.78
Dredging clean mud at seawall trench(1)	2,753	5%	0.78
Deep cement mixing	3,437	100%	19.42
Sandfill at seawall trench (2)	5,056	4.15%	4.13
Total	***13,993***		***25.11***
WCR TKO Section			
Dredging at seawall trench(1)	1,644	5%	0.46
Sandfill at seawall trench(2)	2,177	4.15%	1.93
Total	***3,821***		***2.39***
Difference (%)	27.3%		9.5%

Note:
(1) Dry density of 488 kg/m^3 for marine sediment
(2) Dry density of 1700 kg/m^3 for sandfill material
(3) The deep cement mixing techniques proposed under Area 131 during construction are subject to further assessment and agreement with EPD.

5.5.29 As shown in *Table 5.5d*, the generation rate of suspended solids of the WCR TKO Section reclamation is well within the range (only 27.3% of the total rate of Area 131 and 9.5% of the total loss rate of Area 131) for the worst case scenario generated for Area 131.

5.5.30 As the SS loss rate of the WCR TKO Section reclamation is expected to only be approximately 9.5% of the total generated by the Area 131 reclamation. It is therefore unlikely that any impacts on any of the identified WSRs in *Section 5.4* will be generated due to the small loss rate of sediment generated. Furthermore, the release points of dredging and filling activities for the WCR reclamation will only be around 80 m from the TKO coastline (approximately 300 m closer than the Area 131 reclamation). This will further reduce the transport of sediment, as the current flows are lower closer to the coastline.

5.5.31 No impacts to the Tung Lung Chau FCZ were predicted in the Area 131 Study. As the SS loss rate of the WCR TKO Section reclamation is expected to be a fraction of the total generated by the Area 131 reclamation, impacts are not expected to be generated at Tung Lung Chau Fish Culture Zone by the WCR TKO Section reclamation.

5.5.32 For the Yau Tong reclamation, after discussion with EPD Water Policy Group on 10 September 1997, the reclamation activities for the thin reclamation strip between Yau Tong Bay and Sam Ka Tsuen Typhoon Shelter has been further reviewed to minimise any key adverse water quality impacts identified. An evaluation of the potential transport of sediment and impacts on the nearby WSR water intakes identified in *Section 5.4* would be required, based on an assessment using sediment dispersion modelling.

5.5.33 A summary of the proposed sequencing for the dredging and reclamation construction activities are described in *Section 2.3* and shown in *Figures 2.3d-f*. The proposed preliminary reclamation construction sequence will proceed in 3 stages, with rates of dredging from each particular stage given in *Table 5.5e*.

Table 5.5e Estimated Volumes of Dredging and Fill Materials for Yau Tong Reclamation

Activity	Volume of Dredging (m^3)	Volume of Fill Materials (m^3)
Submerged Reef	60,000	60,000
Dredging of Sloping Seawall	58,650	75,210
Dredging of Vertical Seawall	24,800	26,800
General Reclamation	83,600	418,000
Total	227,050	580,010

5.5.34 These volumes and rates have been based on a construction programme provided by the Engineering Team. Actual volumes for dredging, reclamation, and rate of placement of fill are approximate and need to be finalised during the detailed design stage.

5.5.35 The only reclamation requirement for the WCR in this section will be for the thin strip of reclamation approximately 800 m in length and 80 m in width between Sam Ka Tsuen Typhoon Shelter and Yau Tong Bay. However, after further consideration the reclamation strip between Yau Tong Bay and the Sam Ka Tsuen Typhoon Shelter has been reduced in size to minimise impacts on tidal flows and nearby sensitive receivers. The proposed sequencing for the three stages of reclamation are described below in *Table 5.5f.*

Table 5.5f Estimated Rates of Dredging and Fill Materials for Yau Tong Reclamation

Activity	Volume (m^3)	Period	Monthly Rate (m^3/month)	Daily Rate (m^3/day)
Dredging	227,050	4 months	56,763	1,892
Seawall Construction	162,010	6 months	27,001	900
Reclamation	418,000	6 months	69,667	2,322

5.5.36 A review of the three stages described in *Section 2.3* indicated that Stage 1 would be the worst case scenario, as the filling activities for Stages 2 and 3 occur behind constructed seawalls. After agreement with EPD, a sediment plume modelling was undertaken for Stage 1, using the SEKDS model to determine if the SS concentration generated by the reclamation activities at the identified WSD water intakes would cause an exceedance of the WSD 20 mg L^{-1} and Dairy Farm 30 mg L^{-1} intake criteria.

5.5.37 The sediment plume modelling undertaken by Danish Hydraulics Institute (DHI) is presented in *Annex E.* The results of the sediment plume modelling are summarized in *Table 5.5g* which give the mean and the maximum increases in concentrations above background of suspended sediments at three identified sea water intakes.

Table 5.5g Mean and Maximum Increases in Concentrations of Suspended Sediments.

Location	Spring period		Neap period	
	Mean (mg L^{-1})	Max (mg L^{-1})	Mean (mg L^{-1})	Max (mg L^{-1})
Dairy Ice Farm Factory Seawater Intake	1.6	11.8	2.3	13.7
Cha Kwo Ling Saltwater Pumping Station Intake	1.7	11.4	3.1	17.0
Yau Tong WSD Saltwater Pumping Station Intake	9.9	44.3	11.0	52.4

5.5.38 The spreading of sediment from the dredging and filling activities working area is illustrated in *Figure 6.4* of *Annex E* which provide the depth-averaged concentration of suspended sediment and shows the maximum extent of the sediment plume associated with a peak of the spring and neap tidal flow in the harbour.

5.5.39 It should be noted that the results presented in *Table 5.5g* only provide the concentration of SS from the dredged and fill materials from seawall construction, without the inclusion of background levels. To obtain SS values which include background levels (depth average 90th percentile), the background concentration of SS at EPD's monitoring station VM1 (1996 data), described in *Section 5.2.8*, have been included which are 15.9 mg L^{-1}. The incorporation of the maximum worst case background SS level is presented in *Table 5.5h.*

Table 5.5h Maximum Concentrations of Suspended Sediments the Sea Water Intakes

Location	Spring period	Neap period
	Maximum (mg L^{-1})	Maximum (mg L^{-1})
Dairy Ice Farm Factory Seawater Intake	27.7	29.6
Cha Kwo Ling Saltwater Pumping Station Intake	27.3	32.9
Yau Tong WSD Saltwater Pumping Station Intake	60.2	68.3

5.5.40 The level for the Dairy Farm Ice Factory sea water intake is within the maximum level as advised by the Dairy Farm Ice Factory of 30 mg L^{-1} for their Yau Tong Bay Ice Plant's operation of the condensing system.

5.5.41 However, the resulting levels predicted show that there will exceedances of the 10 mg L^{-1} at both WSD intakes from existing background levels the maximum threshold value of 20 mg L^{-1} would also be exceeded when the increases in concentrations from the dredging activities are added to the background levels. Mitigation measures will therefore be required.

5.4.42 Increases in suspended sediment concentrations have the potential to cause dissolved oxygen depletions through the chemical oxygen demand of the sediment, to increase nutrient concentration through the release of nitrogen compounds associated with the sediments and for the release of metals within the sediments to the water column. These impacts to water quality will be related to the increase in suspended sediment concentrations from the dredging works and the properties of the dredged sediments. It should be noted that such impacts are unlikely to be caused by the fine sediments contained within the sand fill material, as these sediments are typically low in both COD and nitrogen compounds. In order for the sediments to impact water quality, through exertion of the chemical oxygen demand or release of nutrients and metals, it is necessary for them to be in suspension for a period of time. In order to account for this it is proposed to consider the daily average increases is suspended sediment concentrations and not the instantaneous maxima.

5.5.43 The modelling results have predicted that maximum depth averaged increases in suspended sediment concentrations in the vicinity of the works area (at the Yau Tong WSD Intake) are 52.4 mg L^{-1}, while further away from the works area (at the Cha Kwo Ling pumping station) maximum concentrations are 17.0 mg L^{-1}. However, these increased suspended sediment concentrations are due to losses from both dredging and filling. Impacts to water quality are likely to be only caused by the sediments lost to suspension from dredging, which account for 62% of the total loss of fines (*Page 4-1* of *Annex E*). Therefore maximum increases in suspended sediment concentrations from the dredging are 32.5 mg L^{-1} close to works area and 10.5 mg L^{-1} further away. Inspection of the time history graphs in *Annex E* shows that the average concentrations are approximately 27% of the maximum concentrations close to the works area and 35% of the maximum concentrations further away. This gives average increases in concentrations from the dredging works of 9 mg L^{-1} close to the works area and 4 mg L^{-1} further away.

5.5.44 EPD routine sediment quality monitoring data for 1997 shows that at Station VS3, the closest to the works area, that maximum COD is 23,000 mg kg sediment^{-1}, the maximum total nitrogen is 1,099 mg kg sediment^{-1} and the maximum ammoniacal nitrogen concentration is 259 mg kg sediment^{-1}. Assuming that all of the COD is exerted and all of the nitrogen is released gives a DO deficit of 0.2 mg L^{-1}, a total nitrogen increase of 0.01 mg L^{-1} and an increase in ammoniacal nitrogen concentration of 0.002 mg L^{-1} close to the dredging works. Impacts to water quality would be much reduced further away from the dredging works. EPD routine water quality monitoring data at Station VM1 in 1997 shows that the 10th percentile for depth averaged dissolved oxygen is over 4.2 mg L^{-1}, which means that the reduction from the increased suspended sediment concentrations would not cause a breach of the Water Quality Objectives. The average total inorganic nitrogen level at this station is 0.32 mg L^{-1} and, if it assumed that all of the increased total nitrogen is inorganic (a very conservative estimate), then the increase would not cause a breach of the Water Quality Objectives. Data for Station VM1 shows that the unionized ammonia accounts for 4.1% of the ammoniacal nitrogen concentration. If is assumed that the same ratio applies to the ammoniacal nitrogen released from the suspended sediments then there will be an increase of $8x10^{-5}$ mg L^{-1}. The background average unionized ammonia concentration is 0.009 and so the increase in unionized ammonia will not cause a breach of the Water Quality Objective. There will therefore be no adverse impacts to water quality in terms of dissolved oxygen reduction and total inorganic nitrogen and unionized ammonia release from the dredging works.

5.5.45 Sediment quality monitoring was undertaken for this Project in order to classify the sediment to be dredged into contaminated and uncontaminated categories. It was found that a number of the sediment samples would be classified as Class C contaminated, requiring special disposal (see *Annex D*). The highest levels of contamination were found at Station WCV3, where five of the seven metals (chromium, copper, lead, mercury and zinc) were found to be above the Class C limits. It is the potential release of these contaminants which is assessed here. The release of metals to the water column is defined by partition coefficients and values for the partition coefficients were derived from previous studies[7]. The results of the analysis are shown in *Table 5.5i*.

Table 5.5i Analysis of Metals Release to the Water Column

Metal	**Concentration in Sediment (mg kg^{-1}) (C_{sed})**	**Partition Coefficient (l g^{-1}) (K_d)**	**Total Concentration (μg L^{-1}) (C_t)**	**Concentration in Water (μg L^{-1}) (C_s)**
Chromium	656	290	5.90	1.63
Copper	190	122	1.71	0.82
Lead	100	130	0.90	0.41
Mercury	1.1	700	0.01	0.0014
Zinc	250	100	2.25	1.18
where	$C_t = C_s + C_s x K_d x SS x 10^{-3}$ $SS = 9$ mg L^{-1} $C_t = 9xC_{sed}$			

(7) ERM(1998). Environmental Impact Assessment: Dredging an Area of Kellett Bank for Reprovisioning of Six Government Mooring Buoys. Report for the Civil Engineering Department.

5.5.46 It should be noted that the above predicted increases in dissolved metals concentrations are conservative because no account is taken of the dilution of the dissolved metals by the receiving waters. However, the above results do not predict any adverse impacts to water quality.

Cooling Water Discharge

5.5.47 Due to the relatively small size of the WCR reclamation, tidal flushing in the area is unlikely to be reduced. It is thus considered that no insurmountable impacts are predicted to occur as a result of the reclamation works, in terms of temperature increases.

Stormwater Discharge

5.5.48 The degree of impact upon water quality associated with stormwater discharge into the Yau Tong Bay Area, particularly during the formation of any temporary embayment, will be dependent upon the volume of discharge, the degree of organic pollution, the amount of flushing within the embayed area and the tidal status at the time.

5.5.49 Another important factor for consideration, in relation to stormwater drainage, is the implementation of the *East Kowloon Sewerage Master Plans* (SMP) in the vicinity of the Study Area. A major concern associated with stormwater discharge is the pollutant loads contributed from illegal and expedient connections to the stormwater drainage system.

5.5.50 However, a review of the *Development of a Master Plan for Sewage Disposal for East Kowloon Study* (Pypun, 1989) has shown that the stormwater discharge for sub-catchments 1 - 3 are relatively small. Illegal and expedient connections will be located and reconnected into the foul sewerage system in the longer term. It is envisaged that all the SMPs in the vicinity of the Study Area would have been implemented and the connections to the sewage treatment plant for proper treatment at Kwun Tong would have been established before the commencement of WCR construction. No insurmountable impacts are expected to arise from contaminated stormwater discharge during the construction phase, provided proper diversion of existing stormwater outfalls are in place to avoid discharge into any temporary embayment.

General Construction Activities

5.5.51 Ongoing site construction activities may cause water pollution as detailed in *Section 5.5.17 - 5.5.20*. It is considered unlikely that runoff from the construction site will have any impact on the water quality of the receiving waters provided that standard measures are implemented to control and treat the runoff prior to discharge. Appropriate mitigation measures and site management practices are detailed in the following *Sections*.

Recommended Mitigation Measures

Mitigation Measures for Reclamation Activities

5.5.52 In accordance with the EIAO-TM, and based on the results of the water impact assessment, mitigation measures have been developed, refined, finalised and recommended below to effectively reduce water quality impacts predicted from the reclamation activities associated with the proposed reclamation.

Yau Tong and TKO Section Reclamations

5.5.53 The maximum rates of working for the TKO Section are as follows:

- Dredging at the seawall trench is restricted to 1,644 m^3 day^{-1}; and
- Sandfilling at the seawall trench is restricted to 2,177 m^3 day^{-1}.

5.5.54 The maximum rates of working for the Yau Tong Section are as follows:

- Dredging at the seawall trench is restricted to 1,892 m^3 day^{-1}; and
- Sandfilling at the seawall trench is restricted to 900 m^3 day^{-1}.

5.5.55 In addition to the above requirements on seawall construction, sand filling for both the TKO and Yau Tong Section should be carried out behind completed seawalls. This will ensure that any fines in the sandfill are retained behind the seawalls and therefore minimise impacts to sensitive receivers.

5.5.56 Mitigation measures to control impacts resulting from the generation, transport, and disposal of dredged or excavated material during the construction phase recommended for the proposed reclamations at Yau Tong and TKO Section include:

- the use of containment structures such as silt curtains or screens around the construction site;
- the use of closed clamshell grab dredgers to remove seriously contaminated (Class C) material; and
- the prohibition of stockpiling of any moderately or seriously contaminated (Class B and C) material, and careful control of stockpiling of any uncontaminated (Class A) material to prevent runoff, resuspension and odour nuisances;
- minimising dredging/reclamation activities near the intakes of WSD's salt water pumping stations and preferably carrying out work during non-peak hours when the abstraction rate at the Salt Water Pumping Stations (SWPS) is low in order to maintain water quality. A schedule of dredging/reclamation activities near the intakes should be provided to WSD prior to commencement of construction works.

5.5.57 It should be noted that currents may reduce the efficacy of silt curtains. Previous research indicates that rates of 0.5 m s^{-1} would be the upper limit for protection from semi-permanent silt curtains. At times when the tidal currents are too high for effective deployment of silt curtains the works should be suspended.

5.5.58 Mitigation measures should also include, but not limited to, construction method and phasing, control over dredging and filling rates, restriction on fine content of fill materials, filling and reclamation to be conducted behind completed seawall, pretreatment of effluent arising from construction activities for compliance with TM standards and provision of proper covering to stockpiles. In regard to the storage of chemical classifiable as dangerous goods, reference should be made of the *Dangerous Goods Ordinance* and relevant standards.

5.5.59 Marine dredging and disposal of contaminated sediments requires special mitigation measures as follows:

- all vessels should be sized such that adequate clearance is maintained between vessels and the sea bed at all states of the tide to ensure that undue turbidity is not generated by turbulence from vessel movement or propeller wash;
- all barges and hopper dredgers should be fitted with tight fitting seals to their bottom openings to prevent leakage of material;
- loading of barges and hoppers should be controlled to prevent splashing of dredged material to the surrounding water, and barges or hoppers should not be filled to a level which will cause the overflow of materials or polluted water during loading or transportation; and
- the construction works should cause no visible foam, oil, grease, scum, litter or other objectionable matter to be present on the water within the site or dumping grounds.

5.5.60 Additional provisions will be required where sediments are contaminated. The locations and depths of any areas of contaminated sediments should be indicated in the construction contract following the completion of the sediment quality survey. The Contractor should be required to ensure that contaminated sediments are dredged, transported and placed in approved special dumping grounds in accordance with the *EPDTC 1-1-92*, *WBTC 22/92* and *WBTC 6/92*. Typical mitigation measures to minimise the loss of contaminated material to the water column are listed below:

- use of new specialized water tight grabs to control sediment loss;
- transport of contaminated mud to the marine disposal site should, wherever possible, be by split barge of not less than 750 m^3 capacity, well maintained and capable of rapid opening and discharge at the disposal site;
- the material should be placed in the pit by bottom dumping, at a location within the pit specified by the FMC;

- discharge should be undertaken rapidly and the hoppers should then immediately be closed, material adhering to the sides of the hopper should not be washed out of the hopper and the hopper should remain closed until the barge next returns to the disposal site;
- the dumping vessel should be stationary throughout the dumping operation;
- the Contractor must be able to position the dumping vessel to an accuracy of +/-10 m;
- monitoring of the barge loading to ensure that loss of material does not take place during transportation;
- transport barges or vessels shall be equipped with automatic self-monitoring devices; and
- on site audit of the equipment and plant is essential to ensure it is used in the correct manner.

5.5.61 Final decision making regarding the fate of dredged and excavated material lies with various departments in Government and will depend upon the volume and quality of the material, and other factors.

Further Mitigation Measures for WSD Seawater Pumping Stations at Yau Tong Bay

5.5.62 Further mitigation measures are recommended to reduce these impacts at the Yau Tong Bay and Cha Kwo Ling salt water pumping stations to within WSD water quality criteria. The proposed measures will involve the use of a silt curtain around the WSD intakes during dredging and filling activities. This has been proposed and shown to be effective for other reclamation project[8].

5.5.63 According to previous studies[9], the deployment of a silt curtain around the WSD intake can reduce SS levels by a factor of 2.5. The total resulting suspended sediment concentrations at the intakes are presented in *Table 5.5j*. This table presents the total suspended sediment concentrations, including background, following the implementation of silt curtains at the dredging site and at the Yau Tong and Cha Kwo Ling Saltwater Intakes.

(8) Pak Shek Kok Reclamation, Public Dump Environmental Impact Assessment Study, Final Report, Hong Kong Government Civil Engineering Department, Agreement No. CE 13/93, April 1997.

(9) Pak Shek Kok Reclamation, Public Dump Environmental Impact Assessment Study, Final Report, Hong Kong Government Civil Engineering Department, Agreement No. CE 13/93, April 1997.

Table 5.5j Maximum Concentrations of Suspended Sediments at the Nearby Intake with the Incorporation of Mitigation Measures.

Location	Spring period	Neap period
	Maximum(1) (mg L^{-1})	Maximum(1) (mg L^{-1})
Dairy Ice Farm Factory Seawater Intake	20.6(2)	21.4(2)
Cha Kwo Ling Saltwater Pumping Station Intake	8.2(3)	9.1(3)
Yau Tong WSD Saltwater Pumping Station Intake	13.4 (3)	14.7 (3)

Note:
(1) Background concentration of 15.9 mg L^{-1} added to maximum SS concentrations from model predictions
(2) Includes a reduction by a factor of 2.5 on the SS from the reclamation resulting from the implementation of silt curtains at the works area.
(3) Includes a reduction by a factor of 2.5 on the SS from the reclamation resulting from the implementation of silt curtains at the works area and a further reduction by a factor of 2.5 on the total concentrations resulting from the implementation of silt curtains at each of the two intakes.

5.5.64 The use of a silt curtain in front of the WSD intakes, as well as at the dredging sites, would not fulfil the 10 mg L^{-1} WSD intake criteria at Yau Tong WSD saltwater pumping station but would satisfy the upper limit of 20 mg L^{-1}. However, the concentrations from the dredging works which have been used in this assessment are maximum values which only occur for a short period of time and at other times the concentrations are much less. This is demonstrated in *Figures 6.1* and *6.2* in *Annex E*.

5.5.65 Other mitigation measures could include reducing the dredging and filling rate during reclamation activities to further reduce the SS levels to within WSD water quality criteria and restricting dredging to the ebb phase of the tidal cycle, if necessary. However, it should be noted that reducing the dredging and filling rate may impose constraints on the proposed Project programme. This would only be required for Stage 1 prior to the construction of the seawall. It is expected that once the seawall is constructed that filling will occur behind the seawall and the Yau Tong WSD intake will be reprovided to the new proposed waterfront. The need for reducing the dredging rate will be confirmed during the Environmental Monitoring and Audit (EM&A) which will monitor suspended sediment concentrations at the WSD intakes. EM&A results will be provided to WSD for review.

5.5.66 The assessment of impacts to the Yau Tong WSD Saltwater Pumping Station during construction of the WCR reclamation assume that the pumping station had not been reprovisioned to the seaward face of the WCR reclamation. According to the construction programme, as described in *Sections 2.3.7* and *2.3.11*, the new pumping station will be constructed as part of Phase 2 of the reclamation and the old pumping station will be demolished as part of Phase 3. In order to keep the SS at the intake at, or below, the levels presented above, the existing pumping station should be kept in operation until the completion of the sea wall dredging. Once the outfall is reprovisioned there will be no impact from the reclamation filling because the sediment will be retained by the sea walls.

Mitigation Measures for Cooling and Stormwater Discharge

5.5.67 Potential water quality impacts may arise from the accumulation of stormwater discharge into the temporary embayment formed during the construction phase. Diversion schemes of all the existing outfalls should be incorporated into the Preliminary Design to ensure that all stormwater discharges will be diverted prior to Phases 1 and 2 seawall placement. It is therefore expected that these discharges will not have any insurmountable impacts on water quality.

Mitigation Measures for Floating Debris

5.5.68 Floating refuse and debris is not only unsightly but may also lead to deterioration of water quality, if left for a long period. Although the accumulation of floating refuse will be prevented through the adoption of a configuration and phasing scheme that maximise flushing, it is still recommended that collection and removal of floating refuse be performed at regular intervals, on a twice daily basis, and increased when considerable amounts of refuse are observed. The Contractor should be responsible the collection of all floating refuse within the site boundary as well as outside the site boundary, if floating refuse is attributed to the WCR construction works.

Mitigation Measures for General Construction Activities

5.5.69 All site construction runoff should be controlled and treated to prevent high levels of SS entering surrounding waters. All effluent and waste water arising from construction activities shall comply with the relevant ProPECC Notes (in particular ProPECC PN 1/94) and the WPCO. The following measures, which constitute good site practices, should be undertaken by the Contractor during construction and should be included as part of the contract documents:

- Temporary ditches should be provided to facilitate runoff discharge into the appropriate watercourses, via a sediment trap/sediment retention basin, prior to discharge;
- Permanent drainage channels should also incorporate sediment basins or traps, and baffles to enhance deposition rates;
- All traps (temporary or permanent) should also incorporate oil and grease removal facilities;
- Sediment traps must be regularly cleaned and maintained by the Contractor. Daily inspections of such facilities should be required of the Contractor;
- Concrete batching plants should be bunded to contain the surface water runoff;
- Water from concrete batching plants must also pass through sediment traps and settlement tanks prior to runoff into watercourses. These must be regularly cleaned and maintained by the Contractor;

- Collection of spent bentonite/other grouts in a separate slurry collection system for either cleaning and reuse/disposal to landfill;

- Maintenance and plant areas should be bunded and constructed on a hard standing with the provision of sediment traps and petrol interceptors;

- All drainage facilities must be adequate for the controlled release of storm flows;

- Minimising of exposed soil areas to reduce the potential for increased siltation and contamination of runoff;

- All chemical stores shall be contained (bunded) such that spills are not allowed to gain access to water bodies. Chemical waste arising from site should be properly stored, handled, treated and disposed of complying with the requirements stipulated under the Waste Disposal (Chemical Waste) (General) Regulation; and

- Chemical toilets will be required to handle the sewage from the onsite construction workforce.

5.5.70 In order to prevent any deterioration in water quality, it will be important that appropriate measures are implemented to control runoff and drainage, and thereby prevent high loadings of SS from entering the nearby rivers or water bodies. Proper site management will be essential to minimise surface water runoff and good housekeeping practices should be implemented to ensure that debris and rubbish does not enter water bodies.

Construction Runoff

5.5.71 The following mitigation measure should be implemented prior to the commencement of site preparation works.

- The boundaries of critical areas of earthworks should be marked and surrounded by dykes or embankments for flood protection.

5.5.72 Construction runoff should be controlled in the following manner to prevent runoff with high levels of SS.

- Traps (temporary or permanent) should incorporate oil and grease removal facilities such as oil interceptors at areas where there are high risk of oil/grease pollution;

- Oil interceptors should be installed for the maintenance workshop and storage areas in compliance with EPD regulations. These should be emptied regularly and should have a bypass to prevent flushing during periods of heavy rain;

- Ditches which tie into the temporary cut off drains or tarpaulin covers should be provided to reduce sediment runoff;

- Slope exposure during the wet season should be minimised through avoiding primary earthworks movements during the wet season and adopting, wherever possible, a construction sequence which reduces the exposed areas through maintaining short work faces;

- Spent cement mix or other paving materials should be collected in a separate collection system for either cleaning and reuse or disposal to landfill;

- Hydroseeding is recommended, wherever practical, to minimise exposed soil areas and reduce the potential for increased siltation and contamination of runoff;

- Disposal of any solid materials, litter or wastes to the stream should be prohibited; and

- Accidental release of soil, debris or solid wastes into adjoining land and streams should be prevented by the installation of boarding at the site boundary, particularly along stream banks.

Oils and Solvents

5.5.73 To prevent spillages of fuel oils or other polluting fluids to coastal water, all fuel tanks and storage areas should be provided with locks and be sited on sealed areas, within bunds of a capacity equal to 110 % of the storage capacity of the largest tank.

Sewage

5.5.74 Portable toilets should be provided for the onsite construction workforce. Appropriate treatment and discharge should be in compliance with the TM.

Stream Culverting and Diversions

5.5.75 Stream Culverting is proposed for several of the streams in the Study Area. The stream courses currently discharging into Sam Ka Tsuen Typhoon Shelter will be culverted in 2004. For other stream course discharges, the timing of culverting is unknown. Impacts to the water quality of these streams should be minimised as far as possible. In addition, temporary diversions of the streams should be constructed so as to allow the water flow to discharge without overflow, erosion or washout. The areas concerned should be properly reinstated after diversion to their original conditions so that the drainage pattern would not be affected.

Residual Impacts

5.5.76 With the implementation of the above mitigation measures, project specific residual impacts are not expected to occur to water quality from construction activities. However, it should be noted that impacts from constructions of the WCR Yau Tong Bay reclamation have been considered in isolation, which assumes that there will be no overlap in the construction works. This is based on the assumption that the construction of the SEKR and Yau Tong Bay CDA will not commence during construction of the WCR. Should this assumption change at a later date, when construction programmes for the projects become available, then it will be necessary to carry out further modelling to examine cumulative impacts.

5.6 Operation Phase

Potential Sources of Impact

Water Movement

5.6.1 The final configuration of the alignment is not expected to alter tidal flows and current velocities within the Study Area, and Victoria Harbour as a whole because the reclamation is not planned to intrude into the main flow channel in Victoria Harbour and will not cause any narrowing of the Lei Yue Mun Gap. It is therefore unlikely that the reclamations will have any effect on the global flows in Victoria Harbour and will not therefore cause a reduction in the tidal exchange of waters in the harbour. Therefore, no further assessment was made of the global flows through Victoria Harbour and the modelling concentrated on local impacts to tidal flows.

5.6.2 For the TKO Section, a comparative assessment with the Area 131 reclamation layout was undertaken in *Annex D* to assess the potential impacts to water movement within the TKO area. The reclamation proposed runs along the coast of TKO is only 80 m in width and is substantially smaller than the Area 131 reclamation layout. It is, therefore, unlikely to alter the flow in the TKO area.

5.6.3 For the Yau Tong Section, the reclamation proposed for the WCR between Sam Ka Tsuen Typhoon Shelter and Yau Tong Bay is relatively small and would not have an impact on the far field tidal flows of Victoria Harbour. It was, therefore, agreed with EPD that modelling for far field effects would not be undertaken. In terms of the local area, potential embayment problems may result from the proposed reclamation and submerged reef works for the WCR where stormwater outfalls presently discharge into Yau Tong Bay.

Cumulative Impacts During Operation

5.6.4 No cumulative assessment was made with respect to either the Yau Tong Bay CDA reclamation or the SEKR. The programme for the Yau Tong Bay CDA reclamation is not yet finalised and the reclamation area is not yet confirmed so there are no details as to the likely timing. There was thus no established information available that indicated that the Yau Tong Bay CDA reclamation should be included in the operational modelling. The SEKR has not yet started, particularly the proposed breakwater adjacent to the WCR reclamation at Yau Tong Bay. There is no firm information on the likely timing and layout for the SEKR, in fact there have been a number of objections concerning this project which will may result in changes to the layout/construction phasing for this project. There was therefore no sound information available to establish the model for the operational phase which included any part of the SEKR.

Water Quality

5.6.5 Any changes in tidal flow identified in the local area may also result in impacts upon water quality. In particular, if the proposed reclamation and submerged reef significantly reduce the flushing volumes of Yau Tong Bay then water quality problems could arise from stagnation of water. This may also lead to the accumulation of floating refuse and debris, which may reduce the aesthetic water quality in Yau Tong Bay. In addition, cooling water (thermal) discharge may also be an issue of key concern as such discharge may raise the temperature of the water column and lead to associated impacts such as reduction in DO concentrations. DO will be monitored prior to, during and after proposed construction activities as part of the EM&A programme. If levels are found to be below acceptable criteria, then remedial measures would be required.

5.6.6 The following Section demonstrates that the WCR reclamation will not result in significant impacts to tidal flows. This means that there will not be reductions in flushing capacities which could cause a deterioration in water quality. As the Project would not result in substantial changes in tidal flow, full parameter water quality modelling is not considered to be necessary. However, semi-quantitative assessment of the impacts on dissolved oxygen, nutrient concentration and heavy metals release during the construction phase were undertaken.

Evaluation of Water Quality Impacts

Water Movement

5.6.7 For the TKO Section of Reclamation, it was originally assumed that the WCR would be built on the reclamation formed as part of the Area 131 Study and thus water quality assessment for reclamation activities in the TKO section were excluded. However, following a request by TDD on 20 March 1998 (ref (37) in NTEJB2/584TH/41 IX) to include the TKO section reclamation, it was considered that a qualitative comparative assessment of the Area 131 based on the *Area 131 Working Paper on Tidal Flow and Sediment Plume Modelling Report HRHK February 1998* be undertaken to determine the potential impacts generated by the proposed WCR reclamation in the TKO area.

5.6.8 The resulting proposed WCR TKO Section reclamation has a total area of 7.52 ha as shown in *Figure 2.3f*. However, due to the small size and width of the proposed reclamation, the TKO coastline will be largely uniform and the temporary slack waters should be eliminated. A comparative assessment has been undertaken to assess the difference in reclamation size (and hence impacts to tidal flow) between the Area 131 reclamation and the WCR TKO Section reclamation. The results are presented in *Table 5.6a*.

Table 5.6a Comparison of Area 131 and WCR Reclamation Size

Area	Length (m)	Width (m)	Area (ha)
Area 131 Reclamation	1,100 m length	410 m width	45 ha
WCR TKO Section Reclamation	940 m length	80 m width	7.52 ha
Comparison	85.5%	19.5%	16.7%

5.6.9 By comparison, the proposed WCR reclamation in the TKO area is only 19.5 % of the total width and 16.7% of the total area of the Area 131 reclamation and should therefore not affect the tidal flow in the TKO area. More importantly the WCR reclamation does not impinge on the Lei Yue Mun Headland as the reclamation is only 80 m in width and runs along the TKO coastline.

5.6.10 The findings of the Area 131 Study have shown that the Area 131 reclamation is acceptable in terms of tidal flow. As the WCR reclamation in the TKO section is substantially smaller in terms of size and shape, it is therefore considered that there is unlikely to be any adverse impacts by the WCR TKO Section reclamation on tidal flow in the TKO area.

5.6.11 For the Yau Tong Reclamation Section, upon completion of the alignment for WCR, the water movement will still be influenced by the prevailing tidal flows and contribution from Victoria Harbour, which are currently experienced in the Study Area. Once the reclamation is completed, the coastline will be largely uniform and the temporary slack waters should be eliminated with the completion of the CDA site at Yau Tong as stated in the report *Request for Rezoning Yau Tong Bay CDA*. However, the timing of the reclamation for the CDA site has not been confirmed and thus a worst case scenario has been assessed, assuming that no reclamation for the CDA site is in place.

5.6.12 Hydrodynamic modelling was undertaken for the proposed reclamation and submerged reef to confirm that there is not a significant reduction in the flushing of the Yau Tong Bay such that water quality could be adversely impacted. The results of the simulations are presented in *Table 5.6b* which gives the integrated values over the simulation periods of the absolute discharge into or out of Yau Tong Bay. Results show that the WCR reduces the integrated discharge by 11.4 % during spring tide and 12.9 % during neap tide.

Table 5.6b Integrated Values over the Simulation Periods of the Absolute Discharge In or Out of Yau Tong Bay, and the Change Caused by the Western Coast Road

Scenario	Spring period	Neap period
SEKDS Scenario A1 (m^3)	2,203,812	1,215,103
SEKDS A1 with WCR (m^3)	1,951,889	1,058,833
Change (%)	-11.4	-12.9

5.6.13 The results of the simulations indicate that the planned WCR reclamation at Yau Tong has a minor effect on the local hydrodynamics in terms of the local flow pattern as well as the water exchange of Yau Tong Bay. This also means that the likely effects on the local siltation/regime, which are controlled by the hydrodynamics, will be small.

5.6.14 It has been proposed that a total of 12 culverts (2.5 m diameter) set 15 m apart could be incorporated into the submerged reef as shown in *Figure 5.6a*. This would be expected to further increase the flow into and out of Yau Tong Bay. Results of calculations undertaken by DHI show that the incorporation of these culverts will increase the flow across the mouth Yau Tong by approximately 1%.

Water Quality

5.6.15 A key area of concern for the operation phase, will be the discharge of polluted stormwater into the surrounding waters of WCR, especially in any areas of slack water and embayment. However, assuming all the works for SMPs in East Kowloon will have been completed before the commencement of works for WCR, it is expected that the influence of untreated sewage on stormwater discharge should be eliminated. The assumption on the progress of the SMP works and effectiveness of the storm drain diversion will be reviewed and necessary contingency measures devised in the detailed design stage of the WCR project. However, even if some expedient connections of sewage discharges to the stormwater system remain, this will be effectively mitigated by the proposed diversion of the stormdrains, as discussed below.

5.6.16 According to current information provided by the WCR Engineering Team, the major stormwater outfalls will be reprovided to the edge of the proposed reclamation for CDA site, with the major stormwater drains running generally in the direction of the proposed coastline. The relocation of these outfalls will ensure that the stormwater discharge from the Study Area is sufficiently dispersed by the main flows in Victoria Harbour and should minimise the water quality impacts which may arise from the potential presence of pollutants in the stormwater during wet seasons. Furthermore, the position of the relocated outfalls should be at least 100m from the nearest sea water intakes, which will avoid adverse water quality at these sensitive receivers.

5.6.17 The potential for contamination of the coastal waters arise mainly from storm runoff across paved surfaces of the proposed WCR alignment. Such runoff particularly in the first flush following a prolonged dry period, could contain several different contaminants resulting from fuel combustion; eroded brake linings; tyre deposits; and discarded refuse. In addition, the WCR may be used for the transport of a variety of materials which may be potentially hazardous or polluting. The potential for spills should be allowed for in the design of pollution control mechanisms.

5.6.18 As the proposed road lies close to the coast, it is unlikely that any serious contamination of surface water courses would occur. Therefore, few such watercourses crossed by the roads and any spills would be carried rapidly to the coastal waters. It is unlikely that any beneficial uses of such watercourses such as water abstraction would be affected. It also appears unlikely that any stream diversions will be required, although culverting may need to be considered. The need for such measures should be reviewed carefully at the detailed design stage so that alteration to the existing stream courses and the extent of culverting can be minimised.

5.6.19 In general, operational water quality impacts are likely to be minimal provided appropriate pollution control mechanisms are installed to protect sensitive receivers from pollution contained in runoff and as a result of spills following road accidents.

Recommended Mitigation Measures

Water Movement

5.6.20 Although the modelling has predicted that there will not be significantly reduced flushing of Yau Tong Bay it is still recommended that the proposed culverts through the submerged breakwater be implemented. This will further improve the flushing of Yau Tong Bay following the construction of the Yau Tong section of the WCR.

5.6.21 It is recommended that if the reclamation at Yau Tong Bay is constructed prior to the WCR, that the stormwater discharges in Yau Tong Bay be reprovided to the new waterfront to further avoid any embayment of polluted discharges. The phasing of the salt water pumping station intake relocation will need to be determined during the detailed design stage. However, it is recommended that the existing pumping station to be relocated is to be maintained operational at its existing location until all seawall dredging has been completed. The Engineering Team will liaise with WSD on the timing of the relocation during the detailed design.

5.6.22 Berthing facilities for the Kwun Tong Wholesale Fish Market, Sam Ka Tsuen Ferry Pier and CED Maintenance Depot should be sited more than 100 m from the Yau Tong Salt Water Pumping Station intake.

Road Runoff

5.6.23 The following mitigation measures for road runoff should be implemented in order to ensure that impacts during the operational phase are minimised and meet the existing regulatory requirements.

- Silt traps in gully inlets and oil interceptors should be installed along the route to minimize pollution to stormwater systems; and
- Silt traps and oil interceptors should be cleaned and maintained regularly to ensure that they function properly.

Residual Impacts

5.6.24 With the implementation of the above mitigation measures, Project specific residual impacts are not expected to occur to water quality from construction activities. As described in *Section 5.5*, Project related impact have been assessed in isolation due to the uncertainty of programming of the SEKDS and the Yau Tong Bay CDA reclamation. Therefore, cumulative impacts associated with these projects and WCR are not provided.

5.7 Conclusions

Construction Phase

5.7.1 Assessment of the proposed reclamation in the TKO Section has been undertaken to determine the potential impacts generated during the construction phase. Results of the comparative assessment of the SS plume modelling used in the Area 131 Study show that the dredging and placement of fill for the WCR is unlikely to lead to impacts due to the relatively small volumes of material involved and long distances from any sensitive receivers. However, suitable mitigation measures have been recommended as good site practice to ensure that the water quality impacts are minimised.

5.7.2 For the reclamation at Yau Tong, SS modelling results have predicted an exceedance of the WSD criteria at both intakes assessed. However, it is anticipated that the employment of the recommended mitigation measures will be able to minimise SS impacts to within the WSD upper limit of 20 mg L^{-1}. Specific mitigation measures were provided by deploying silt curtains around the works area and at the water intakes. Provided that the recommended mitigation measures are incorporated, there should be no insurmountable residual water quality impacts due to the proposed construction of the WCR.

5.7.3 Impacts from the construction of the WCR Yau Tong Bay reclamation have been considered in isolation, which assumes that there will be no cumulative impacts from other projects. This is based on the assumption that construction work for the SEKR will not commence during construction of the WCR and there will be no overlap in the construction works. The Yau Tong Bay CDA reclamation has not started and so the WSD intakes will be in their current positions. Should either of the above assumptions change at a later date when the construction programmes for the SEKR and the Yau Tong Bay CDA reclamation become available then it will be necessary to carry out further modelling to examine cumulative impacts.

Operational Phase

5.7.4 A comparative assessment has been undertaken to assess the difference in reclamation size between the Area 131 reclamation and the WCR TKO Section reclamation which showed that there should not be an impact on water flow.

5.7.5 Hydrodynamic modelling was undertaken for the proposed Yau Tong reclamation and submerged reef to confirm that there is not a significant reduction in the flushing of the Yau Tong Bay. The results of the simulations showed that the reclamation has a minor effect on the local hydrodynamics in terms of the local flow pattern as well as the water exchange of Yau Tong Bay.

5.7.6 With improvement in sewerage and collection of sewage for treatment at Kwun Tong proposed in the *Development of a Master Plan for Sewage Disposal for East Kowloon Study*, it is expected that no insurmountable impacts will arise from the operation of the WCR.

5.7.7 As part of this Project, the Yau Tong (YT) salt water pumping station will eventually be relocated to the new waterfront. The findings of the Water Quality Impact Assessment showed that water quality at the Cha Kwo Ling pumping station will not be impacted during the operation of the WCR project.

5.7.8 No cumulative impacts on the operation of the WCR were considered for the Yau Tong Bay CDA reclamation and the SEKR. The Yau Tong Bay CDA reclamation has not started and is not a confirmed project which means that there are no details as to the likely timing. There was thus no information available that indicated that the Yau Tong Bay CDA reclamation should be included in the operational modelling. The SEKR has not started, particularly the breakwater adjacent to the WCR reclamation at Yau Tong Bay. There is no firm information on the likely timing and layout for the SEKR, and as there have been a number of objections lodged concerning that project possible changes to the layout/construction phasing for the project may occur. There was therefore no sound information available to set up the model for the operational phase which included any part of the SEKR. Should either of the above assumptions change at a later date when the construction programmes and layouts for the SEKR and the Yau Tong Bay CDA reclamation become available then it will be necessary to carry out further modelling to examine cumulative impacts.

5.8 EM&A Requirements

5.8.1 Based on the results of this assessment of water quality impacts, it is recommended that a water quality monitoring and audit programme be conducted during the reclamation works to detect any deterioration in water quality in a proactive manner. Site specific environmental monitoring and audit (EM&A) requirements have been formulated and presented in an EM&A programme. The EM&A programme has been presented separately in the EM&A Manual and is summarised in *Section 10.5*.

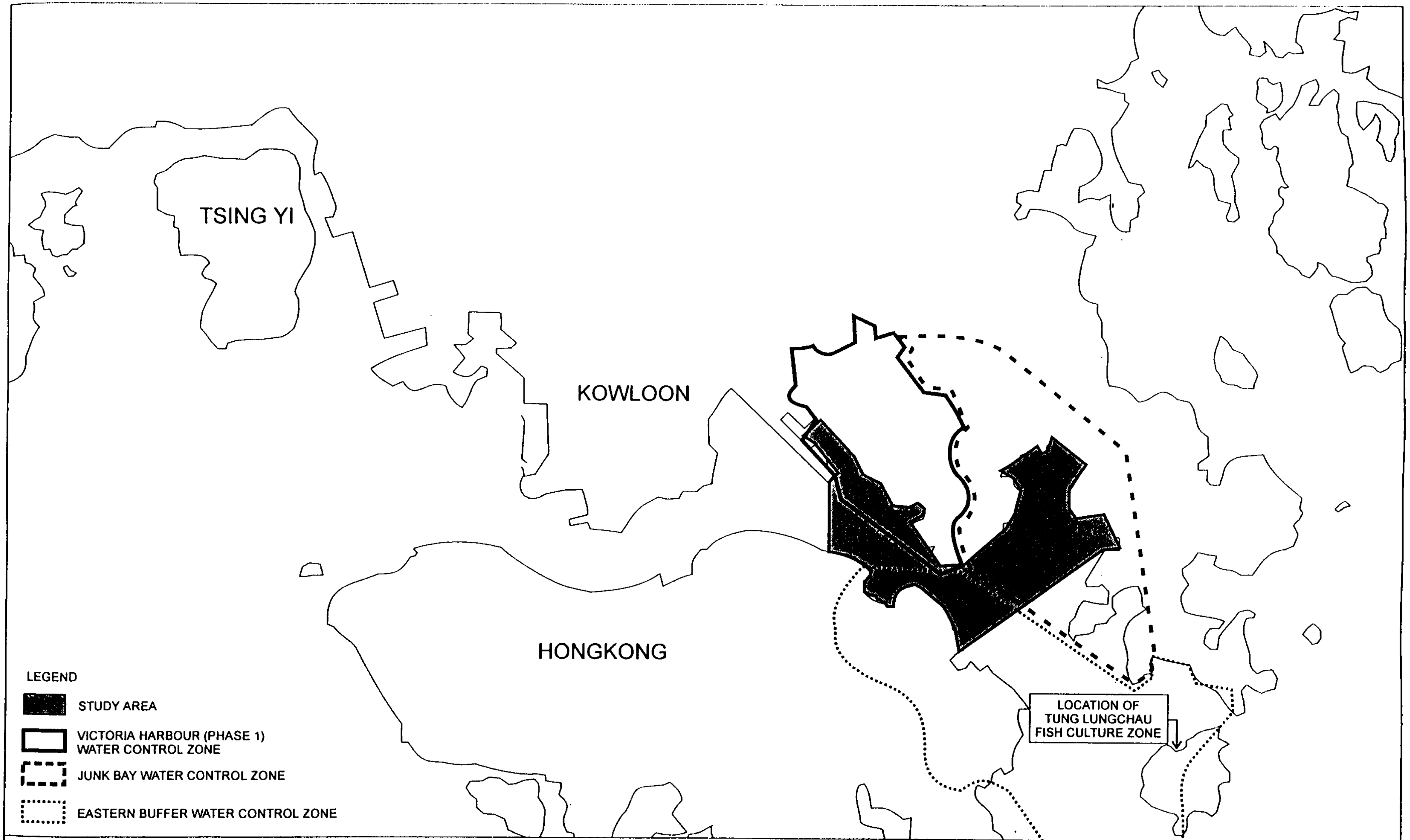

FIGURE 5.2a

STUDY AREA BOUNDARY AND WATER CONTROL ZONES

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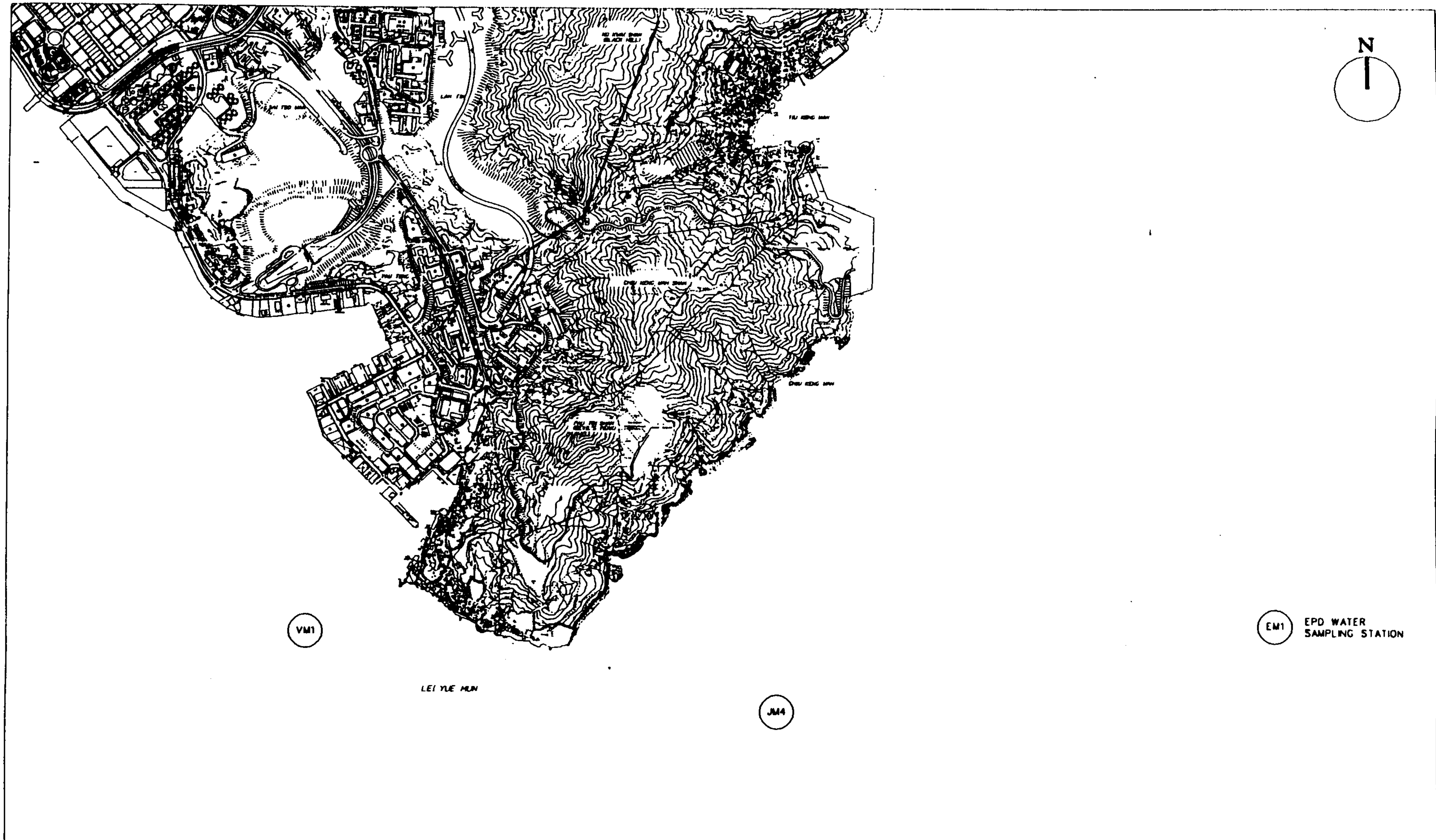
DATE: 13/01/99

Environmental
Resources
Management
ERM



LOCATION OF EPD MONITIORING STATIONS

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DATE: JUN 98	FIGURE No. 5.3a
SCALE: 1 : 22000	

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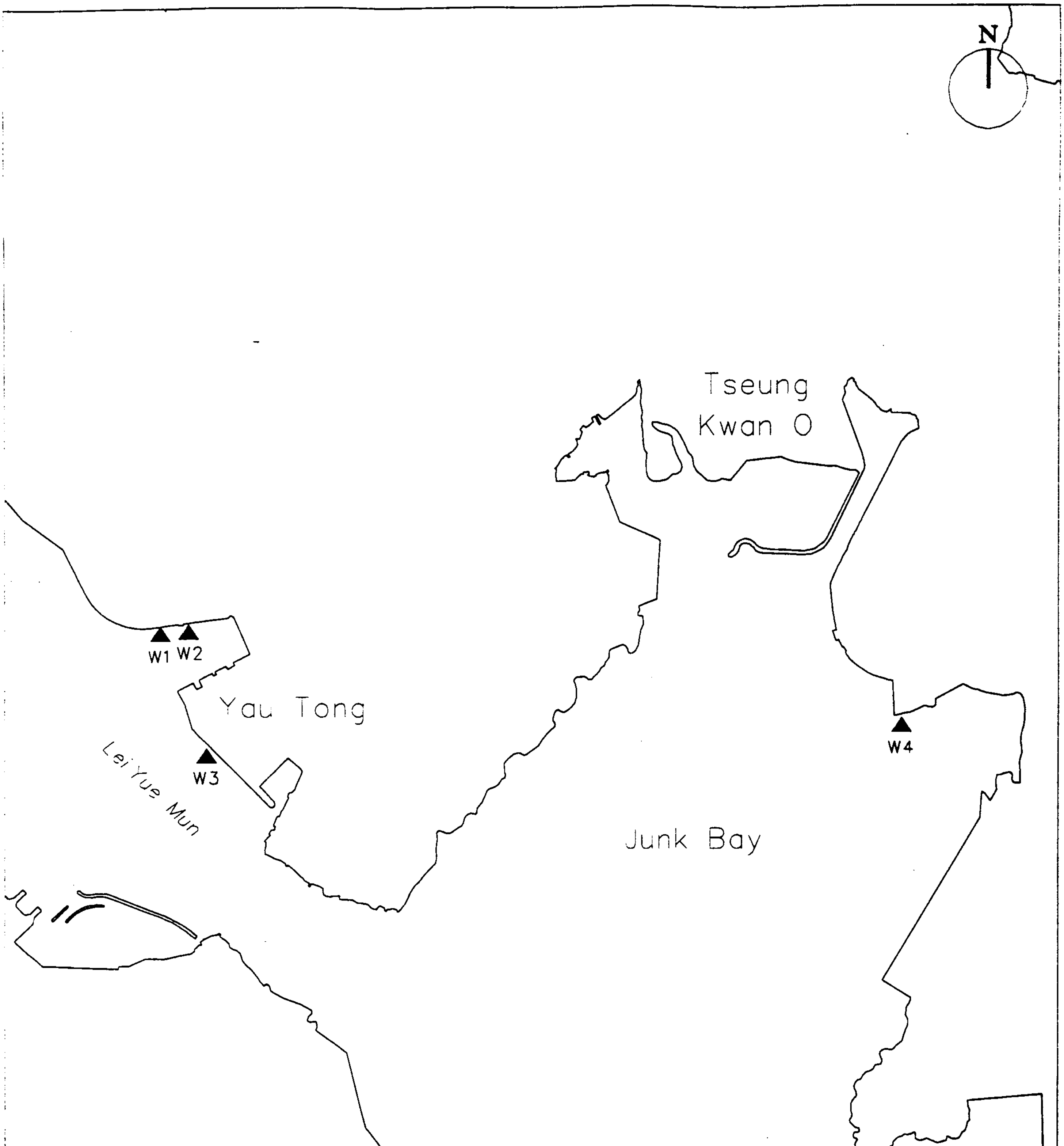

Sea Water Intakes

- W1 - Dairy Ice Farm Factory Seawater Intake for cooling
- W2 - Cha Kwo Ling Saltwater Pumping Station Intake
- W3 - Yau Tong WSD Saltwater Pumping Station Intake
- W4 - TKO WSD Seawater Pumping Station

NB: Although WSR W5, the Tung Lung Chau Fish Culture Zone (FCZ) is identified within the text as a sensitive receiver, it is not included on the figure as it is located outside the EIA Study Area and will not be impacted by the project.

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LOCATION OF WATER QUALITY SENSITIVE RECEIVERS

DATE: FEB 99	FIGURE No. 5.4a
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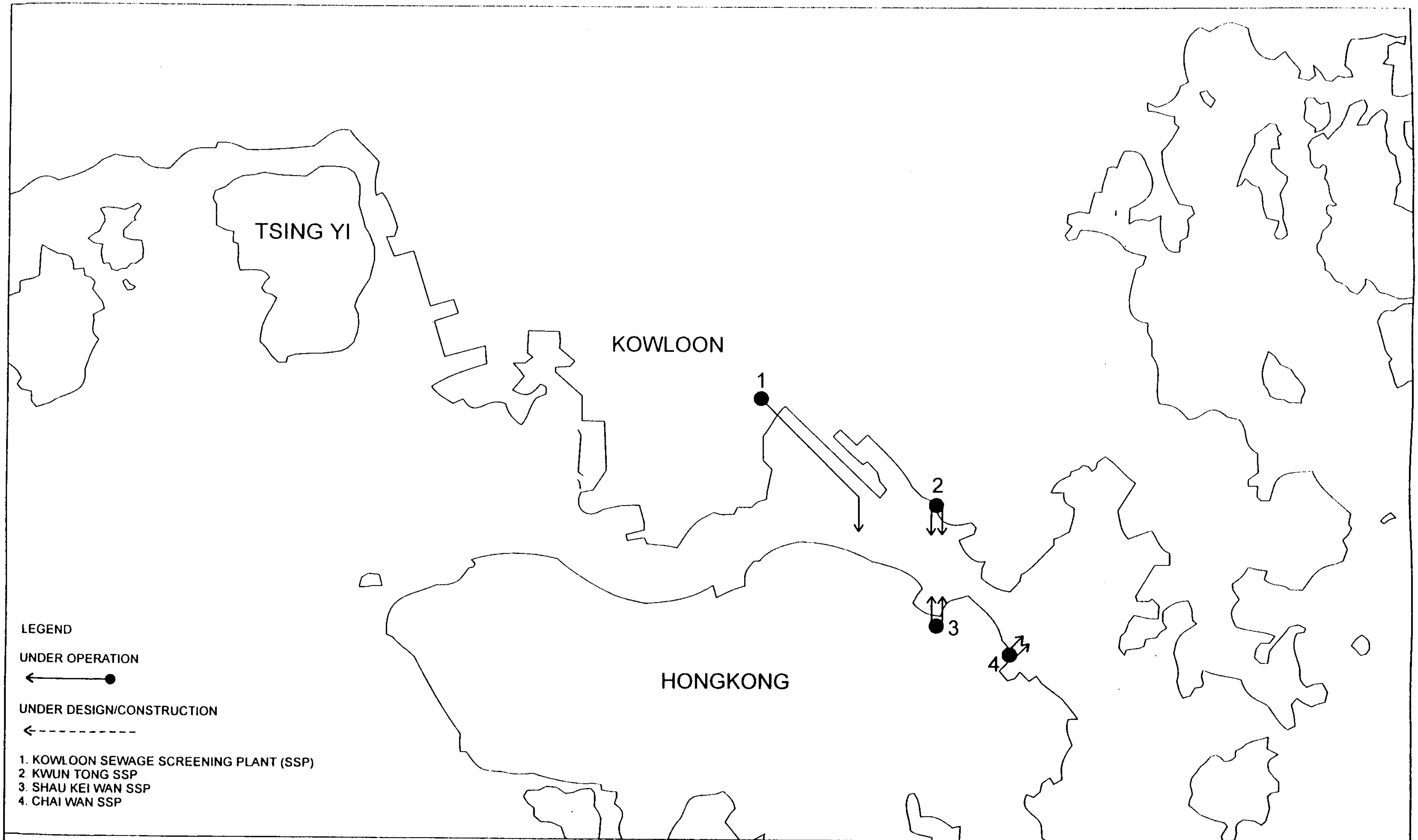


FIGURE 5.5a

LOCATION OF SEWAGE SCREENING PLANTS IN VICTORIA HARBOUR

Environmental Resources Management

ERM

FILE: C1609/C1609b
DATE: 23/06/98

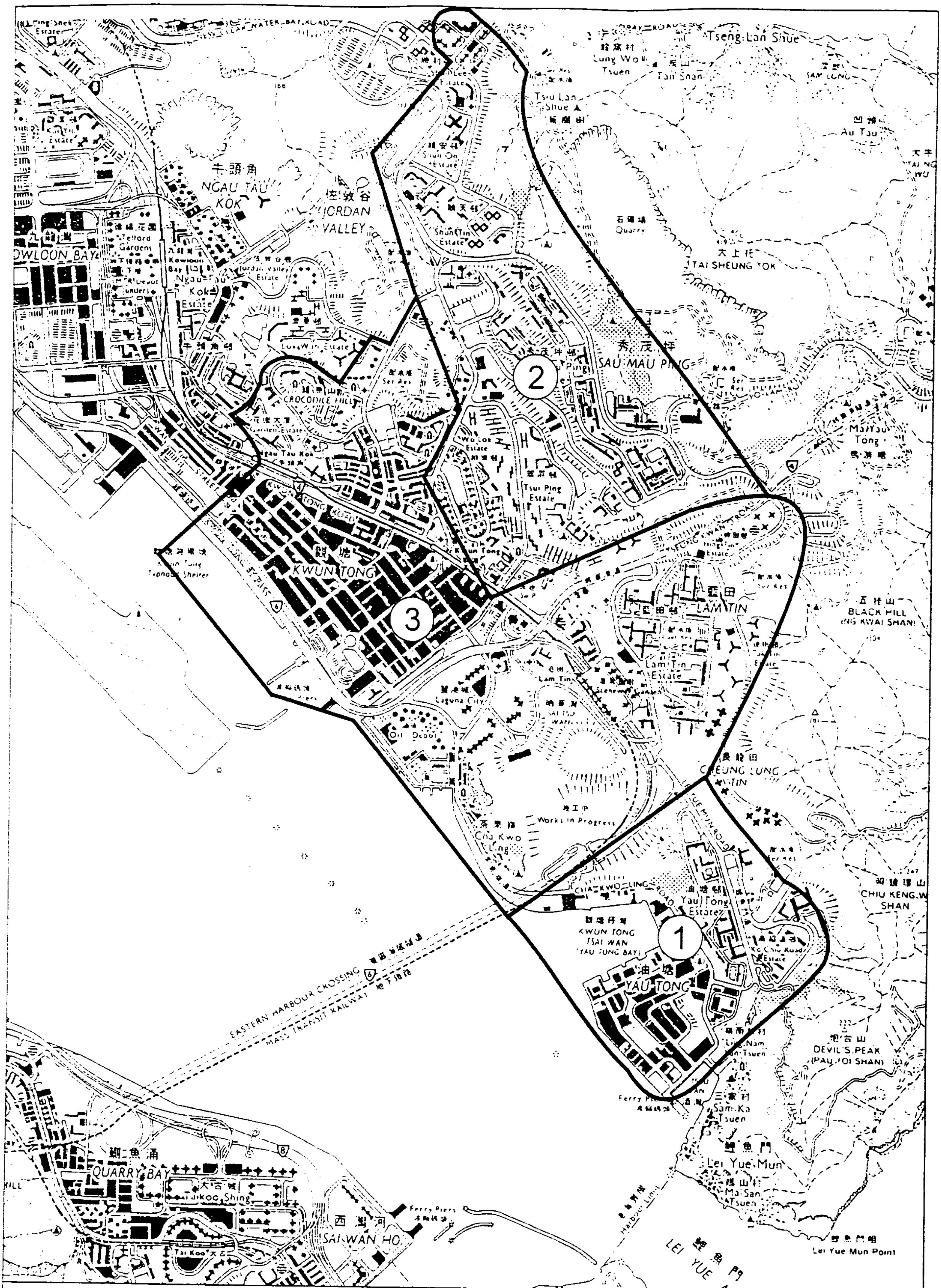


FIGURE 5.5b

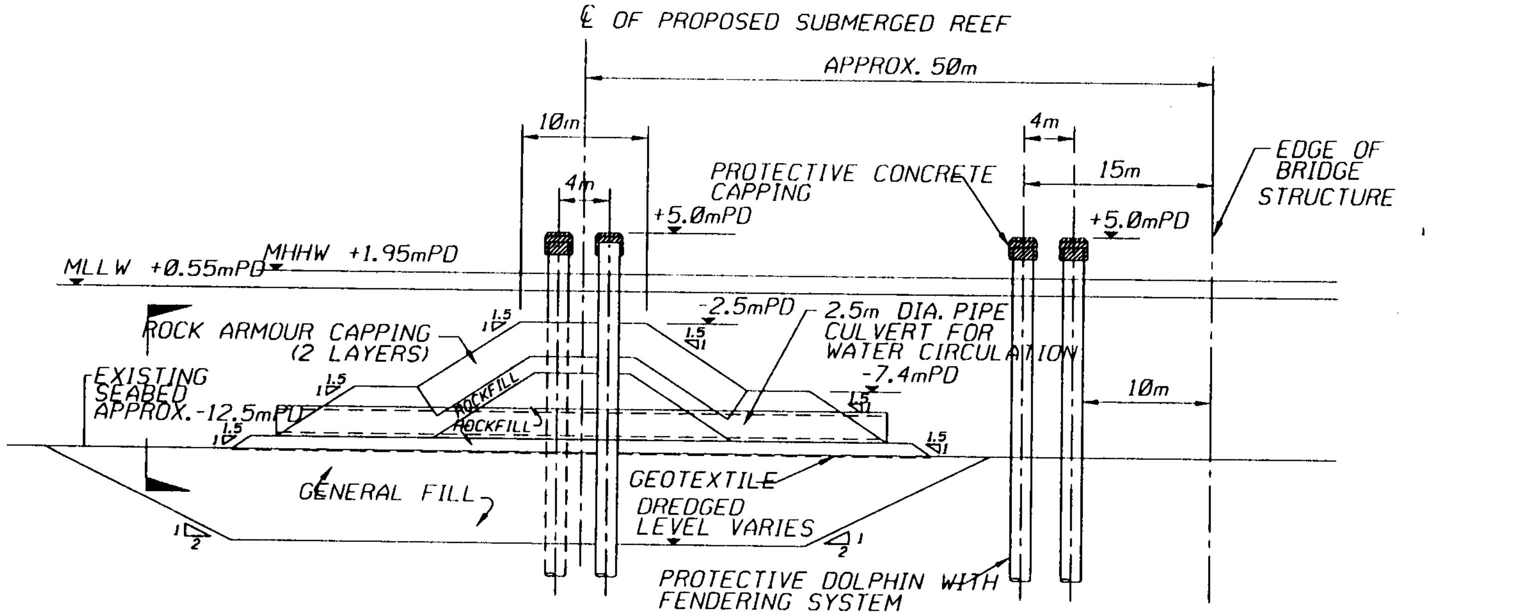
EASTERN KOWLOON SMP - SUB-CATCHMENTS

Environmental Resources Management

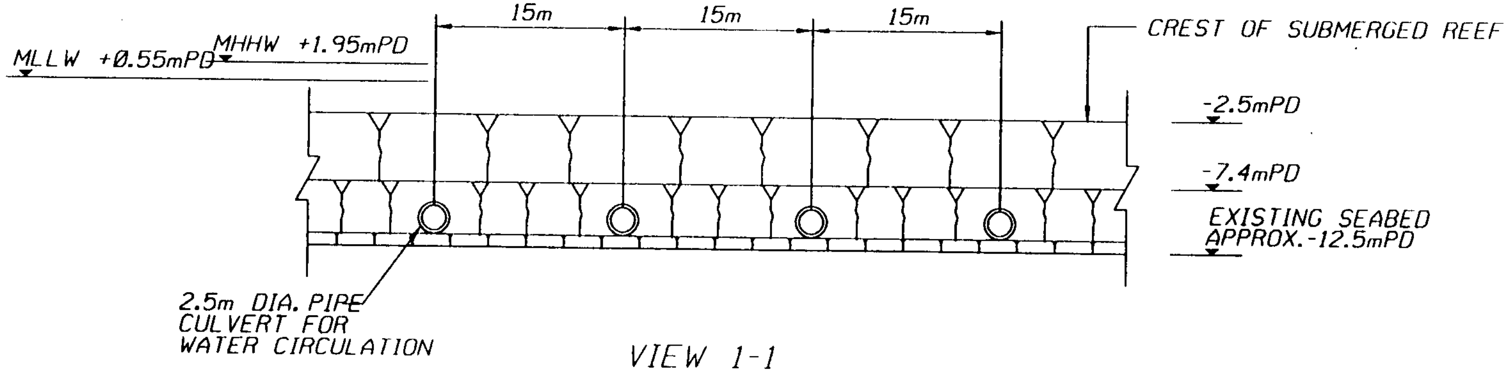
ERM

FILE: C1609/C1609c

DATE: 23/06/98



SECTION C-C



VIEW 1-1

CULVERTS IN SUBMERGED REEF

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DATE: JAN 99
SCALE: NTS
FIGURE No. 5.6a

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