

4. WATER QUALITY

Introduction

- 4.1 The EIA Report recommended an optimum disinfection level for the proposed advance disinfection facilities (ADF) at Stonecutters Island Sewage Treatment Works (SCISTW), on one hand, to protect the beneficial uses of the identified water sensitive receivers, and on the other hand, to minimize the chlorine dosage and thus the potential formation of chlorination by-products (CBPs). An operation monitoring programme for concentration of TRC and potential CBPs in effluent and marine water will be implemented to confirm the predictions of the water quality, human health and ecological risk impact made in the EIA report. A close to real time on-line monitoring programme on the dosage of sodium hypochlorite and sodium bisulphite, and the TRC concentration has also been developed under this EM&A Manual. Details of the effluent and marine water monitoring programme for TRC and CBPs are presented in this Section. The monitoring programme for human health risk and ecological risk will be described in **Sections 5** and **6** respectively. Effluent quality, including *E. coli* level and TRC, from the SCISTW will be governed by the discharge licence conditions after the Project is commissioned.
- 4.2 Emergency response plans have been formulated in this EM&A Manual to deal with situations including system failure and deviation of monitoring results from the prediction in respect of water quality and marine ecological risk. Detailed contingency plan and operational procedures for the ADF will be developed separately before commissioning of ADF. Marine water quality monitoring is also recommended to be carried out during and after any emergency discharge of undisinfecting effluent from SCISTW in the event of chlorination / dechlorination plant failure during the ADF stage.
- 4.3 In this section, the requirements, methodology, equipment, monitoring locations, criteria and protocols for the monitoring and audit of water quality impacts during the construction and operation phase of the Project are presented.

Effluent Discharge Standards

- 4.4 The current discharge license of the SCISTW has specified the discharge standards for suspended solid (SS) and 5-Day biochemical oxygen demand (BOD₅) to be 55mg/L (95 percentile) and 75 mg/L (95 percentile) respectively. Since the Project would not cause any change in the treatment capacity of SCISTW, it is considered that the above discharge standards for SS and BOD₅ are still valid for SCISTW after the Project commissioned.
- 4.5 The Final EIA Report has recommended the effluent discharge standards for *E coli* and TRC concentration after the Project commissioned as presented in Table 4.1 based on the water quality modeling results.

Table 4.1 Recommended Effluent Discharge Standards for ADF

Parameters		Recommended Discharge Standard
E.Coli (no. per 100ml)	Geometric Mean	200,000
	95 percentile	3,000,000
TRC (mg/L)	95 percentile	0.2
	Maximum	0.4

- 4.6 In accordance with Table 9b of the Technical Memorandum - Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters, pH standard for effluents discharged into the marine waters of Victoria Harbour Water Control Zone is 6-10. Such standard for pH shall be applicable for effluent discharge from SCISTW.

Chlorination/Dechlorination Dosage Record

- 4.7 A close to real time on-line monitoring (reading to be taken at 5-minute intervals) shall be performed on the dosage of sodium hypochlorite and sodium bisulphite used for the chlorination/dechlorination process under the Project through the plant control system. Summary of the monitoring results shall be uploaded to the dedicated web site on a monthly basis. For any over-dosage of sodium hypochlorite recorded (i.e. exceeding 20 mg/L), the incident shall be reported to EPD and the incident report shall be uploaded to the dedicated web site as soon as possible but not later than seven days after the incident.
- 4.8 The Environmental Consultant shall collect from SCISTW the chemical dosage record for the first year operation after the commissioning period of the Project for data analysis. The Environmental Consultant shall compare the actual dosages with those predicted under the EIA Study as shown in Table 4.2 and the chlorine dosage adopted in the pilot tests under the EIA study (i.e. 20 mg/L(maximum) for CEPT effluent) to see whether there is any significant difference which causes deviations of the monitoring results from the model prediction under the EIA Study. The review finding shall be submitted to DSD and EPD.

Table 4.2 Recommended Sodium Hypochlorite and Sodium Bisulphite Dosages for ADF

Description		Recommended Operational Range
Sodium Hypochlorite Dosage (mgCl ₂ /L)		11 - 15
Sodium Bisulphite Dosage (mg NaHSO ₃ /l)	Automatic Mode	4 – 7
	Manual Mode	8 – 11

Close To Real Time On-line Monitoring on TRC Concentration in the Chlorinated Effluent

- 4.9 A close to real time on-line monitoring (reading to be taken at 5-minute intervals) shall be performed on the TRC concentration of the chlorinated effluent collected from Chamber 15 measured by TRC analyser through the plant control system. The proposed sampling location for the monitoring is indicated in **Figure 4.3**. The Environmental Consultant shall collect from SCISTW the operation data for the first year operation after the commissioning period of the Project for data analysis. TRC concentration of the dechlorinated effluent shall be monitored following the details specified in the section on effluent quality monitoring below. Summary of the monitoring results shall be uploaded to the dedicated web site on a monthly basis. In case the TRC concentration of the dechlorinated effluent found to be higher than the discharge limit (i.e. exceeding 0.4 mg/L), the incident shall be reported to EPD and the incident report shall be uploaded to the dedicated web site as soon as possible but not later than seven days after the incident.

Effluent Quality Monitoring

- 4.10 Effluent samples shall be collected at appropriate location for monitoring of concentrations of SS, BOD₅, TRC, CBPs, *E.Coli* level and pH. The Environmental Consultant shall collect from SCISTW the monitoring data for the first year operation after the commissioning period of the Project for data analysis.
- 4.11 The monitoring data on the concentrations of CBPs in the treated effluent shall be used to investigate whether there is any significant difference which causes deviations of the monitoring results from the model prediction under the EIA Study. The monitoring data could also provide information to investigate any abnormalities found in marine water quality monitoring and whole effluent toxicity test.
- 4.12 Nine CBPs species, including four Trihalomethanes (THMs) and five Haloacetic Acids (HAAs), as listed in Table 4.3, are selected for monitoring because:

- they are known to be the most important and abundant CBPs, relatively more toxic and of greater concern, and therefore serve as good indicators for CBPs;
- international drinking water standards for these nine CBPs are available for protection of public health;
- they were classified as contaminants of concern (COCs) in the EIA study, and found to be of concentrations higher than other halogenated organics in the chlorinated/dechlorinated (C/D) HATS effluent;
- for the other 25 halogenated organics grouped as “potential CBPs” and studied in the EIA, inclusion in the monitoring programme is not considered necessary because almost none of them were found in the C/D HATS effluent and most of these compounds are not directly related to the disinfection process, but were included in the EIA study merely for conservative assessment as some of them are regulated by US for controlling industrial discharges.

4.13 Based on the review conducted on local and overseas practices, no CBPs limits for effluent disinfected by chlorination were identified from other practices. As a conservative approach, a set of CBPs discharge limit is developed with reference to the Toxicity Reference Value (TRVs) used in the ecological risk assessment under the EIA. The TRVs for the CBPs species are either the most stringent international water quality criteria (for such species), or values specifically derived from relevant ecotoxicity of the highest toxicity using the USEPA procedures. Effluent reaching the zone of initial dilution (ZID) is assumed to have diluted to 47 times which is the minimum dilution predicted for the ADF Stage. The limits are set such that all proposed TRVs should be met at the edge of ZID. The discharge limits derived according to the above approach are presented in Table 4.3.

Table 4.3 Recommended Discharge Limits for CBPs

Determinant		Toxicity Reference Values (mg/L)	Discharge Limit (measured in HATS effluent) (mg/L)
Bromoform	Tri-halomethanes (THMs)	0.36	16
Bromodichloromethane		0.022	1
Chloroform		0.012	0.56
Dibromochloromethane		0.034	1.5
Bromoacetic acid	Halo-acetic Acids (HAAs)	1.6	75
Chloroacetic acid		32	1500
Dibromoacetic acid		0.69	32
Dichloroacetic acid		0.23	10
Trichloroacetic acid		93	4300

Effluent Sample Analytical Methods

4.14 The concentrations of the TRC and CBPs in the effluent shall be determined by laboratory. The recommended analysis methods for the TRC and CBPs are presented in Table 4.4.

Table 4.4 Analytical Methods to be applied

Determinant		Suggested Method	Suggested Detection Limit (µg/L)
Total residual chlorine (TRC)		APHA 4500CL:G	5*
Bromoform	Tri-halomethanes (THMs)	USEPA 8260 (Purge & Trap GCMS)	0.1*
Bromodichloromethane			0.1*
Chloroform			0.1*
Dibromochloromethane			5
Bromoacetic acid	Halo-acetic Acids (HAAs)	APHA 6251	2
Chloroacetic acid			2
Dibromoacetic acid			2
Dichloroacetic acid			2
Trichloroacetic acid			2

* The suggested detection limit was in light of the concentration of interest (COI) for human health and/or ecological resources, which was based on local/international authority approved standard. Determinant at concentration below COI is not expected to induce concern to human health and ecological resources.

Effluent Sample Collection

4.15 Effluent from SCISTW shall be collected at a suitable location. The sampling location should be agreed with the Environmental Consultant, approved by DSD and EPD, and should fulfil the requirements listed below. The proposed effluent sampling locations are shown in **Figure 4.3**.

- Effluent collected at the sampling location is representative to the effluent discharged at the effluent diffuser
- Sampling works at the sampling location would not interfere with the SCISTW operation
- Sampling works at the sampling location would not induce safety hazard (e.g. staff sampling effluent drops into the culvert)

4.16 The effluent should be collected in a full 24-hour period. Twenty four-hour flow-weighted composite effluent sample for subsequent chemical analysis and testing¹ should be prepared by the following procedures:

- Collect effluent sub-sample at bi-hourly interval over a 24 hour period
- Obtain flow record of SCISTW for the 24-hour sampling period
- Calculate the volume of each sub-sample for preparation of flow-weighted composite sample
- Transfer the appropriate volume of sub-samples to a clean container and mix thoroughly

4.17 For compliance checking of *E.Coli* and TRC monitoring, representative grab samples should be collected for analysis and testing.

4.18 The effluent sampling should be planned carefully to ensure appropriate volume of effluent sub-samples is collected to prepare sufficient amount of flow-weighted composite effluent sample for carrying out subsequent chemical analysis and testing.

Effluent Sample Monitoring Schedule

4.19 For baseline monitoring, effluent sampling on TRC and CBPs shall be performed monthly over a year before commissioning of the Project to give adequate coverage during both wet and dry seasons. The baseline monitoring shall be ceased in the events of any emergency discharges.

4.20 Similarly, for operation phase monitoring on TRC and CBPs, effluent sampling shall be performed monthly over the first year of Project operation after the commissioning period of the Project to give adequate coverage during both wet and dry seasons. The operation phase monitoring shall be ceased in the events of any emergency discharges.

¹ Including Whole Effluent Toxicity Test (WETT) to be conducted during operation phase of the Project.

- 4.21 As part of the compliance checking monitoring programme for SCISTW, effluent sampling on SS, BOD₅, TRC, *E.Coli* and pH is recommended to be performed three times per week after the commissioning period of the Project subject to the agreement of EPD.
- 4.22 The Environmental Consultant shall conduct a review on the monitoring frequency after the first year of operation of the Project. The review results shall be submitted to DSD and EPD. Termination or any amendment to the monitoring programme shall be agreed by DSD and EPD.

Sample Containers and Storage

- 4.23 Effluent samples collected for chemical analysis shall be stored and preserved in suitable and clean containers according to the Standard Methods, and packed in ice (cooled to 4°C without being frozen) and delivered to the laboratory and analysed within 24 hours after collection.

Laboratory Measurement / Analysis

- 4.24 Analysis of TRC, CBPs and *E.Coli* shall be carried out in a HOKLAS or other international accredited laboratory. The analysis shall commence within 24 hours after collection of the effluent samples. 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 shall be submitted to the Environmental Consultant for approval prior to the commencement of monitoring programme. If in-house or non-standard methods are proposed, details of the method verification shall be required to submit to Environmental Consultant. In any circumstance, the sample testing shall have comprehensive quality assurance and quality control programmes. The laboratory shall prepare to demonstrate the programmes to Environmental Consultant or his representatives when requested.

Marine Water Quality Monitoring (for TRC and CBPs)

- 4.25 The marine water quality (for TRC and CBPs) monitoring is recommended in order to achieve the following objectives:
- To check whether the Project would cause an increase in TRC and CBP concentrations in marine water
 - To verify the predictions of the Human Health Risk Assessment
 - To verify the predictions of the Ecological Risk Assessment

Monitoring Locations

- 4.26 It is recommended to set up 6 monitoring stations with their locations and co-ordinates as shown in **Figure 4.1**, which also shows the boundary of the Zone of Initial Dilution (ZID) and the boundary of mixing zone determined by the water quality modelling. As shown in **Figure 4.1**, 4 stations would be located at the edge of ZID (stations 2 and 3) and the edge of mixing zone (stations 1 and 4), forming a transect line perpendicular to the effluent diffuser. Stations SM6 and SM12 would be located in areas that would unlikely be affected by the Project and will therefore serve as control stations. The coordinates of the proposed monitoring stations are listed in **Table 4.5**.

Table 4.5 Proposed Marine Water Quality Monitoring Stations

Station	Description	Easting	Northing
1	Edge of Mixing Zone (northwest of effluent diffuser)	829762.00	819604.47
2	Edge of ZID (northwest of effluent diffuser)	830117.99	819251.93
3	Edge of ZID (southeast of effluent diffuser)	830186.21	819184.37
4	Edge of Mixing Zone (southeast of effluent diffuser)	830525.00	818848.87
SM6	Control Station	826179.81	805902.89
SM12	Control Station	819524.19	808420.40

4.27 Monitoring Stations 1 to 4 are located at northwest of Stonecutters Island which are predominantly used for marine traffic. Installing long-term TRC analyzer within the water body at the proposed monitoring stations for real time monitoring of TRC concentration is not considered practicable. Hence, laboratory testing on grab samples collected by vessel shall be conducted to verify the predictions under the EIA study in respect of water quality.

4.28 Sampling shall be taken at three water depths, namely, 1m below water surface, mid-depth and 1m above sea bed, except where the water depth is less than 6m, in which case the mid-depth station may be omitted. Shall the water depth be less than 3m, only the mid-depth station will be monitored. At each depth, same amount of water sample shall be collected and transferred into a clean container to form a composite sample, which shall be in sufficient volume for CBPs analysis to achieve the required detection limit. It is recommended to collect six composite samples (replicates) at each monitoring station, which is a reasonable number of replicates for environmental monitoring data to be analyzed by common statistical analysis method (Townend, 2002). The Environmental Consultant shall review the number of replicates by statistical power analysis after the first set of baseline marine water quality monitoring.

Monitoring Schedule

4.29 For baseline monitoring, marine water sampling shall coincide with the baseline effluent sampling, and be performed monthly over a year before commissioning of the Project to give adequate coverage of different tidal states during both wet and dry seasons. The purpose of the baseline monitoring is to establish ambient conditions without disinfected effluent discharge from the Project. The baseline monitoring shall be ceased in the events of any emergency discharges.

4.30 Similarly, the marine water sampling for operation phase monitoring shall coincide with the effluent sampling for operation phase monitoring, and be performed monthly over the first year of Project operation to give adequate coverage of different tidal states during both wet and dry seasons. The operation phase monitoring shall be ceased in the events of any emergency discharges. The Environmental Consultant shall conduct a review on the monitoring frequency of the marine water quality tests after the first year of operation of the Project. The review results shall be submitted to DSD and EPD. Termination or any amendment to the monitoring programme shall be agreed by DSD and EPD.

Monitoring Equipment

Sampler

4.31 A water sampler is required. It shall comprise a transparent PVC cylinder, with a capacity of not less than 2 litres, which can be effectively sealed with latex cups at both ends. The sampler shall have a positive latching system to keep it open and prevent premature closure until released by a messenger when the sampler is at the selected water depth (for example, Kahlsico Water Sampler or an approved similar instrument).

Water Depth Detector

- 4.32 A portable, battery-operated echo sounder shall be used for the determination of water depth at each designated monitoring station. This unit can either be hand held or affixed to the bottom of the work boat, if the same vessel is to be used throughout the monitoring programme.

Monitoring Position Equipment

- 4.33 A hand-held or boat-fixed type digital Differential Global Positioning System (DGPS) with way point bearing indication or other equipment instrument of similar accuracy, shall be provided and used during marine water monitoring to ensure the monitoring vessel is at the correct location before taking measurements.

Monitoring Parameters

- 4.34 The TRC and CBP concentrations in the marine water shall be determined by laboratory. The list of parameters to be analyzed as well as the corresponding analysis method and detection limit are same to those presented for effluent monitoring as specified in Table 4.4.

Sample Containers and Storage

- 4.35 Marine water samples collected for chemical analysis shall be stored and preserved in suitable and clean containers according to the Standard Methods, and packed in ice (cooled to 4°C without being frozen) and delivered to the laboratory and analysed within 24 hours after collection.

Laboratory Measurement / Analysis

- 4.36 The requirements for laboratory measurement and analysis of collected marine water samples are the same to those presented for effluent monitoring.

Statistical Analysis of Monitoring Data

- 4.37 After the data of the first set of baseline marine water quality monitoring has been obtained, a statistical power analysis shall be conducted to verify and review the number of replicates required for subsequent baseline and operation phase monitoring sessions.
- 4.38 The monitoring data (TRC and CBP concentrations in marine water) should be analyzed using analysis of variance techniques to test for differences between sampling locations. Once a time series of data (sequential sampling events) has been gathered, difference should be tested between the stations and between the different sampling events to examine any temporal trends in TRC/CBP concentrations in marine water. The statistical analysis of monitoring data would provide information to identify any difference of TRC/CBP concentration in marine water in spatial and temporal terms.
- 4.39 The main objective of the proposed monitoring programme is to check whether the Project would cause an increase in TRC and CBP concentrations in marine water. Therefore, once the operation phase monitoring programme for the year is completed, the operation phase monitoring data obtained for the year should be compared with the baseline monitoring data using statistical analysis technique to determine whether there is increase of TRC/CBP concentrations in marine water after implementation of the Project. Should the statistical analysis reveal that TRC/CBP concentrations in marine water increase after implementation of the Project, the monitoring data collected in effluent quality monitoring shall be used to provide information to investigate whether such increase is due to the effluent discharged by the Project.

Review of *E.coli* Concentrations in Marine Water and Effluent

- 4.40 The Environmental Consultant shall review and analyze the *E. coli* concentration collected in the following monitoring works during the one year before the commissioning of the Project and the first

year of Project operation:

- Water quality monitoring at beaches along Tsuen Wan coast conducted by EPD
- Monthly water quality monitoring at EPD marine water quality stations WM2, WM3, WM4, VM7 and VM8 conducted by EPD
- SCISTW effluent quality monitoring conducted by DSD

4.41 Based on the review and analysis of the monitoring data, the Environmental Consultant shall review the effectiveness of the Project for improving the water quality (in terms of *E. coli* level) of the beaches along the Tsuen Wan coast and the western harbour. Also, the Environmental Consultant shall provide recommendation on the review of SCISTW effluent standard (in terms of *E. coli* level).

Emergency Discharge of Undisinfected Effluent

Monitoring Locations and Schedule

4.42 It is recommended to set up 17 monitoring stations as shown in **Figure 4.2**. The stations (B7 to B14, WSD18 to WSD20 and F5) represent the sensitive receivers which could potentially be affected by the undisinfected effluent from the SCISTW. The gradient stations, WM4, VM8 and VM7, are proposed to assist in the identification of the source of any impact at the sensitive receivers. Stations SM6 and SM12 are located outside the influence zone of the undisinfected effluent as predicted by the water quality modelling and would unlikely be affected by the Project and will therefore serve as control stations.

4.43 The coordinates of the proposed monitoring stations are listed in **Table 4.6**.

Table 4.6 Proposed Marine Water Quality Monitoring Stations for Emergency Discharge

Station	Description	Easting	Northing
B7	Anglers' Beach	823836.36	825044.52
B8	Gemini Beach	825215.29	824933.71
B9	Ho Mei Wan Beach	825388.98	825067.17
B10	Casam Beach	825731.46	825330.90
B11	Lido Beach	825917.78	825385.83
B12	Ting Kau Beach	826277.40	825519.01
B13	Approach Beach	827237.94	825301.02
B14	Ma Wan Beach	824431.47	823415.85
F5	Ma Wan Fish Culture Zone	823875.25	823699.48
WSD18	Central Water Front	833935.18	816624.15
WSD19	Sheung Wan	833383.13	816836.34
WSD20	Kennedy Town	830826.34	816244.46
WM4	Gradient Station	825366.76	823461.98
VM8	Gradient Station	830363.95	817092.23
VM7	Gradient Station	832513.90	817465.40
SM6	Control Station	826179.81	805902.89
SM12	Control Station	819524.19	808420.40

4.44 A six-month baseline monitoring programme covering both dry and wet seasons is proposed at a frequency of once per month to establish the baseline water quality conditions at the 17 stations after

commissioning of the Project. During each monitoring event, water samples shall be collected at different tidal status (one for mid-flood tide and one for mid-ebb tide). The baseline water quality data shall be reviewed together with the routine marine water quality data collected by EPD at the Victoria Harbour to establish the baseline water quality conditions. The purpose of the baseline monitoring is to establish ambient conditions when the Project is operated normally. The baseline monitoring shall be ceased in the events of any emergency discharges.

- 4.45 During each sampling occasion, measurements shall be taken at three water depths, namely, 1 m below water surface, mid-depth and 1 m above sea bed, except where the water depth is less than 6 m, in which case the mid-depth station may be omitted. Shall the water depth be less than 3 m, only the mid-depth station will be monitored.
- 4.46 During the operation phase of the Project, in the event of emergency discharge of treated but undisinfecting effluent when the chlorination plant is closed down, daily marine water monitoring shall be conducted at the 17 monitoring stations throughout the whole emergency discharge period until the baseline water quality resumes after the normal plant operation is restored. During each monitoring event, water samples shall be collected at both mid-flood tide and mid-ebb tide (i.e. twice a day).
- 4.47 The monitoring programme for such emergency discharge event shall be conducted in the first 2 years after the completion of the baseline monitoring. After the 2-year monitoring period, a review shall be conducted by the Environmental Consultant to determine whether such monitoring shall be continued. The review results shall be submitted to DSD and EPD. Termination or any amendment to the monitoring programme shall be agreed by DSD and EPD.
- 4.48 The status and locations of water sensitive receivers and the marine activities may change after issuing this Manual. Necessary change in the monitoring locations shall be reviewed and approved by EPD, before the commencement of the monitoring. It is recommended that DSD should monitor the quality (i.e. *E.coli* level, pH value, temperature) and quantity of sewage effluent discharged from the SCISTW during the marine water sampling for data interpretation.
- 4.49 It is recommended that relevant government departments including EPD, WSD and LCSD shall be informed of any emergency discharge events. The Plant operators shall make reference to the response approach documented in the Beach Pollution Response Plan maintained by EPD and maintain good communications with various concerned parties. A list of address, email address, phone and fax number of key persons in various departments responsible for action shall be made available to the Plant operators. A framework of the emergency response for emergency discharge events is provided in **Table 4.8**.

Water Quality Parameters

- 4.50 The *E.coli* levels shall be monitored and determined by laboratory.

Site Record

- 4.51 Other relevant data shall also be recorded, including monitoring location / position, time, water depth, pH value, salinity, temperature, turbidity, dissolved oxygen, tidal stages, weather conditions and any special phenomena or work underway nearby which may induce water quality impact on the sensitive receivers. A sample data record sheet based on the one presented in the *EM&A Guidelines for Development Projects in Hong Kong*, is shown in **Appendix B**. The Monitoring Team Leader may modify the data record sheet for this EM&A programme, the format of which should be approved by the Environmental Consultant.

Monitoring Equipment

Dissolved Oxygen and Temperature Measuring Equipment

- 4.52 The instrument shall be a portable and weatherproof DO measuring instrument complete with cable and sensor, and use a DC power source. The equipment shall be capable of measuring:
- a DO level in the range of 0 - 20 mg L⁻¹ and 0 - 200% saturation; and
 - a temperature of 0 - 45 degree Celsius.
- 4.53 It shall have a membrane electrode with automatic temperature compensation complete with a cable. Sufficient stocks of spare electrodes and cables shall be available for replacement where necessary. (For example, YSI model 59 meter, YSI 5739 probe, YSI 5795A submersible stirrer with reel and cable or an approved similar instrument).
- 4.54 Shall salinity compensation not be built-in to the DO equipment, *in-situ* salinity shall be measured to calibrate the DO equipment prior to each DO measurement.

Turbidity Measurement Instrument

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

Sampler

- 4.56 A water sampler is required. It shall comprise a transparent PVC cylinder, with a capacity of not less than 2 litres, which can be effectively sealed with latex cups at both ends. The sampler shall have a positive latching system to keep it open and prevent premature closure until released by a messenger when the sampler is at the selected water depth (for example, Kahlsico Water Sampler or an approved similar instrument).

Water Depth Detector

- 4.57 A portable, battery-operated echo sounder shall be used for the determination of water depth at each designated monitoring station. This unit can either be hand held or affixed to the bottom of the work boat, if the same vessel is to be used throughout the monitoring programme.

Salinity

- 4.58 A portable salinometer capable of measuring salinity in the range of 0 - 40 parts per thousand (ppt) shall be provided for measuring salinity of the water at each monitoring location.

pH

- 4.59 The instrument shall consist of a potentiometer, a glass electrode, a reference electrode and a temperature-compensating device. It shall be readable to 0.1pH in a range of 0 to 14. Standard buffer solutions of at least pH 7 and pH 10 shall be used for calibration of the instrument before and after use. Details of the method shall comply with APHA, 19th ed. 4500-HTB.

Monitoring Position Equipment

- 4.60 A hand-held or boat-fixed type digital Differential Global Positioning System (DGPS) with way point bearing indication or other equipment instrument of similar accuracy, shall be provided and used during marine water monitoring to ensure the monitoring vessel is at the correct location before taking measurements.

Calibration of *In-Situ* Instruments

- 4.61 All *in situ* monitoring instruments shall be checked, calibrated and certified by a laboratory accredited under HOKLAS or any other international accreditation scheme before use and subsequently re-calibrated at three monthly intervals throughout all stages of the water quality monitoring programme. Responses of sensors and electrodes shall be checked with certified standard solutions before each use. Wet bulb calibration for a DO meter shall be carried out before measurement.
- 4.62 Sufficient stocks of spare parts shall be maintained for replacements when necessary. Backup monitoring equipment shall also be made available so that monitoring can proceed uninterrupted even when some equipment is under maintenance, calibration, etc.

Sample Containers and Storage

- 4.63 Water samples shall be stored and preserved in suitable containers according to the Standard Methods, APHA, and packed in ice (cooled to 4°C without being frozen) and delivered to the laboratory and analysed within 24 hours after collection. Sufficient volume of samples shall be collected to achieve the required detection limit.

Laboratory Measurement / Analysis

- 4.64 Analysis of *E.coli* levels shall be carried out in a HOKLAS or other international accredited laboratory. The analysis shall commence within 24 hours after collection of the water samples. The laboratory shall be HOKLAS accredited for analysis of *E.coli* in marine water. Detailed testing methods, pre-treatment procedures, instrument to be used, Quality Assurance/Quality Control (QA/QC) details (such as blank, spike recovery, number of duplicate samples per batch, etc.), detection limits and accuracy shall be submitted to the Environmental Consultant for approval prior to the commencement of monitoring programme. Remaining samples after analysis shall be kept by the laboratory for 3 months in case repeat analysis is required. If in-house or non-standard methods are proposed, details of the method verification shall be required to submit to the Environmental Consultant. In any circumstance, the sample testing shall have comprehensive quality assurance and quality control programmes. The laboratory shall demonstrate the programmes to the Environmental Consultant or his representatives when requested.

Table 4.7 Analytical Methods to be applied to Marine Water Quality Samples

Determinant	Suggested Method	Suggested Detection Limit
<i>E.coli</i>	EPD HKSAR, Wat. Sci. Tech. Vol. 35, No. 11-12 pp 409-413	1 cfu per100mL

Emergency Response

Emergency Response Plan due to System Failure

- 4.65 The Plant operator / DSD shall inform EPD, WSD and LCSD in case of any emergency discharge of undisinfected effluent due to power supply failure, system failure or equipment failure in SCISTW. A list of address, email address, phone and fax number of key persons of concerned parties responsible for action should be made available to the Plant operators. The Plant operator / DSD shall be responsible for carrying out marine water quality monitoring within 24 hours when the discharge event occurs. The Plant operator / DSD shall closely liaise with relevant parties so that the EPD, WSD and LCSD can be informed promptly of any cases of emergency discharge. The event and action plan under emergency discharge of treated but undisinfected effluent are provided in **Table 4.8**.
- 4.66 Under emergency discharge, it is recommended that DSD should monitor daily quality (i.e. *E.coli* level, pH value, temperature) and quantity of sewage effluent discharged from the SCISTW during the whole water quality monitoring period for data interpretation.

Table 4.8 Emergency Response Plan for System Failure

Event	Action Plan
Chlorination plant failure	<ol style="list-style-type: none"> 1. Stop the dechlorination plant operation 15 minutes after the chlorination plant failure. 2. If emergency discharge is required, Plant operators / DSD to inform EPD, WSD and LCSD within 1 hour after the discharge commence. 3. Plant operators / DSD to investigate the reason of chlorination plant failure and to implement appropriate remedial measures as stipulated in the contingency / operation plan for the ADF. 4. EPD / LCSD to review and take necessary actions to prevent any bathing and water sports activities at the beaches and secondary contact recreation subzones. 5. Plant operators / DSD to instruct the Monitoring Team to commence water monitoring within 24 hours after the emergency discharge event occurs. 6. Plant operators / DSD to record the effluent flow and effluent quality (i.e. <i>E.coli</i> level, pH value and temperature) during the water monitoring period. 7. Plant operators / DSD to implement appropriate remedial measures as stipulated in the contingency / operation plan and resume disinfection operation. 8. Monitoring Team to conduct daily marine water monitoring (as discussed in Section 4.46) until the baseline water quality levels are restored or 3 days after the emergency discharge is ceased, whichever is the shortest. 9. The Environmental Consultant shall compare the impact monitoring data with the baseline data to identify the degree of impact caused by the emergency discharge (if any) and to determine when the normal water quality conditions are restored. The findings shall be provided to EPD and LCSD.
Dechlorination plant failure	<ol style="list-style-type: none"> 1. Stop the chlorination plant operation immediately. 2. Plant operator / DSD to inform the EPD, WSD and LCSD of the emergency discharge within 1 hour after the chlorination plant operation is stopped. 3. Plant operators / DSD to investigate the reason of dechlorination plant failure and to implement appropriate remedial measures as stipulated in the contingency / operation plan for the ADF. 4. EPD / LCSD to review and to take necessary actions to prevent any bathing and water sports activities at the beaches and secondary contact zones. 5. Plant operators / DSD to instruct the Monitoring Team to commence water monitoring within 24 hours after the emergency discharge event occurs. 6. Plant operators / DSD to record the effluent flow and effluent quality (i.e. <i>E.coli</i> level, pH value, and temperature) recorded during the water monitoring period. 7. Plant operators / DSD to implement appropriate remedial measures as stipulated in the contingency / operation plan and resume disinfection operation. 8. Monitoring Team to conduct daily marine water monitoring (as discussed in Section 4.46) until the baseline water quality levels are restored or 3 days after the emergency discharge is ceased, whichever is the shortest. 9. The Environmental Consultant shall compare the impact monitoring data with the baseline data to identify the degree of impact caused by the emergency discharge (if any) and to determine when the normal water quality conditions are restored. The findings shall be provided to EPD and LCSD.

4.67 The impact monitoring data shall be compared with the baseline data and relevant water quality objectives to identify the degree of impact caused by the emergency discharge. For each emergency discharge event, a *Water Quality Monitoring Report* shall be submitted by the Environmental Consultant to EPD within 10 days after the laboratory testing result for the last sample collected during the monitoring period is available. The findings of the water quality monitoring results including data presentation, statistical analysis, discussion, conclusion and recommendation shall be provided in the *Water Quality Monitoring Report*. The detailed reporting requirements shall be agreed with DSD and EPD.

Emergency Response Plan due to Deviation of Monitoring Results from the Predictions in respect of Water Quality and Marine Ecological Risk

4.68 In case the monitoring results for TRC or any of the CBPs listed in Table 4.3 are found to have exceeded the predictions, the Plant operator / DSD shall carry out investigation following the procedures as presented in **Table 4.9** and shall inform EPD if exceedance persists.

Table 4.9 Emergency Response Plan for exceedance of TRC or CBP discharge limits

Event	Action Plan
Effluent monitoring result of TRC or any of the CBPs listed in Table 4.3 found to have exceeded the discharge limits	<ol style="list-style-type: none"> 1. Check equipment, measurements and analyses. 2. Conduct further sampling and testing on the influent and effluent before and after chlorination / dechlorination. 3. Review operation process and check for any abnormalities in the dosing and mixing systems and rectify any defects found. 4. Conduct further sampling and testing. 5. Adjust chemical dosages to reduce TRC and CBPs levels in the effluent to levels within the discharge limits. 6. Review disinfection design for improvement.
Marine water monitoring result of TRC at edge of ZID found to have exceeded 0.013 mg/L or TRC at edge of mixing zone found to have exceeded 0.008 mg/L	<ol style="list-style-type: none"> 1. Check equipment, measurements and analyses. 2. Check the TRC level in effluent and at other marine water monitoring stations and investigate the reason of the exceedance. 3. If the effluent discharged from SCISTW is found to be the source of the exceedance, conduct further sampling and testing on the influent and effluent before and after chlorination / dechlorination. 4. Review operation process and check for any abnormalities in the dosing and mixing systems and rectify any defects found. 5. Conduct further sampling and testing. 6. Adjust chemical dosages to reduce TRC levels in the effluent. 7. Review disinfection design for improvement.

4.69 In case exceedance is found in the Whole Effluent Toxicity Test results, the Plant operator / DSD shall carry out investigation following the procedures as presented in Section 6.24.

Construction Phase Monitoring

Construction Site Audits

4.70 Regular site audits shall be conducted to confirm that the recommended mitigation measures are properly undertaken during construction phase of the Project. It can also provide an effective control of any malpractices and therefore achieve continual improvement of environmental performance on site.

4.71 Site audits shall include site inspections and compliance audits.

Site Inspections

4.72 Site inspections shall be carried out by the ET on the mitigation measures recommended for water pollution control in the implementation schedule as attached in **Appendix A**. In the event that the recommended mitigation measures are not fully or properly implemented, deficiency shall be recorded and reported to the ER and IEC. Suitable follow up actions are to be carried out to:

- Record the problems and investigate the causes;
- Issue action notes to the Contractor who is responsible for the works;
- Implement remedial and corrective actions immediately;

- Re-inspect the site conditions upon completion of the remedial and corrective actions; and
- Record the event and discuss with the Contractor for preventive actions.

Compliance Audits

- 4.73 Compliance audits are to be undertaken by ET in accordance with the discharge license issued by EPD prior to the discharge of effluent from the Project site. Monitoring of the treated effluent quality from the Works Areas is required during the construction phase of the Project, and should be carried out in accordance with the WPCO license which is under the ambit of regional office (RO) of EPD. In case of non-compliance, suitable actions by the relevant parties should be undertaken to:
- Notify the ER and IEC of the non-compliance;
 - Identify the sources of pollution;
 - Check the implementation status of the recommended mitigation measures;
 - Investigate the operating conditions of the on-site treatment systems;
 - Implement corrective and remedial actions to improve the effluent quality;
 - Increase monitoring frequency until the effluent quality is in compliance with the discharge licence requirements; and
 - Record the non-compliance and propose preventive measures.

Mitigation Measures

- 4.74 Mitigation measures for water quality control have been recommended in the EIA Report and are listed in the implementation schedule given in **Appendix A**.