5. HUMAN HEALTH RISK

Introduction

5.1 The Human Health Risk Assessment (HHRA) in the EIA Report, which focused on assessing the potential risks/impacts to human health due to chronic exposure to the contaminants produced in the disinfection process (i.e. disinfectant residual and Contaminants of Concern (COCs)) in the SCISTW effluent discharge, predicted that the potential total residual chlorine (TRC) and COCs present in the chlorinated/dechlorinated SCISTW CEPT effluent discharge would not induce unacceptable risk/impact to human health.

5.2 In addition to the monitoring programme for TRC and the nine CBPs specified in **Section 4**, a monitoring programme for the concentration of other COCs in SCISTW effluent and marine water is also recommended and detailed in this section. Together with the data obtained from the monitoring programme specified in **Section 4**, the full set of monitoring programme aims to achieve the following objectives:

- To check whether the Project would cause an increase in TRC and COC concentrations in marine water
- To verify the predictions of the HHRA; and
- To verify the predictions of the Ecological Risk Assessment

Scope

5.3 Although the HHRA conducted for the EIA Study has covered the potential human health impact due to TRC and COCs discharged during ADF Stage, Stage 2A and Stage 2B of the HATS operation as well as the cumulative risk impact due to other pollutants present in the HATS effluent, the scope of this monitoring programme for the Project shall be limited to the TRC and COCs. The proposed monitoring programme shall be conducted one year before and after the commissioning of the Project for baseline monitoring and operation phase monitoring respectively.

Effluent COCs Monitoring for verification of risk prediction

5.4 **Table 5.1** presents the list of COCs (other than those covered in Section 4) to be analyzed in the effluent monitoring, the corresponding analysis method as well as detection limit. HOKLAS accredited analysis methods can also be used for the contaminant concentration determination. The requirement, methodology, equipment and sampling location as well as the statistical analysis of monitoring data shall follow those specified for CBPs in **Section 4** of the EM&A Manual.

Table 5.1 Analytical Methods for COCs Monitoring

Determinant	Suggested Method	Suggested Detection Limit (µg/L)
Methylene chloride	USEPA 8260 (Purge and Trap GCMS)	20
Carbon tetrachloride		0.5
Chlorobenzene		0.5
1,1-dichloroethane		0.5
1,2-dichloroethane		0.5
1,1-dichloroethylene		0.5
1,2-dichloropropane		0.5
Tetrachloroethylene		0.5
1,1,1-trichloroethane		0.5
1,1,2-trichloroethane		0.5
Trichloroethylene		0.5
2-chlorophenol	USEPA 8270/GCMS	0.5
2,4-dichlorophenol		0.5
p-chloro-m-cresol		0.5
Pentachlorophenol		0.5*
2,4,6-trichlorophenol		0.5

Determinant	Suggested Method	Suggested Detection Limit (µg/L)
Bis(2-chloroethoxy)methane		0.5
1,4-dichlorobenzene		0.5
Hexachlorobenzene	USEPA 8270/GCMS	0.01*
Hexachlorocyclopentadiene		2.5
Hexachloroethane		0.5
1,2,4-trichlorobenzene		0.5
Alpha-BHC		0.01*
Beta-BHC		0.01*
Gamma-BHC		0.01*

* 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.

5.5 For baseline monitoring, effluent sampling shall be performed four times over a year before commissioning of the Project to give adequate coverage during both wet and dry seasons. The sampling shall coincide with the baseline effluent sampling for TRC and CBPs detailed in **Section 4** of the EM&A Manual for those four months. The baseline monitoring shall be ceased in the events of any emergency discharges.

5.6 Similarly, for operation phase monitoring on COCs, effluent sampling shall be performed four times 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 sampling shall coincide with the operational phase effluent sampling for TRC and CBPs detailed in **Section 4** of the EM&A Manual for those four months. The operation phase monitoring shall be ceased in the events of any emergency discharges.

Marine water COCs Monitoring for verification of risk prediction

5.7 The list of COC to be analyzed in the marine water COCs monitoring, the corresponding analysis method as well as detection limit are same as those listed for effluent monitoring in Table 5.1. The requirements, methodology, equipment and monitoring locations as well as the statistical analysis of monitoring data have been detailed in **Section 4** of the EM&A Manual.

5.8 For baseline monitoring, marine water sampling shall coincide with the baseline effluent sampling, and be performed four times 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.

5.9 Similarly, the marine water sampling for operation phase monitoring on COCs 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 and the monitoring programme after the first year of operation of the Project will be subject to the first year review.

Human Health Risk Assessment

5.10 If statistical analysis of baseline and operation phase monitoring data reveals that marine water concentration of TRC and/or COCs (one or more) increases after operation 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. If such increase is found to be due to the Project operation, HHRA using the operation phase monitoring data should be conducted to verify if the human health risk due to TRC and COCs discharged from SCISTW effluent is acceptable.

5.11 The HHRA shall follow the approach and methodology adopted in the EIA Study which has been presented in **Appendix 6.1** of the EIA Report. The HHRA will consist of the following 5 stages:

- Problem Formulation
- Hazard Identification
- Exposure Assessment
- Dose-response Assessment
- Risk/hazard Characterization

5.12 Apart from the chemical analysis data obtained from the monitoring programme, the following data are needed in the HHRA:

- Human receptor parameter values including seafood consumption rate and frequency
- Parameters related to COCs including bioconcentration factor, food chain multiplier and dermal exposure related parameters
- Health benchmarks (i.e. cancer slope factor and reference dose) of COCs

5.13 The above data items used in the EIA Study should be reviewed and updated by the Environmental Consultant (if more up-to-date data is available) when performing the HHRA. Should the HHRA results reveal that there is potential occurrence of unacceptable human health risk, a review of HHRA shall be conducted, which shall involve:

- Identifying major exposure pathway[1] to COCs contributing to the calculated health risk
- Reviewing and using more realistic exposure assumptions related to the identified major exposure pathway to refine the HHRA results
- If potential occurrence of unacceptable human health risk is still found in the refined HHRA, measures to prevent COCs exposure (e.g. restriction of water related activities at location near SCISTW effluent diffuser, restriction of fisheries activities within the ZID of the HATS effluent[2]) shall be considered
- Extension of COCs monitoring programme (in terms of location[3] and duration) may be considered to obtain data for more realistic risk estimation

[1] Note: HHRA conducted in the EIA Study revealed that marine water ingestion and dermal contact during swimming activity would be the major exposure pathways contributing to the estimated health risk.
[2] Restriction of fisheries activities within the ZID of the HATS effluent has been currently exercised.
[3] Bathing beaches and fish cultural zones near the HATS effluent diffuser.