4 WATER QUALITY

Water Quality Parameters

4.1 Monitoring of temperature, dissolved oxygen (DO, in both mg/l and % saturation), turbidity and suspended solids (SS) at monitoring stations W1 –W3, will be carried out by the ET to ensure that any deteriorating water quality is readily detected and timely action can be taken to rectify the situation. At the monitoring station WS, monitoring of conductivity, temperature, optical turbidity and dissolved oxygen is required to be conducted.

4.2 In association with the water quality parameters, other relevant data will also be measured, such as monitoring location/position, time, water depth, salinity, weather conditions, sea conditions, tidal stage, any special phenomena and work underway at the construction site and any other relevant information.

Monitoring Equipment

4.3 For water quality monitoring, the following equipments will be supplied by the ET, verified by IEC and approved by the ER. Table 4.1 summarizes the details of the monitoring equipment to be deployed, the model number, manufacturer and the calibration date.

Position System

4.4 A hand held or boat fixed type digital Global Positioning System (GPS) will be used to ensure that the correction location has been selected prior to sample collection.

Water Depth Detector

4.5 A portable, battery-operated echo sounder (Seafarer 700 or a similar approved instrument) will be used for the determination of water depth at each designated monitoring station. This unit can either be hand held or affixed to the underside of the survey boat, if the same vessel is to be used throughout the monitoring programme.

Dissolved Oxygen (DO) and Temperature Measuring Equipment

4.6 The instrument for measuring dissolved oxygen and temperature will be portable and weatherproof complete with cable, sensor, comprehensive operation manuals and use DC power source. It will be capable of measuring:

- a dissolved oxygen level in the range of 0-20 mg/L and 0-200% saturation; and
- a temperature of 0-45 degree Celsius.

4.7 It will have a membrane electrode with automatic compensation complete with a cable.

4.8 Sufficient stocks of spare electrodes and cables will be available for replacement where necessary (e.g. YSI model 59 meter, YSI 5739 probe, YSI 5795A submersible stirrer with reel and cable or an approved similar instrument).

4.9 In situ salinity will be measured to calibrate the DO equipment prior to each DO measurement if salinity compensation is not built-in in the DO equipment.

Turbidity

4.10 Turbidity will be measured *in situ* by the nephelometric method. The instrument will be portable and weatherproof using a DC power source complete with cable, sensor and comprehensive operation manuals. The equipment will be capable of measuring turbidity between 0-1000 NTU. The probe cable will not be less than 25m in length. The meter will be calibrated in order to establish the relationship between NTU units and the levels of SS.

Water Sampling for Laboratory Analysis

4.11 A water sampler as detailed in Section 4.12 will be used to collect samples for laboratory analysis.

Suspended Solids (SS)

4.12 A water sampler, consisting of a transparent PVC or glass cylinder of a capacity of not less that two litres which can be effectively sealed with cups at both ends will be used (Kahlsico Water Sampler 135DW 150 or an approved similar instrument). The water sampler will have a positive latching system to keep it open and prevent premature closure until released by a messenger when the sampler is the selected water depth.

4.13 Water samples for SS will be collected in high density polythene bottles, packed in ice and delivered to HOKLAS accredited laboratory for analysis as soon as possible after collection.

Sample Container and Storage

4.14 Following collection, water samples for SS will be stored in high density polythene bottles with no preservative added, packed in ice (without being frozen), delivered to the laboratory and analysed as soon as possible.

Calibration of In Situ Instruments

4.15 All *in situ* monitoring instruments will be checked, calibrated and certified by a laboratory accredited under HOKLAS or other international accreditation scheme before use, and subsequently re-calibrated at 2 monthly intervals throughout all stages of the water quality monitoring.

4.16 For the on site calibration of field equipment, the Equipment or Operation Manual provided by the manufacturer will be followed. The BS 1427:1993, "Guide to Field and on-site test methods for the analysis of waters" will also be referenced.

4.17 Sufficient stocks of spare parts will be maintained for replacements when necessary. Backup monitoring equipment will also be made available so that monitoring can proceed uninterrupted even when some equipment is under maintenance, calibration, etc.

Table 4.1 Details of the Monitoring Equipment to be Deployed, the Model Number, Manufacturer and Calibration Date

Parameters/ Functions	The Equipment to be Deployed	Model and Make	Calibration Dated
Positioning	Digital Global Positioning System (GPS)	"Standard Horizon" Handheld GPS Magnum NAV-40	N/A
Water Depth	Echo sounder	"Humminbird" In-Dash Digital Depthsounder HDR 600	N/A
Water Sampling	Kahlsico Water Sampler	135 WB150	N/A
Routine Water Quality Monitoring			
Dissolved Oxygen and Temperature	YSI Model 6820 CE-C-M-Y	YSI 6820	3 September 2003
Turbidity	YSI Model 6820 CE-C-M-Y	YSI 6820	3 September 2003
12-hours Continuous Water Quality Monitoring			
Dissolved Oxygen and Temperature	YSI Model 6920 M	YSI 6920	9 September 2003
Turbidity	YSI Model 6920 M	YSI 6920	9 September 2003

Laboratory Analytical Methods

4.18 Analysis of SS will be carried out in a HOKLAS or other international accredited laboratory. The following table shows the standard test methods of the proposed determinants for laboratory analysis.

Table 4.2 Methods for Laboratory Analysis for Water Samples

Parameters (Unit)	Suggested Method
SS (mg/L)	APHA 2540 D

Notes:
APHA = American Public Health Association: Standard Methods for the Examination of Water and Wastewater Ed. 19.

4.19 The testing laboratory will be HOKLAS accredited and comprehensive quality assurance and control procedures in place in order to ensure quality and consistency in results.

4.20 For the testing methods of other parameters as recommended by EPD, detailed testing methods, pre-treatment procedures, instrument use, quality assurance/quality control (QA/QC) details (such as blank, spike recovery, number of duplicate samples per batch, etc.), detection limits and accuracy will be submitted to EPD for approval prior to the commencement of monitoring programme. The QA/QC will be in accordance with the requirement of HOKLAS or international accredited scheme. The QA/QC results will

be reported. EPD may also request the laboratory to carry out analysis of know standards provided by EPD for quality assurance. Additional duplicate samples may be required by EPD for inter laboratory calibration. Remaining samples after analysis will be kept by the laboratory for 3 months in case repeat analysis is required. If in-house or nonstandard methods are proposed, details of the method verification may also be required for submission to EPD. In any circumstance, the sample testing will have comprehensive quality assurance and quality control programmes. The laboratory will prepare to demonstrate the programmes to EPD.

4.21 **Table 4.3** summarises the equipment used for the 12-hour continuous water quality monitoring.

Table 4.3 12-Hour Continuous Water Quality Monitoring Equipment

Equipment Name	Model
Multi-Sensor Probe	YSI 6920
Dissolved Oxygen Sensor	YSI 6562
Temperature & Conductivity Sensor	YSI 6560
Turbidity Sensor	YSI 6026

Monitoring Locations

4.22 The water quality monitoring locations are shown in **Figure 4.1** and their coordinates are provided in **Table 4.4**.

Table 4.4 Water Quality Monitoring Locations

Station	Co-ordinates	
	Northing	Easting
W1	804471.4	809611.2
W2	804330.9	809558.6
W3	804393.9	809725.0
WS	804555.2	809535.9

4.23 Prior to the commencement of the EM&A programme, the proposed water quality monitoring stations will be proposed by the ET Leader, verified by IEC and approved EPD.

Monitoring Programme

4.24 A water quality monitoring schedule, as shown in **Table 4.5,** is established to ensure that any deterioration in water quality can be readily detected and timely action can be taken to rectify the situation.

Table 4.5 Water Quality Monitoring Schedule

Monitoring Stations	Parameters, unit	Depth	Frequency[1]
W1, W2, W3	• DO Saturation, % • DO, mg/L • Temperature, °C • Turbidity, NTU • SS, mg/L	Three depths (1m below surface, mid-depth and 1m above seabed) at mid-flood and mid-ebb tides	**Baseline:** • 4 times per week for 2 weeks prior to commencement of pertinent construction activity **Impact:** • 3 times per week during construction of unloading facility
12-Hour Monitoring Station: WS	• Conductivity • Water depth, m • DO Saturation, % • DO, mg/L • Temperature, ºC • Turbidity, NTU	Mid-depth, with data logging at every 5 minutes for 12 hours between 0700 and 1900	

1. 2 consecutive readings of in-situ parameters will be taken in order to agree accuracy within 25%

Baseline Monitoring

4.25 Baseline monitoring program for marine water quality will be established by ET Leader, verified by IEC and approved by EPD prior to the commencement of baseline monitoring works. The purpose of the baseline monitoring is to establish ambient conditions prior to the commencement of the works and to demonstrate the suitability of the proposed monitoring stations.

4.26 The baseline conditions will be established by measuring all the water quality parameters for the construction phase monitoring as illustrated in **Table 4.5** prior to the commencement of marine works.

4.27 Two consecutive measurements will be taken at each monitoring stations W1, W2 and W3 at 1 m below surface, mid-depth and 1m above bottom in-situ at mid-flood and mid-ebb tides, 4 times a week for a period of 2 weeks. If the two consecutive readings do not agree to within 25%, the readings will be discarded and repeated.

4.28 Logging of the water quality parameters stipulated in **Table 4.5** will be undertaken at monitoring station WS every 5 minutes for complete working day for 12 hours between 0700 and 1900 at approximately mid-depth.

4.29 There will not be any marine construction activities in the vicinity of the stations during the baseline monitoring.

4.30 In exceptional cases when insufficient baseline monitoring data or questionable results are obtained, the ET Leader will seek approval from IEC and EPD on an appropriate set of data to be used as baseline reference.

4.31 Sample of water quality field data sheet is attached in **Appendix C**.

Impact Monitoring

4.32 During construction of the off-loading facilities, two consecutive measurements of DO (in both mg/l and % saturation) and turbidity (NTU) will be taken at each monitoring stations W1, W2 and W3 at 1 m below surface, mid-depth and 1m above bottom in-situ at mid-flood and mid-ebb tides, 3 times a week. If the two consecutive readings do not agree to within 25%, the readings will be discarded and repeated. Duplicate water samples for SS will be taken and analysed.

4.33 Logging of the water quality parameters stipulated in **Table 4.5** will be undertaken at monitoring station WS every 5 minutes for complete working day for 12 hours between 0700 and 1900 at approximately mid-depth.

4.34 Statistical analysis, e.g., One Way Analysis of Variance (ANOVA)[1] will be applied to check if the baseline monitoring data for parameters DO, Turbidity and SS collected at each station are significantly different with that collected at other stations. The data at each routine monitoring station (W1 to W3) at each tide will be arranged in four different groups, including DO (surface and middle depth), DO (bottom depth), turbidity (depth-average) and SS (depth-average) for the analysis. If no significant difference is observed, the A/L levels for the parameters will be derived from the pooled data of all the stations. Otherwise, the A/L levels will be calculated separately for each specific group of stations in which no significant difference in the baseline data is observed.

4.35 The A/L levels will be derived with agreement from EPD following the completion of the baseline monitoring. The A/L levels will be calculated as outlined in **Table 4.6**. An exceedance will be considered to be valid when the monitoring result exceeds both the A/L levels derived from the baseline data and the monitoring result at the control station.

Event and Action Plan for Water Quality

4.36 When the monitoring results of the water quality parameters at any designated monitoring stations exceed the water quality criteria, the actions in accordance with the Event/Action Plan in **Table 4.7** will be carried out.

Operational Phase Monitoring

4.37 Effluent from non-active sources is expected to comprise of foul effluent from toilets and sinks/washbasins in other areas of the facility. Ventilated dry latrine type toilets will be used at the facility unless otherwise agreed by the EPD. No operational phase monitoring and special mitigation measures will be required.

[1] The analysis is a technique used to test the null hypothesis that multiple population means are all equal. If the calculated P value is less than 0.05, then one can accept the hypothesis that there is an influence of the qualitative fact on the data, or that the means of at least two of the groups of data differ significantly.

Table 4.6 Action and Limit Levels for Water Quality

Parameter	Action Level	Limit Level
DO in mg/L (Surface, Middle & Bottom)	Surface & Middle 5%-ile of baseline data for surface and middle layer. Bottom 5%-ile of baseline data for bottom layer.	Surface & Middle 4 mg/L except 5mg/L for Fish Culture Zone or 1%-ile of baseline data for surface and middle layer. Bottom 2 mg/L or 1%-ile of baseline data for bottom layer.
Turbidity (Tby) in NTU (depth-average)	95%-ile of baseline data or 120% of upstream control station's Tby at the same tide of the same day	99%-ile of baseline data or 130% of upstream control station's Tby at the same tide of the same day
SS in mg/L (depth-average)	95%-ile of baseline data or 120% of upstream control station's SS at the same tide of the same day	99%-ile of baseline data or 130% of upstream control station's SS at the same tide of the same day and specific sensitive receiver water quality requirements (e.g. required suspended solids level for concerned sea water intakes)

Notes:
- This table is extracted from *Table 3.1* of *Environmental Monitoring and Audit Guidelines for Development Projects in Hong Kong*.
- For DO, non-compliance of the water quality limits occurs when monitoring results is lower than the limits.
- For SS and Tby, non-compliance of the water quality limits occurs when monitoring results is higher than the limits.
- All the figures given in the table are used for reference only and the EPD may amend the figures whenever it is considered as necessary.
- %-ile denotes percentile
- depth-average denotes the average values obtained from the three depths
- During the mid-ebb tide, W2 is treated as the control station for W3.
- During the mid-flood tide, W3 is treated as the control station for W1 and W2.

Table 4.7 Event and Action Plan for Water Quality

EVENT	ACTION			
	ET	**IEC**	**ER**	**CONTRACTOR**
ACTION LEVEL				
Action level being exceeded by one sampling day	1. Repeat in-situ measurement to confirm findings; 2. Identify source(s) of impact; 3. Inform IEC, Contractor and ER; 4. Check monitoring data, all plant, equipment and Contractor's working methods; 5. Discuss mitigation measures with IEC and Contractor; 6. Repeat measurement on next day of exceedance.	1. Discuss with ET and Contractor on the mitigation measures; 2. Review proposals on mitigation measures submitted by Contractor and advise the ER accordingly; 3. Assess the effectiveness of the implemented mitigation measures.	1. Discuss with IEC on the proposed mitigation measures; 2. Make agreement on the mitigation measures to be implemented.	1. Inform the ER and confirm notification of the non-compliance in writing; 2. Rectify unacceptable practice; 3. Check all plant and equipment; 4. Consider changes of working methods; 5. Discuss with ET and IEC and propose mitigation measures to IEC and ER; 6. Implement the agreed mitigation measures.
Action level being exceeded by two or more consecutive sampling days	1. Repeat in-situ measurement to confirm findings; 2. Identify source(s) of impact; 3. Inform IEC, Contractor and ER; 4. Check monitoring data, all plant, equipment and Contractor's working methods; 5. Discuss mitigation measures with IEC, Contractor and ER; 6. Ensure mitigation measures are implemented; 7. Prepare to increase the monitoring frequency to daily; 8. Repeat measurement on next day of exceedance.	1. Discuss with ET and Contractor on the mitigation measures; 2. Review proposals on mitigation measures submitted by Contractor and advise the ER accordingly; 3. Assess the effectiveness of the implemented mitigation measures.	1. Discuss with IEC on the proposed mitigation measures; 2. Make agreement on the mitigation measures to be implemented; 3. Assess the effectiveness of the implemented mitigation measures.	1. Inform the ER and confirm notification of the non-compliance in writing; 2. Rectify unacceptable practice; 3. Check all plant and equipment; 4. Consider changes of working methods; 5. Discuss with ET and IEC and propose mitigation measures to IEC and ER within 3 working days; 6. Implement the agreed mitigation measures.

Remarks: ET = Environmental Team
IEC = Independent Environmental Checker
ER = Employer's Representative

EVENT	ACTION			
	ET	**IEC**	**ER**	**CONTRACTOR**
LIMIT LEVEL				
Limit level being exceeded by one sampling day	1. Repeat in-situ measurement to confirm findings; 2. Identify source(s) of impact; 3. Inform IEC, Contractor, ER and EPD; 4. Check monitoring data, all plant, equipment and Contractor's working methods; 5. Discuss mitigation measures with IEC, ER and Contractor; 6. Ensure mitigation measures are implemented; 7. Increase the monitoring frequency to daily until no exceedance.	1. Discuss with ET and Contractor on possible mitigation measures; 2. Review the proposed mitigation measures submitted by Contractor and advise the ER accordingly; 3. Assess the effectiveness of the implemented mitigation measures.	1. Discuss with IEC, ET and Contractor on the proposed mitigation measures; 2. Request Contractor to critically review the working methods; 3. Make agreement on the mitigation measures to be implemented; 4. Assess the effectiveness of the implemented mitigation measures.	1. Inform the ER and confirm notification of the non-compliance in writing; 2. Rectify unacceptable practice; 3 Check all plant and equipment 4. Consider changes of working methods; 5. Discuss with ET, IEC and ER and propose mitigation measures to IEC and ER within 3 working days; 6. Implement the agreed mitigation measures.
Limit level being exceeded by two or more consecutive sampling days	1. Repeat in-situ measurement to confirm findings; 2. Identify source(s) of impact; 3. Inform IEC, Contractor, ER and EPD; 4. Check monitoring data, all plant, equipment and Contractor's working methods; 5. Discuss mitigation measures with IEC, ER and Contractor; 6. Ensure mitigation measures are implemented; 7. Increase the monitoring frequency to daily until no exceedance of Limit level for two consecutive days.	1. Discuss with ET and Contractor on possible mitigation measures; 2. Review the proposed mitigation measures submitted by Contractor and advise the ER accordingly; 3. Assess the effectiveness of the implemented mitigation measures.	1. Discuss with IEC, ET and Contractor on the proposed mitigation measures; 2. Request Contractor to critically review the working methods; 3. Make agreement on the mitigation measures to be implemented; 4. Assess the effectiveness of the implemented mitigation measures; 5. Consider and instruct, if necessary, the Contractor to slow down or to stop all or part of the marine work until no exceedance of Limit level.	1. Inform the ER and confirm notification of the non-compliance in writing 2. Rectify unacceptable practice; 3 Check all plant and equipment 4. Consider changes of working methods; 5. Discuss with ET, IEC and ER and propose mitigation measures to IEC and ER within 3 working days; 6. Implement the agreed mitigation measures; 7. As directed by the ER, to slow down or to stop all or part of the marine work or construction activities.

Remarks: ET = Environmental Team
IEC = Independent Environmental Checker
ER = Employer's Representative

Water Quality Mitigation Measures

4.38 The implementation schedule for recommended mitigation measures is presented in **Appendix A**.

Construction Phase

4.39 The Contractor will be responsible for the design and implementation of these mitigation measures. These include:

- Unnecessary disturbance to the seabed will be minimised by exerting care when lowering and lifting the tools/equipment into seabed;
- All vessels will be sized such that adequate clearance (i.e. minimum clearance of 0.6m) is maintained between vessels and the seabed in all tide conditions, to ensure that undue turbidity is not generated by turbulence from vessel movement or propeller wash;
- Use of silt curtains surrounding the dredger and the dredged area during dredging;
- Barges will be used which are fitted with tight fitting seals to their bottom openings to prevent leakage of material;
- Barge loading will be ensured accurately to avoid splashing of loading material to the surrounding water;
- Adequate freeboard (i.e. minimum of 200mm) will be maintained on barges to ensure that decks are not washed by wave action;
- Grabs (if any) will be closed tightly and that hoist speeds will be suitably low;
- No visible foam, oil, grease, scum, litter or other objectionable matter will be present in the water within the site or dumping grounds;
- Appropriate monitoring of water quality will be undertaken to allow the implementation of appropriation action plans to prevent unacceptable water quality impacts;
- Carry out earth works in dry season as much as possible;
- Cover areas of exposed earth;
- Install sand traps or catchpits at all drainage discharge points;
- Oil and fuel bunkers to be bunded;
- Immediate disposal and correct handling of any chemical spill; and
- Prevent surface runoff into coastal water through construction of bunds between works area and sea shore.

Worker Generated Waste

- Provide proper sewage treatment facilities for site workers.

Operational Phase

4.40 Waste water generated during operations will either be an active stream or an in-active stream. A monitoring tank will be provided at the facility to intercept all active water. The contents of the tank will be monitored for radioactivity prior to being pumped out or otherwise treated prior to disposal, assuming that agreement on discharge limits has been reached with EPD. Details of the drainage arrangement will be mentioned in EM&A Manual (Part 2 - Radiological).

4.41 Effluent from non-active sources is expected to comprise of foul effluent from toilets and sinks/washbasins in other areas of the facility. Ventilated dry latrine type toilets will be used at the facility unless otherwise agreed by the EPD. No operational phase monitoring will be required.

4.42 The mitigation measures stipulated in Sections 2.7 to 2.9 of EP and are summarized as follows will be provided:

- LRWF shall be operated as dry facility with no production of radioactive liquid effluent.
- Ventilated dry latrine type toilets shall be used at the LRWF unless otherwise agreed by the Director.
- Electric powered vehicles shall be used at the LRWF unless otherwise agreed by the Director.