Agreement No. CE29/2002 (EP)

Baseline Monitoring and Performance Verification of Sham Tseng Sewage Outfall - Investigation

Draft Brief

Table of Contents

Appendices

Figures

1. Introduction

This Brief is to be read in conjunction with the Memorandum of Agreement, the General Conditions of Employment for an Investigation Assignment (1997 Edition), the Special Conditions of Employment (if any), the Schedule of Fees and any other detailed instructions issued by the Director's Representative.

2. Description of project

2.1 To improve the water quality of the bathing beaches in the Ting Kau and Sham Tseng area, the 'Ting Kau and Sham Tseng Sewerage Scheme' (The Sewerage Scheme) was recommended under the Tsuen Wan, Kwai Chung and Tsing Yi Sewerage Master Plan Study which was commissioned by the Environmental Protection Department and completed in December 1991. As part of this Sewage Scheme, the new Sham Tseng Sewage Treatment Works has been proposed to treat sewage from the catchment using a chemically enhanced primary treatment process followed by disinfection prior to disposal to the marine water via a submarine outfall.

2.2 The Environmental Impact Assessment (EIA) Study on the Sewerage Scheme, completed in late 1995, confirmed the environmental benefits of this Sewerage Scheme which benefits would include, among others, improvements to water quality at the local bathing beaches. This Environmental Impact Assessment also recommended that environmental monitoring of the outfall performance should be undertaken to ensure compliance with the defined water quality standards.

2.3 As part of the implementation stage of the Sewerage Scheme, the Drainage Services Department initiated an additional study on the outfall alignment in 1997 which recommended a preferred alternative outfall location. The study concluded that the performance of this outfall and impacts arising from the effluent is consistent with the predictions made in the course of the EIA Study for the original design. Construction of the new sewage treatment plant and outfall has commenced with an anticipated commissioning date in late 2003.

2.4 The purpose of this study is to establish the environmental baseline prior to commissioning of the sewage treatment facilities and outfall, to verify the satisfactory performance of the outfall and to confirm the acceptability of the impact of the effluent discharge on the receiving marine environment.

3. Objectives of the Assignment

The objectives of the Assignment are defined as follows:

<u>Pre-commissioning phase</u>

3.1 to identify beneficial uses of the receiving marine waters and any sensitive receivers within the study area that may potentially be impacted by the effluent discharge;

3.2 to specify the monitoring programme to verify the performance of the outfall and to assess the impact of the discharge;

3.3 to characterise baseline environmental and ecological conditions so as to facilitate assessment of compliance with relevant water quality objectives;

3.4 to characterise the hydrodynamic regime and other dominant influences on marine environmental quality in order to establish predictive capability to accurately represent the movement and the dispersion of the sewage plume.

Post-commissioning phase

3.5 to quantitatively assess the flow and load of the effluent;

3.6 to determine the effluent plume dispersion characteristics and other dominant influences on the marine environmental quality in order to accurately predict the impact of the effluent on the receiving waters, including, specifically, its impact on bathing water quality at gazetted beaches in the Tsuen Wan area;

3.7 to monitor the impact of the effluent on the environment and any identified sensitive receivers, distinguishing those impacts arising from other pollution sources and anthropogenic activities, and identifying any improvements attributable to the provisioning of the outfall;

3.8 to assess the impact of the effluent on the receiving water quality in terms of their effect on the attainment of the gazetted Water Quality Objectives;

3.9 to assess the impact of the effluent on bathing water quality at gazetted beaches in the Tsuen Wan area, identifying any improvements arising following the provisioning of the outfall;

3.10 to assess the toxicity of the effluent;

3.11 to evaluate the impact of the effluent and its interaction with the receiving environment on marine ecology, commercial fisheries especially the mariculture activity at Ma Wan fish culture zone and other sensitive receivers and assess risk to human health;

3.12 to assess whether the outfall performance and impacts arising from the effluent are in keeping with the predictions made in the course of the Ting Kau and Sham Tseng Sewerage Scheme – Environmental Impact Assessment Study and other studies associated with the detailed design and decision on positioning of the outfall;

3.13 to draw conclusions as to whether the effluent discharge is causing any significant adverse impact on the receiving environment and, if so, in what respects;

3.14 to make recommendations on the need for, and requirements of, any upgrade or improvements to the sewage treatment facilities and outfall, if necessary, to

ensure acceptability of the impact of the effluent discharge on the receiving environment; and

3.15 to make recommendations on the necessity for, and requirements of, any future monitoring work to give confidence in the continued satisfactory performance of the outfall and acceptability of the discharge.

4. Description of the Assignment

4.1 The Consultants shall formulate and conduct the Assignment in such a way as to ensure that the objectives defined in Clauses 3.1 to 3.15 above are fulfilled. The key tasks to be undertaken in the course of the Assignment can be summarized as follows:

4.1.1 review available information;

4.1.2 establish data requirements and design the monitoring programme;

4.1.3 field surveys, sampling and associated testing to characterise environmental conditions;

4.1.4 effluent plume dispersion and water quality modelling (Clause 6.13 refers);

4.1.5 evaluate the impact of the effluent discharge on the receiving environment.

4.2 The study area shall comprise the geographical area delineated on the attached Figure 1 covering the territorial waters and foreshores between Castle Peak, Lautau Island, the Western Harbour and the southern approaches to the Ma Wan Channel and the Rambler Channel. The study area shall include marine and inshore waters within the North Western, Western Buffer and Southern Water Control Zones. An assessment shall also be made of the severity of impact in any adjacent waters likely to be impacted by the effluent discharge.

4.3 The Assignment shall take into account the findings of previous studies of relevance and also the results from any other relevant monitoring programmes (Appendix A refers). The study shall principally comprise assessment of the following elements:

4.3.1 beneficial uses of the receiving waters and sensitive receivers within the study area that may potentially be affected by the effluent discharge and other water pollution sources in the study area;

4.3.2 baseline conditions prior to commissioning of the outfall;

4.3.3 physical condition and operational performance of the outfall diffuser systems in terms of achieving design criteria;

4.3.4 dispersion characteristics of the effluent plume in the near and far field

so as to establish its zone of influence i.e. the geographically defined volume of water beyond which the influence of the effluent discharge on ambient conditions is undetectable. Determination of the zone of influence shall be based on a list of parameters to be proposed by the Consultants and agreed by the Director's Representative and shall include substances of interest such as Biochemical Oxygen Demand (and its interaction with dissolved oxygen), suspended solids, nutrients, *E.coli* and trace contaminants of concern;

4.3.5 extent of and influence on size of the mixing zone within which the gazetted Water Quality Objectives are not achieved as a direct result of the sewage discharge;

4.3.6 impact of the effluent discharge on the receiving water quality and compliance with the gazetted Water Quality Objectives;

4.3.7 impact of the effluent discharge on bathing water quality;

4.3.8 impact of the effluent discharge on the sediment quality within the receiving marine waters;

4.3.9 risk to human health associated with adverse impact on sensitive receivers within the study area arising from the effluent discharge;

4.3.10 ecotoxicological effect of the effluent;

4.3.11 likely effects of the effluent discharge on marine ecology including benthos and the Chinese White Dolphin, *Sousa chinensis* as well as commercial fisheries including the mariculture activity at Ma Wan fish culture zone; and

4.3.12 impact on sensitive receivers other than those specifically covered above.

4.4 The Consultants shall carry out any necessary investigations including field surveys to identify sensitive receivers and water pollution sources and determine the pre-commissioning baseline conditions, the hydrodynamic regime and other dominant influences on marine environmental quality and ecology.

4.5 The Consultants shall assess the performance of the outfall and the impact of the effluent discharge on the marine environment. This assessment shall be based on field monitoring of the marine environment which may potentially be affected by the effluent. Field data collection shall be carried out over a period of one year prior to commissioning of the outfall in order to determine a baseline. Field monitoring shall be carried out in the first year of the post-commissioning period. Field investigations shall be carefully structured in terms of sampling, methodology and statistical analytical techniques to ensure robust statistically valid conclusions can be drawn on the impact of the effluent discharge on the receiving environment. The sampling design to be devised

shall incorporate adequate and cost-effective replication to give sufficient statistical power to detect the impact of the effluent discharge on the receiving environment having regard for the effects of spatial and temporal variation and other potentially confounding factors.

4.6 The field survey and monitoring requirements shall be proposed by the Consultants and agreed with the Director's Representative in such a way as to ensure that the study objectives defined in Clauses 3.1 to 3.15 are fully satisfied. The monitoring programme shall at least comprise the following components:

4.6.1 effluent quality monitoring;

4.6.2 water quality monitoring;

4.6.3 sediment quality monitoring;

4.6.4 benthic survey;

4.6.5 ecotoxicological assessment.

An indicative brief outline of the basic requirements of the above is suggested in Clause 6.6 for the consideration of the Consultants.

4.7 The existence of any pollution gradients away from the points of discharge shall be established for parameters and trace contaminants of concern pertaining to water quality and sediment quality.

4.8 The monitoring programme shall maintain a degree of flexibility to allow the incorporation of the findings based on the monitoring results obtained as the study progress. Therefore, the location and number of monitoring stations, number of samples and replicates, and types of tests and analyses will be subject to continual review by the Consultants and amendment as necessary. Accordingly, upon direction from the Director's Representative, resources for the monitoring programme may be redeployed, reduced or increased within the study area.

4.9 The Consultants shall assess the potential impacts of the effluent discharge on marine ecology including benthos and commercial fisheries based on the water quality, sediment quality, benthic survey and ecotoxicological assessment in Clause 4.6 above and assessment of the available data in respect of the water and sediment quality.

4.10 The Consultants shall take account of, and distinguish, the impacts arising as a consequence of the discharge from the outfall, as distinct from those arising from other pollution sources and anthropogenic activities.

5. Deliverables

5.1 General

5.1.1 All reports and manuals containing analytical results shall include relevant QC data to facilitate interpretation of results. Field notes, raw data including bench sheets, log book entries with calculation, chain of custody forms and QC data, leading to the final results shall be made available for examination upon the request of the Director's Representative.

5.1.2 The Consultants shall submit to the Director's Representative papers, reports, manuals and information both in hard copies and in agreed format on magnetic media in accordance with the requirements of Clauses 5.2 to 5.14 below. The final version of all reports and manuals shall be signed by the Project Director responsible for implementation of the Assignment.

5.2 Inception Report

5.2.1 The Consultants shall submit to the Director's Representative a draft Inception Report for the study within 4 weeks of commencement of the Assignment. Comments will be conveyed to the Consultants within 3 weeks from receipt of the draft report. Responses to these comments shall be submitted by the Consultants within 10 days from the date of receipt of comments. The Consultants shall submit the final version of the report, which shall basically be a fair reproduction of the draft report with amendments as required upon consultation and discussion of the draft report, within 2 weeks of satisfactorily resolving all comments from the Director's Representative.

5.2.2 The draft and final version of the report shall set out the hypotheses of potential impacts to be assessed through the monitoring study, the basis for, and description of the approach underlying the proposed monitoring programme and in particular how the Consultants propose to address each study objective (Clauses 3.1 to 3.15 refer). The report shall identify the data requirements, the data available, the data gaps, the rationale for filling the data gaps and the data quality objectives.

5.2.3 The report shall include:

5.2.3.1 discussion of the key features of the receiving environment and ecosystem and identify beneficial uses of the receiving waters and sensitive receivers within the study area which may potentially be affected by the effluent discharge;

5.2.3.2 the basis for the environmental assessment and monitoring, including an outline of the proposed Assignment scope, approach and methodology having regard for the available Assignment budget;

5.2.3.3 a timetable showing the proposed work programme, key decision points and meeting dates, the date of submission of deliverables; and

5.2.3.4 the organization of the study team and details of the roles and time input of key staff members.

5.3 Monitoring and Audit Manual

5.3.1 The Consultants shall submit to the Director's Representative a draft Monitoring and Audit Manual within 7 weeks of commencement of the Assignment. Comments will be conveyed to the Consultants within 3 weeks from receipt of the draft Manual. Responses to these comments shall be submitted by the Consultants within 2 weeks from the date of receipt of comments. The Consultants shall submit the revised version of the Manual, which shall basically be a fair reproduction of the initial draft with amendments as required upon consultation and discussion of the draft Manual, within 2 weeks of satisfactorily resolving all comments from the Director's Representative.

5.3.2 The Consultants shall further revise the Manual, at times required, upon direction from the Director's Representative, to take into account the findings obtained during the progress of the Assignment and decisions taken at meetings of the Project Steering Group and any other meetings (Clauses 14.1 and 14.2 refer).

5.3.3 The Manual shall define the monitoring programme and the details of its constituent elements including the rationale on which the data will be evaluated and interpreted. The Manual shall include a detailed description of the statistical procedures that will be used to interpret the data. Details of the database to be developed by the Consultants in accordance with the requirements of Clause 5.12 shall also be included in the Manual.

5.3.4 All versions of the Manual shall include appropriate and detailed Standard Operation Procedures (SOPs) for each aspect of sample collection, storage, transportation and analysis. These SOPs should also state the length of time from sample collection to availability of results for each aspect of the monitoring. It shall also include full details of quality assurance and quality control programmes including the procedures to be fulfilled to demonstrate the reliability of field sampling, sample handling and laboratory analysis that will ensure the data collected meet the required standards of quality and time. The Manual shall specify the criteria (e.g. accuracy and precision) to which laboratory analytical data will conform.

5.3.5 The Manual shall include an estimated cost breakdown for any works items to be procured within the programme (Clause 6.10 refers).

5.4 Tender Documents

5.4.1 The Consultants shall submit to the Director’s Representative draft tender documents for the field works and laboratory tests described in

Clause 6.10.3, which are to be conducted by Contractors/Laboratories, within 4 weeks of commencement of the Assignment. Comments will be conveyed to the Consultants within 10 days from receipt of the draft report. The final tender documents, which shall basically be a fair reproduction of the draft report with amendments, shall be submitted within 7 days.

5.4.2 The draft and final tender documents will generally include the following:

(i) General Conditions of Tender;
(ii) Special Conditions of Tender;
(iii) Form of Tender;
(iv) Schedule of Proportions for calculating the Price Fluctuation Factor;
(v) General Conditions of Contract;
(vi) Special Conditions of Contract;
(vii) General Specification;
(viii) Particular Specification;
(ix) Bills of Quantities;
(x) Standard Method of Measurement; and
(xi) Drawings.

5.5 Contract Documents

5.5.1 The Consultants shall submit to the Director's Representative the contract documents within 3 months of commencement of the Assignment.

5.5.2 The Contract Documents will include the documents listed in Clause 5.4.2, the letter of acceptance of the tender and the Articles of Agreement.

5.6 Working Papers

5.6.1 The Consultants shall prepare and submit a Working Paper describing the proposed approach and methodology for Water Quality and Plume Dispersion Modelling not later than 1 month after approval of the Inception Report.

5.6.2 The Consultants shall submit a Working Paper reporting on the modelling results with full explanation for the findings within 1 month upon completion of the model simulation runs described in Clause 6.13.3.

5.6.3 The Consultants shall prepare two Working Papers, 7 months after the start of the baseline monitoring and 7 months after the start of the post-commissioning monitoring respectively. These reports shall include the results of the monitoring and preliminary assessment of the findings of the first 6 months of baseline monitoring and the first 6 months of

performance verification monitoring. They should include a quality assurance and control audit report. The reports will highlight any deviations from the work programme and also any deficiencies identified within the work programme or procedures set down in the Monitoring and Audit Manual and will also make recommendations as to, inter alia, modifications to the monitoring programme.

5.7 Progress Reports

5.7.1 The Consultants shall submit to the Director's Representative, within 10 days from the end of every quarterly monitoring period, progress reports in a format agreed by the Director's Representative on all aspects of the Services relating to progress of the Programme referred to Clause 8 of this Brief. The reports shall include a list of those parts of the Services the execution of which is behind the Programme together with proposals to expedite progress, so as to complete the work on time. The reports shall also include updated expenditure forecasts in accordance with Clause 10 of this Brief.

5.7.2 To achieve these objectives, the reports shall contain the following tabulated information:

(i) a list of activities including sampling, tests, analyses and assessments performed in the reporting period according to that detailed in the Monitoring and Audit Manual;

(ii) a list of outstanding activities as well as the schedule for completing these outstanding items; and

(iii) a list of previously outstanding activities that have been completed in the reporting period.

5.8 Draft Final Report

The Consultants shall prepare a Draft Final Report within two months of completion of the field survey programme incorporating all findings and recommendations from the study. The report shall include a clear statement on the acceptability of the impact of the effluent discharge on the receiving environment with specific reference to the impact hypotheses tested and recommendations on the need for and timing of any necessary improvements to the treatment and disposal facilities. The report shall also contain recommendations on the requirements of future monitoring programmes to give confidence in the continued acceptability of the effluent discharge into the receiving environment. The report shall provide a full analysis and audit of the information and data obtained in the course of the Assignment and specifically address how each of the Assignment objectives detailed in Clauses 3.1 to 3.15 has been met and include as an appendix a fully revised version of the Monitoring and Audit Manual if there are subsequent amendments made to the initial version. This report shall be circulated for comment to concerned Government departments by the Director's Representative.

5.9 Final Report

The Consultants shall submit to the Director's Representative the Final Report on the Assignment within three weeks from the receipt of comments from Director's Representative on the Draft Final Report amended as required following consultation and circulation of the Draft Final Report and taking account of comments received from the Director's Representative and the decisions of the Project Steering Group. The Final Report shall include a summary of comments received from the Director's Representative, Government offices concerned and other parties as a result of consultation and circulation of the Draft Final Report and the appropriate response from the Consultants to all comments. The report shall include recommendations for further action considered to be necessary, or at least beneficial, to facilitate the implementation of any of the Consultants' proposals.

5.10 Executive Summary

5.10.1 The Consultants shall submit to the Director's Representative, at the same time as the Final Report, a Draft Executive Summary, in English, outlining the scope, issues of concern and major findings of the Assignment.

5.10.2 The Consultants shall submit to the Director's Representative the Final Executive Summary, in both English and Chinese, within three weeks of receipt of comments from the Director's Representative on the Draft Executive Summary. The Final Executive Summary shall comprise a fair reproduction of the Draft Executive Summary amended as required following consultation and circulation of the Draft Executive Summary and taking account of comments received from the Director's Representative and the decisions of the Project Steering Group.

5.11 Presentation of the Findings of the Assignment

5.11.1 The Consultants shall prepare on behalf of the Director's Representative a paper for consideration by the Advisory Council on the Environment (ACE) that summarises the findings and recommendations of the Assignment to the Director's Representative. This paper shall be submitted in draft form at the same time as the Draft Final Report. The Consultants shall present this paper to ACE and answer any questions arising from it either verbally at the presentation or in writing through the Director's Representative.

5.11.2 The Consultants may also be required to deliver one presentation on the findings of the Assignment to other public forum as directed by the Director's Representative. Input from the Consultants for such a presentation, if instructed, shall be remunerated as an additional service.

5.12 Provision of Data

The Consultants shall develop and maintain a database of all monitoring data, records and photographs collected during the Assignment including those relevant data obtained from other studies in a digital format on magnetic media to be agreed with the Director's Representative. This whole set of data both in hard copy and in magnetic media shall be delivered with the Draft Final Report (Clause 5.8. refers). Only summaries of data and any identified data trends shall be included in reports.

5.13 Number of reports to supply

The Consultants shall provide the following reports:

(i) ten copies of the draft and final Inception Report;
(ii) ten copies of the draft and revised Monitoring and Audit Reports;
(iii) ten copies of the draft tender documents and 30 copies of the final tender documents;
(iv) ten copies of the contract documents;
(v) ten copies of the working papers
(vi) five copies of the progress reports;
(vii) ten copies of the draft Final Report and 20 copies of the Final Report; and
(viii) 40 copies of the Executive Summary, in both English and Chinese.

5.14 Preparation of Reports

5.14.1 All reports are to be of A4 size and bound with an appropriate cover. The content and format of all reports, technical notes, working papers and manuals prepared by the Consultants shall be subject to the satisfaction of the Director's Representative.

5.14.2 Unless otherwise specified by Director's Representative, all tender documents, tender submissions, final report, executive summary, working papers and other relevant reports including their draft forms should be of A4 size and printed on both sides of recycled paper with no less than 50% recycled materials. The logo of recycled paper should be printed in a prominent area of the report. Recycled paper should not exceed 80 gsm.

5.14.3 Unnecessary use of plastic laminates, glossy covers or double cover and blank papers in the production of the documents should be avoided as far as possible. Use of recyclable non-glossy art board paper as document covers is recommended.

5.14.4 Excessive space around borders and in between paragraphs should be avoided. As a general rule, a margin of 2cm should be sufficient. The font size to be used in the typing of all documents should be in the range of 10-12 characters per inch.

5.14.5 Unless otherwise specified, comments shall be conveyed to the Consultants within three weeks from the receipt of the deliverables in Clauses 5.2 to 5.10. The Consultants shall submit responses to these

comments within two weeks from the date of receipt of comments.

5.15 The Consultants shall draw to the Employer's attention any Deliverables that are under licence and any pre-existing copyright or patent on any Deliverables and any other restriction whatsoever affecting the Employer's use of the same and, if required by the Director's Representative, to establish the existence of any licence, copyright, patent or restriction.

6. Services to be provided by the Consultants

6.1 General

6.1.1 The Consultants shall carry out the duties as set out in the General Conditions of Employment and as amplified, extended and stipulated in this Brief.

6.1.2 Throughout the course of the Assignment, the Consultants shall comply with all instructions of the Director's Representative so far as they are applicable to the Assignment and shall supply such information and documents as may be required by the Director's Representative for compliance with appropriate Statutory Regulations, Government procedures, Instructions and Circulars in connection with the Assignment.

6.1.3 Recommendations and proposals put forward by the Consultants shall have due regard for engineering, economic, financial, environmental, legal, social, operational and contractual implications of their proposals and recommendations.

6.1.4 The Consultants shall report to the Director's Representative or any other delegated person on day-to-day administration of the Assignment and shall attend, serve or report to progress meetings at quarterly or any other intervals as agreed with the Director's Representative and other meetings required under Clause 14.

6.1.5 The Consultants shall communicate and correspond directly with other Government departments, public utility companies, and other authorities, bodies, consultants, contractors or persons to obtain information in connection with the Assignment, copying such correspondence to the Director's Representative. The co-ordination of all works and services in connection with the Assignment will be the responsibility of the Consultants. Any problems in communication or liaison should be referred to the Director's Representative for assistance. In particular, communication may be required with the following Government departments:

Agriculture, Fisheries and Conservation Department
Civil Engineering Department
Drainage Services Department
Food and Environmental Hygiene Department

Government Laboratory
Highways Department
Hong Kong Observatory
Marine Department
Planning Department
Territory Development Department
Water Supplies Department

6.2 The Consultants shall plan, design, review and supervise the monitoring programme and perform all necessary activities and assessments based on available data obtained either from this Assignment or other sources to ensure that the study objectives as stated in Clauses 3.1 to 3.15 and all other requirements specified in this Assignment will be satisfactorily fulfilled. This programme shall make reference to, be complementary to and compatible with:

6.2.1 the ongoing Environmental Protection Department monitoring programmes of river, marine, sediment and beach water quality;

6.2.2 other programmes for monitoring sewage outfall; and

6.2.3 other monitoring programmes that may facilitate the assessment of the impact of the effluent discharge.

6.3 The techniques that the Consultants employ to assess the performance of the outfall and impact of the effluent discharge shall be based on sound scientific principles. Impact hypotheses for each aspect of the assessment shall be proposed prior to finalizing the monitoring programme and tested in the course of the assessment. The statistical basis by which the data will be evaluated shall be agreed with the Director's Representative.

6.4 The Consultants shall review and collate data from other sources that are relevant and useful to the assessment of the impact of the effluent discharge.

6.5 Costs incurred on all services including those specified in Clauses 4.8 and 6.9, other than the optional additional services specified in Clauses 5.11.2 and 6.13.3.6 and the field work and laboratory tests allowed for in Clause 6.6 below, shall be included in the Lump Sum Fee.

6.6 <u>Components of Monitoring Programme</u>

The Consultants shall plan and propose for approval with cost estimates and time schedules, the field survey, sampling and laboratory testing programmes for execution of the monitoring programme in such a way to ensure that the objectives of the Assignment defined in Clauses 3.1 to 3.15 are fully satisfied. The field work and laboratory tests requirements are suggested below for Consultants' consideration in designing the monitoring programme and formulating the tendering strategy for relevant contracts.

<u>Effluent Quality Monitoring (Indicative)</u>

Effluent sampling shall be conducted during both the wet and dry seasons in the post-commissioning period to characterize the quality of the effluent. Samples of the effluents shall be collected at appropriate time intervals and analysed for a range of variables to be agreed with the Director's Representative such as *E.coli*, Biochemical Oxygen Demand, suspended solids, ammonia, total organic carbon, nitrogen, phosphorus, metals and other contaminants of concern. This sampling shall be performed to coincide with samples of effluent to be assessed for toxicity as described in the Ecotoxicological Assessment below.

Water Quality Monitoring (Indicative)

Sampling for water quality monitoring shall be performed in the pre-commissioning period and the post-commissioning period to give adequate coverage of different tidal states during both wet and dry seasons for both monitoring periods. The locations of the sampling stations shall be proposed by the Consultants, with justification, for the agreement of the Director's Representative prior to commencement of the field work. Samples shall be collected at surface, middle and bottom of the water column at the selected locations during each survey.

Samples collected in accordance with the requirements as specified above shall be analysed for a range of water quality determinands to be agreed with the Director's Representative such as *E.coli*, Biochemical Oxygen Demand, suspended solids, ammonia, nitrite, nitrate, nitrogen, phosphorus, chlorophyll-a and other contaminants of concern. Dissolved oxygen, pH, salinity, temperature and turbidity shall also be measured at all of the selected water quality monitoring stations by vertical profiling at the same time as the water samples are taken as described above.

Sediment Quality Monitoring (Indicative)

Sediment sampling shall be performed in the pre-commissioning period and the post-commissioning period to give adequate coverage of both wet and dry seasons for both monitoring periods. The sampling locations and analysis of sediment samples to be conducted shall be agreed with the Director's Representative. Analysis shall include determinands such as percentage of silt/ clay, pH, acid volatile sulphides, total volatile solids, total organic carbon, ammonia, total nitrogen, total phosphorus, metals and other contaminants of concern identified in the effluent, if any.

Benthic Survey (Indicative)

Benthic sampling shall be conducted in the pre-commissioning period and the post-commissioning period, in parallel with the sediment sampling described above, using the same sediment monitoring stations. The benthos collected shall be identified to the lowest taxonomic level and the benthic community structure determined.

Ecotoxicological Assessment (Indicative)

The Consultants shall propose, with full scientific justification, for the approval of the Director's Representative and undertake a programme of ecotoxicological assessment to determine the toxicity of the treated effluent and toxicity of the receiving marine water by carrying out whole effluent and/or chemical specific toxicity tests over a range of dilution using ambient seawater, and using different local biological species. All ecotoxicological samples shall be fully characterised physically and chemically. The list of determinands shall be proposed by the Consultants and agreed with the Director's Representative such as ammonia, sulphide, heavy metals, Polychlorinated Biphenyls, Polynuclear Aromatic Hydrocarbons and organochlorine pesticides.

6.7 The Consultants shall make recommendations for additional investigations including sampling, surveys, tests and analyses to supplement those stated herein for the evaluation of the impact of the effluent discharge on the receiving environment if there are any potential causes of concern arising.

6.8 The Consultants shall note the following in planning and implementing the monitoring programme:

6.8.1 The Consultants shall note that the study area is frequented by other craft, some travelling at high speed. The monitoring programme shall need to be carried out carefully and safely. The operations shall not impede vessel traffic in the area.

6.8.2 The Consultants shall consult the Marine Department on the best arrangements to conduct the monitoring operations.

6.8.3 The Consultants shall plan and implement the pre-commissioning monitoring in such a way that the construction of the sewage outfall is not affected and so as to ensure that the construction activities will not affect the determination of baseline conditions. Adequate planning and implementation arrangements shall also be applied to the post-commissioning monitoring to enable the impact arising as a consequence of the discharge from the outfall be distinguishable from those arising from other pollution sources and anthropogenic activities (Clause 4.10 refers). The Consultants shall consult and seek the consent of the Drainage Services Department and, if necessary, other Government departments, on the arrangements to conduct the monitoring programme.

6.8.4 All instrumentation shall be approved by the Director’s Representative and detailed in the Monitoring and Audit Manual. All in-situ equipment used for monitoring shall be allowed to reach equilibrium before readings are recorded. All instruments shall be satisfactorily maintained and calibrated. The responses of the sensors and electrodes shall be checked with certified standards at intervals as

detailed in the Monitoring and Audit Manual. Emergency back-up instruments shall be provided in case of instrument failure.

6.8.5 Analytical methodology shall be based on the latest edition of Standard Methods for the Examination of Waste and Wastewater by APHA, AWWA and WPCF. For parameters where no Standard Method exists, the Consultants shall propose a suitable method for approval by the Director's Representative. Laboratory analysis of samples collected shall be performed by a laboratory with HOKLAS accreditation, or equivalent, for all physical and chemical analyses.

6.8.6 Standard operation procedures (SOPs) shall be written for all aspects of field and laboratory work and shall be submitted to the Director's Representative for approval prior to commencement of monitoring work (Clause 5.3.4 refers).

6.8.7 The Consultants shall seek the approval of the Director's Representative prior to commencement of monitoring work.

6.8.8 The Consultants shall, if requested to, arrange for provision of duplicate samples to the Director's Representative for independent analysis.

6.8.9 The Consultants shall make contingency arrangements to ensure that the monitoring programme is completed on time and within budget even if unavoidable delays to field work occur.

6.9 Planning, tendering and supervision of all field survey, sampling, laboratory tests, and investigations required for the proper execution of the Assignment shall be the duty of the Consultants. Reports on results, findings, and conclusion of these surveys, tests and investigations so carried out shall be prepared and submitted by the Consultants to the Director's Representative in accordance with the requirements of the Brief. Copies of field notes, field data and resultant plans arising from these surveys, tests and investigations shall be handed over to the Director's Representative upon completion of the Assignment. The accuracy as well as presentation of these tasks shall be of a standard as agreed by the Director's Representative.

6.10 <u>Field Work and Laboratory Tests Undertaken by Contractors/Laboratories</u>

6.10.1 The Consultants shall arrange, direct, control and supervise the field work and laboratory analysis, prepare specifications and tender documents, and administer the contract(s) for the provisions of these work items in accordance with Clauses 6.10.2 and 6.10.3 below. The Consultants are required to propose to the Director's Representative for his agreement on the cost estimates and programme necessary for the field work and laboratory tests.

6.10.2 For the work items which collectively have a total estimated values less than HK$1.3 million or 20% of the approved lump sum fee of the Agreement, whichever is the less, they will be procured as reimbursable

items and the Consultants shall call for tenders and place orders for carrying out the work. Prior to calling for tenders, the Consultants shall propose for approval competent survey companies and laboratories which are to provide such work. The Consultants shall be reimbursed the out-of-pocket expenses actually and properly incurred by the Consultants in respect of these work items. For work costing in excess of HK$50,000, the Consultants shall obtain competitive quotations, and shall obtain approval from the Director's Representative prior to incurring such reimbursable expenses.

6.10.3 For the remaining work items, they will be procured through contract(s), where the Government will enter into the contract(s) with the work undertaker(s) (or the Contractor(s)). The work shall be procured in the following arrangements:

6.10.3.1 The Consultants shall propose for approval, and recommend a tendering strategy which allows competitive services in terms of cost, work programme and quality of end products to be procured.

6.10.3.2 The Consultants shall prepare draft letters for invitation of tenders. The Consultants shall also prepare all necessary documents and drawings to enable the Director's Representative to obtain the necessary authority to proceed with the tendering exercise.

6.10.3.3 The Consultants shall prepare detailed specifications, field sampling and monitoring procedures and equipment for field measurements, and methodology, precision and accreditation requirements for laboratory tests and any other necessary aspects for incorporation in the tender documents.

6.10.3.4 The Consultants shall submit to the Director's Representative for approval tender documents including form of tender, conditions of tender, conditions of contract, specifications, bills of quantities, method of measurements and any relevant pre-contract correspondence with the Contractor.

6.10.3.5 The Consultants shall also undertake the following activities in the calling of tenders:

(i) distribute tender documents;
(ii) hold pre-tender meeting, if necessary;
(iii) answer queries on the documents; and
(iv) issue tender addenda.

6.10.3.6 The Consultants shall also undertake the following activities in the assessment of tenders and making of tender recommendation:

(i) assess received tenders;
(ii) obtain clarifications/confirmations from the tenderers;
(iii) hold post-tender meetings, if necessary;
(iv) prepare tender reports in a format complying with Appendix III(J) to the Government's "Stores and Procurement Regulations";
(v) assist the Employer in negotiating with tenderers, if necessary.

6.10.3.7 The Consultants shall prepare and provide sufficient sets of contract documents for signatures and record purposes.

6.10.3.8 During the execution of the contract(s) for the field work and laboratory tests, the Consultants shall administer the contract(s), supervise the work, value and certify the work completed for the Employer to pay the amount due to the contractor /laboratory.

6.10.4 The Consultants shall also prepare and incorporate Quality Assurance/Quality Control procedures (Clause 6.12 refers) including inter-laboratory calibration with the Government Laboratory as necessary for the field work and laboratory tests in the tender documents.

6.10.5 Should the tenders submitted for the field work and laboratory tests exceed the budget of the Assignment, the Consultants shall re-design the monitoring programme to enable important data to be collected within the budget. The Consultants shall incorporate flexibility in the tender documents to accommodate this and when necessary re-tender the modified work as required by the Director's Representative.

6.11 Supervision of Field Work and Laboratory Tests

6.11.1 The Consultants shall supervise, direct and control the field survey work and laboratory analysis in such a way as to ensure proper quality control and compliance with the requirements of the Assignment.

6.11.2 On completion of each field survey, the Consultants shall compile all field measurements and laboratory results and prepare a report on the field survey covering the field procedures, summary of data and detailed analysis of results. Any irregularities, abnormal condition and malfunctioning of equipment during surveys shall also be reported. All raw data and laboratory results shall be submitted to the Director's Representative in both hardcopy and magnetic media in agreed format.

6.12 Quality Assurance and Quality Control Requirements

6.12.1 The general requirements for quality assurance and quality control to be implemented by the Consultants for the satisfactory completion of the Assignment are provided in Appendix B for reference. The

Consultants shall develop rigorous QA/QC procedures, to be submitted with the draft Monitoring and Audit Manual, for the approval of the Director's Representative to ensure that the data collected for this Assignment is of suitable quality.

6.12.2 The QA/QC procedures to be developed shall take account of the objectives of the studies and comprise appropriate comparison activities, use of appropriate reference materials, procedures for assessing the ability of laboratories and survey companies, and criteria to be applied in the assessment of resulting data. The data documentation and validation procedures shall be clearly set out in the draft Monitoring and Audit Manual.

6.12.3 The Consultants shall ensure that all data obtained are subject to proper quality assurance and quality control. The estimated accuracy and uncertainty in all field and laboratory measurements must be provided when results are reported.

6.12.4 Laboratories undertaking analytical work in the monitoring programme shall participate in relevant inter-laboratory proficiency testing programmes to demonstrate their analytical competence. They may be required to analyse blind samples provided by the Director's Representative to assess the effectiveness of their QA system.

6.13 Water Quality and Plume Dispersion Models

6.13.1 Modelling software and basic requirements

6.13.1.1 For hydrodynamic modelling and far field water quality modelling, the modeling software shall be accurately simulating stratification and salinity transport in three dimensions within area, at least, covering the study area. The model shall consist of hydrodynamic, water quality and particle dispersion modules. The hydrodynamic and water quality modules shall be strictly mass conserved at all levels.

6.13.1.2 The near field model and the hydrodynamic and water quality models to be used for predicting and quantifying initial dilution zone, mixing zone and far field conditions, shall have had proven successful applications locally and overseas and shall of the latest versions.

6.13.1.3 In general, the grid size of the models to be used shall be less than 400 m in open waters and less than 75 m around sensitive receivers. The grid schematisation shall be agreed with the Director's Representative. All models shall either be dynamically linked to a far field model or form part of a larger model by gradual grid refinement.

6.13.2 Model calibration and validation

6.13.2.1 The models shall at least cover the areas as delineated on Figure 1 to incorporate all major influences on hydrodynamic and water quality. No field data collection is required for the purposes of model calibration for this study. However, the models shall have been properly calibrated and validated before their use in the study to simulate the hydrodynamic and water quality in the minimum model area described above with the field data collected by:

- Hydraulic and Water Quality Studies in Victoria Harbour (1987);
- Port and Airport Development Strategy - Enhancement of WAHMO Mathematical Models (1990);
- Strategic Sewage Disposal Scheme Stage II - Oceanic Outfall, Oceanographic Surveys and Modelling (1992);
- Update on Cumulative Water Quality and Hydrological Effect of Coastal Developments and Upgrading of Assessment Tool (1998);
- EPD's routine monitoring data;
- Tidal data from Hong Kong Observatory, Macau and relevant Mainland Authorities.

6.13.2.2 Tidal elevation data shall be calibrated and validated in both frequency and time domain manner.

6.13.2.3 For the purposes of calibration and validation, the hydrodynamic model shall be run for not less than 15 days of real tide sequence (excluding model spin up) in both dry and wet seasons with due consideration of the time required to establish initial conditions.

6.13.2.4 In general, the hydrodynamic model shall be calibrated to the following criteria:

Criteria	Level of fitness with field data
• Tidal elevation (root mean square)	< 8%
• maximum phase error at High Water and Low Water	< 20 minutes
• maximum current speed deviation	< 30%
• maximum phase error at peak speed	< 20 minutes
• maximum direction error at peak speed	< 15 degrees
• maximum salinity deviation	< 2.5 ppt

6.13.3 Model simulation and assessment

6.13.3.1 The Consultants are required to undertake model runs to simulate the actual conditions to help ascertain and predict the impact of the effluent discharge on the receiving waters. The

water quality modelling results shall be qualitatively explainable, and any identifiable trend and variations in water quality shall be reproduced by the models. The water quality model shall simulate and take account of the interaction of dissolved oxygen, phytoplankton, organic and inorganic nitrogen, phosphorus, silicate, Biochemical Oxygen Demand, temperature, suspended solids, air-water exchange and benthic processes. It shall also simulate salinity transport and *E.coli* dispersion. Salinity results simulated by hydrodynamic models and water quality models shall be demonstrated to be consistent.

6.13.3.2 Scenarios to be modelled shall cover various stages of implementation of the Sham Tseng Sewage Treatment Works including any future expansion or upgrading of these treatment facilities being considered. Corresponding pollution loads, bathymetry and coastline shall be adopted in the model set up.

6.13.3.3 Hydrodynamic and water quality models shall be run to simulate 15 days (excluding model spin up) of real tide sequence.

6.13.3.4 The models shall be used to help ensure cost effective design of the field monitoring programme and to help establish the extent of and influences on the zone of influence.

6.13.3.5 The models shall be used to facilitate the assessment of the impact of the effluent discharge on the receiving environment in order to ensure that the study objectives in Clauses 3.1 to 3.15 are fully satisfied.

6.13.3.6 The Consultants shall install all modelling results and display software other than the modelling software itself on the Government's computers. Should installation of the modelling software and provision of a software licence for the model be required, these will be instructed as additional services.

6.14 Recommendations

6.14.1 The Consultants shall make recommendations with respect to the need for improvement to the Sham Tseng Sewage Treatment Works including the outfall.

6.14.2 The Consultants shall make recommendations with respect to the requirements of, and methodologies to be employed in the course of, future monitoring programmes or supplementary investigations to quantitatively assess and predict future performance of the outfall and the impact of the effluent discharge on the receiving environment.

6.15 Ownership and transfer of data

All data obtained for this Assignment shall be the property of the Hong Kong Government. The Consultants shall acquire no right to transfer nor publish any details of any data obtained for this Assignment to any third party without the permission of the Hong Kong Government. All data obtained including all raw data obtained in field and laboratory testing shall be properly documented and handed over to the Director's Representative on magnetic media, in formats agreed with the Director's Representative.

7. Response to queries

The Consultants shall respond to queries under Clause 20 of the General Conditions of Employment raised prior to a date three months after the endorsement of the Executive Summary. Such date shall be confirmed in writing to the Consultants by the Director's Representative.

8. Programme of implementation

8.1 The due date for commencement of the Agreement is _____.

8.2 The Assignment shall be completed within 36 months in accordance with an agreed Programme. The Draft Final Report shall be completed in accordance with Clause 5.8 of this Brief.

Pursuant to Clause 26(B) of the General Conditions of Employment, the Consultants shall submit the draft programme and revised draft programmes and the Director's Representative shall agree, or instruct, within the following periods:

Submission of the draft programme: Within four weeks of the due date for commencement of the agreement.

Agreement of the draft programme: Within two weeks from receipt of the draft programme or instruction for submission of the revised draft programme.

Submission of the revised draft programme: Within one week from the instruction of the Director's Representatvie

The draft programme and revised draft programme shall detail the activities to be carried out, target dates for particular tasks and any decision dates that may be required for the uninterrupted progress of the Assignment. The Consultants shall discuss with the Director's Representative during the above periods to agree the timing of submission of reports, other documents and plans for each of the main elements of the Assignment, for inclusion in the draft programme and revised draft programme.

8.3 The key dates referred to in Clause 8.2 of this Brief shall include but not be

limited to:

(i) the date of submission of the draft and final Inception Reports (refer to Clause 5.2);
(ii) the date of submission of the draft and revised Monitoring and Audit Manuals (refer to Clause 5.3);
(iii) the date of submission of the draft and final tender documents (refer to Clause 5.4);
(iv) the date of submission of the contract documents (refer to Clause 5.5);
(v) the date of submission of the Working Papers (refer to Clause 5.6)
(vi) the date of submission of the Progress Reports (refer to Clause 5.7);
(vii) the date of submission of the draft Final Report (refer to Clause 5.8);
(viii) the date of submission of the Final Report (refer to Clause 5.9); and
(ix) the date of submission of the draft and final Executive Summary reports (refer to Clause 5.10).

8.4 The Consultants shall endeavor to ensure that the Assignment is carried out in accordance with the Programme and shall submit regular programme reviews as part of the progress reports referred to in Clause 9 of this Brief.

9. Progress Reports

The Consultants shall comply with the requirements in Clause 5.7 regarding the preparation and submission of progress reports.

10. Financial Management

At quarterly intervals or at such other intervals as the Director's Representative may require, the Consultants shall submit a report on the current and forecast expenditure on the Assignment and the fees due to the Consultants, in a form to be agreed by the Director's Representative.

11. Standards and Specifications

The Consultants shall adopt such technical and design standards and specifications as are in current use by Government Departments including the Departments of Environmental Protection, Drainage Services, Marine, Highways, Civil Engineering, and Information Technology Services or, if non-existent, British Standard Codes of Practice and Specifications. Should instances arise for which suitable standards or specifications do not exist or for which the current standards or specifications appear to require modification or if by the adoption of current standards the Consultants would incur additional expenses not within reasonable contemplation, the Consultants shall submit recommendations on appropriate alternatives to the Director's Representative for agreement.

12. Variations and Other Commitments

Not used.

13. Director's Representative

13.1 The Director's Representative as defined in the General Conditions of Employment shall be the Assistant Director of Environmental Protection (Waste and Water) of Environmental Protection Department or such other person as may be authorized by the Director in writing and notified to the Consultants. The Director's Representative may delegate any of the powers and functions vested in him to other officers. If the Consultants are dissatisfied with a decision or instruction of any such officer the matter shall be referred to the Director's Representative for a ruling.

13.2 During the course of the Agreement the Consultants shall report directly to the Director's Representative.

14. Control of the project and assignment

14.1 Project Steering Group

A Project Steering Group, chaired by the Principal Environmental Protection Officer (Water Policy and Planning Group), EPD, or a delegated representative of appropriate seniority, will be formed to provide guidance to the Consultants on policy matters, monitor the progress of the project and consider major recommendations from the Consultants. Meetings will be held to discuss the Inception Report at the beginning of the Assignment, the Monitoring and Audit Manual and the Draft Final Report, a total of not more than five meetings. They shall be attended by the Project Director and, when appropriate, other representatives of the Consultants.

14.2 Other Meetings

14.2.1 In addition to the meetings specified in Clause 14.1 above, the Consultants shall be required to attend other ad hoc meetings as directed by the Director's Representative during the Assignment period.

14.2.2 The Consultants shall attend all meetings as directed by the Director's Representative in accordance with Clauses 5.11.1 and 5.11.2 held in connection with the Assignment for presentation of papers, documents, progress reports and recommendations etc. to the concerned public forum.

15. Information and facilities provided by the Employer

All available information relevant to the Assignment will be provided to the Consultants. Relevant documents including reports, drawings and other background materials are listed in Appendix A to this Brief. The Consultants shall indicate for guidance those documents which they currently hold and those of which a copy may be needed, should the Assignment be awarded to them. A copy of each of the documents indicated as needed will be supplied free to charge by the Director's Representative on request from the Consultants, except those currently available from the Sales section of the Information Services Department. In the case of plans and drawings, one transparency and two prints of each plan or drawing shall be provided free of charge, if

requested, to the Consultants.

16. Consultants' office and staffing

16.1 The Consultants shall maintain for the duration of this Agreement an office in Hong Kong under the control of the Project Director of the Consultants who shall be responsible for the Project. He shall have adequate authority and sufficient professional, technical and administrative support staff in all relevant disciplines to ensure progress of the Assignment to the satisfaction of the Director's Representative.

16.2 The Consultants shall provide the staff and manpower in accordance with the technical proposal made at the tender stage, and the Director's Representative shall have the right to check the time-log record of the Consultants' staff deployed for the Assignment. In the event, for reasons beyond their control, the Consultants are unlikely to provide or maintain any key staff in the technical proposal, they shall report to the Director's Representative as soon as practicable and propose for the Director's Representative's approval a substitute staff having qualification and experience comparable with the staff who is leaving the project team.

16.3 Staff outlined in the Consultants' proposal shall be resident in Hong Kong for the length of their involvement in the Assignment. Consultants in joint ventures shall give an assurance that each of the collaborating parties involved will be bound to the undertaking until the satisfactory completion of the Assignment.

17. Specialist and sub-Consultants services

The Consultants shall provide all specialist and sub-Consultants required for the satisfactory completion of the Assignment. No additional fees or expenses for the provision of such services rendered locally or overseas shall be payable by the Employer except as otherwise provided for in the Schedule of Fees.

18. Surveys

One velograph and two prints of topographical mapping at 1:20,000, 1:5,000 and 1:1,000 scales prepared by the Survey and Mapping Office of the Lands Department, where available for the area covered by the Project for which the Assignment forms a part, can be obtained free of charge on application to the Director's Representative. All field survey work required for the proper execution of the Assignment shall, unless otherwise provided for in the Agreement, be the duty of the Consultants. A copy of field notes, field data and resultant plans arising from these surveys shall be handed over to the Director's Representative upon completion of the Assignment. The accuracy as well as the presentation of these surveys shall be of a standard agreed by the Director's Representative.

19. Insurance

The amount of insurance cover to be maintained in accordance with sub-clause (A) of

Clause 47 of the General Conditions of Employment shall be HONG KONG Dollars (twice the lump sum fee), and subject to a maximum of HK$150 million and a minimum of HK$10 million.

Annex A

Appendix A

Agreement No. CE29/2002 (EP)

Information Relevant to the Assignment

1. Tsuen Wan, Kwai Chung, Tsing Yi Sewerage Master Plan, Final Report.
   Commissioned by: Environmental Protection Department.
   Prepared by: Pypun-Howard Humphreys Ltd., December 1991.

2. Ting Kau and Sham Tseng Sewerage Scheme – Environmental Impact Assessment Study, Final Report.
   Commissioned by: Drainage Services Department
   Prepared by: Mott Connell Ltd., October 1995.

3. Ting Kau and Sham Tseng Sewerage Scheme, Sewage Treatment and Disposal Facilities - Marine Impact Assessment for Submarine Outfall, Draft Report.
   Commissioned by: Drainage Services Department
   Prepared by: Montgomery Watson, February 1996.

4. Ting Kau and Sham Tseng Sewerage Scheme, Sewage Treatment and Disposal Facilities - Contract C – Sewage Treatment Works, Preliminary Report.
   Commissioned by: Drainage Services Department
   Prepared by: Montgomery Watson, February 1996.

5. Planning and Engineering Feasibility Study for Sham Tseng Development - Environmental Impact Assessment Study, Final Report.
   Commissioned by: Civil Engineering Department.
   Prepared by: Scott Wilson (Hong Kong) Ltd., January 2002.

6. North Western, Western Buffer and Southern WCZ Water Quality Objectives.

7. Standard Methods for the Examination of Waste and Wastewater, 19th Edition, 1995, by APHA, AWWA and WPCF.

8. As built drawings of outfall.

9. Admiralty charts.

10. EPD routine marine water and sediment quality data.

11. Pre and Post Project Monitoring for Siu Ho Wan Sewage Outfall, Final Report
    Commissioned by: Environmental Protection Department.
    Prepared by: Montgomery Watson, August 2000.

12. Baseline and Performance Verification Monitoring of the Pillar Point Sewage Outfall, Final Report
    Commissioned by: Environmental Protection Department.
    Prepared by: MWH (Hong Kong) Ltd., May 2002.

13. Strategic Sewage Disposal Scheme Stage I – Baseline Monitoring and Performance Verification (in progress)
    Commissioned by: Environmental Protection Department
    Consultants: Mouchel Asia Limited

14. Strategic Sewage Disposal Scheme – Environmental Impact Assessment Study
    Commissioned by: Environmental Protection Department
    Consultants: Montgomery Watson – Binhai Joint Venture

15. AFCD Port Survey 96/97

Agreement No. CE29/2002 (EP)

Quality Assurance and Quality Control Requirements

1. Positioning Requirements

For all monitoring activities, navigational instruments shall be correctly calibrated before each sampling event.

2. Sediment Sampling

Only the top 2cm to 5cm of each sediment replicate shall be sampled for analysis of contaminants. A grab sampler which collects sufficient sediment from the surface 5cm with minimal disruption of the surficial layer shall be used.

3. Water Quality Monitoring

Water quality instruments shall be calibrated prior to each monitoring event.

The speed of the water quality vertical profiling shall be controlled to enable the DO probe (and other instruments) to equilibrate and provide accurate measurements.

4. Laboratory Analyses

Each of the analytical methods adopted by the laboratories should have an established set of quality assurance/quality control (QA/QC) measures that should be followed in order to obtain reliable data that is technically defensible. It is important that laboratories establish and maintain a formal QA program, such as is required under the HOKLAS accreditation program, to increase the quality of the data being generated. If analyses are to be performed by laboratories outside Hong Kong, they should be able to demonstrate competence equivalent to HOKLAS accreditation criteria.

Before performing a chemical analysis, the laboratory needs to establish its own limits for performance of a particular method (i.e. method validation, establishing detection limits). This is usually done by analysis of QC samples. Laboratories should establish limits (e.g. control charts) for their own measurement systems, and these limits need to be evaluated to ensure that they meet generally accepted guidelines or that there are acceptable reasons for having a less stringent limit. Also if a laboratory has consistently demonstrated better performance than indicated by general guidelines, then those limits should be used to determine whether a problem is present. Exceedance of warning limits indicates that the QC sample data need some sort of qualification before they can be accepted. These limits serve as a warning that some component of the analytical system may not be performing normally and that data should be qualified as "estimated" before using the results for technical analysis; the standard value for warning limits is ± 2SD. Control limits are limits placed on the acceptability of QC sample data. Exceeding the control limits indicates that the analytical system or instrument is performing abnormally and needs to be corrected. Data that exceed control limits are often rejected and excluded from a project database. The standard value for control limits is ± 3SD.

Instrument calibration is always required because it is the means by which instrument responses are properly translated into chemical concentrations (EPA, 1995). Calibration is performed prior to sample analysis and repeated during sample analysis at intervals specific for each method. In addition to performing the instrument calibrations, the acceptability of these calibrations should be evaluated.

Information related to the QA/QC measures that accompany each batch of samples should be included in each laboratory report. This includes the results obtained from the analysis of calibration and method QC samples which are designed to demonstrate the ongoing control of contamination and to define the precision and accuracy of the method for the parameter and type of sample under investigation. These QC samples should be analyzed concurrently with "environmental samples". Types of QC samples should include:

Method Blank - a blank which undergoes processing identical to that carried out for samples. Method Blank results are used to assess contamination and/or provide background correction.

Reference Material - a material or substance, one or more properties of which are sufficiently well established for it to be used for the calibration of an apparatus, the assessment of a measurement method, or for assigning values to materials. Reference material results are used to assess the accuracy and precision of a method. Types of reference materials include:

- Certified Reference Material - a material, one or more of whose property values are certified by a technically valid procedure, accompanied by or traceable to certified or other documentation issued by a certifying body;

- Standard Reference Material - a reference material distributed and certified by the U.S. National Institute for Standards and Technology (NIST), formerly the National Bureau of Standards. SRMs are certified for specific chemical or physical properties and are issued with certificates that report the results of the characterization and indicate the use of the material;

- Other Reference Material - a reference material other than a CRM or SRM, not certified but considered by the laboratory to be useable as a reference material if no suitable CRM or SRM is available. It may come from an external supplier or be prepared in-house.

Method Analyte Spike – sample, clean matrix, or reagents which are fortified with a known quantity of the analyte(s) of interest prior to undergoing sample processing identical to that carried out for samples. Method Analyte Spike results are used to determine effects of the matrix on recovery and losses incurred during sample preparation.

Sample Replicates – two or more independently subsampled portions of the same sample, separately prepared and analyzed by the same method. Sample Replicate results are used to assess the precision of a method.

A method blank, reference material, and sample replicate should be included with each batch of samples as the minimum requirement. Batches should not be larger than 20 samples; QC samples should be analyzed with every 20 samples. GC methods should also require that a method analyte spike be added.

General Considerations

In addition to the QA/QC guidance provided in the previous section, there are a number of general considerations which apply to all the analyses described here. These include prevention of contamination, cleaning procedures and potential interferences. Guidance pertaining to these issues is provided below (EPA, 1995; PSEP, 1996abc).

Sample Storage and Preservation

Sediment samples should be cooled in the field to about $4^{O}C$, and kept cool during shipment to the laboratory. Use of ice chests and artificial ice packs should be sufficient, even for international shipment, provided overnight courier delivery service is used.

All samples should be packed securely to avoid breakage, and should be accompanied by chain-of-custody documentation.

Contamination and Low Level Work

Precautions need to be taken to prevent contamination at each stage of sample collection, handling, storage, preparation and analysis. The best way to control contamination is to avoid any exposure by performing operations in areas known to be free from contamination (e.g., a clean room or a clean, nonmetal, laminar flow fumehood). It is also important that dilution water and reagents used in sample preparation and analysis be of appropriately high purity (e.g., deionized water, analytical grade chemicals). All field equipment and labware must be carefully cleaned and cleaning methods monitored and verified using field and laboratory blanks. Laboratories generating trace level data should conduct trace level work on an ongoing basis so that procedures and facilities are proven. The laboratory's QC program should include regular procedural and equipment blanks to update knowledge about background information in the sample processing environment.

Cleaning Methods for Labware

All labware used for sample preparation and analysis must be free from contamination, and ideally it should be dedicated according to sample type and anticipated concentrations of analytes. For metals analyses, all labware should be thoroughly cleaned with a detergent solution, rinsed with metal-free water, and soaked overnight, or longer, in a covered acid bath containing dilute nitric acid prepared from reagent grade nitric acid. The laboratory should have written procedures for labware cleaning methods, and should routinely verify their effectiveness by analyzing blanks.

Interferences

Analysis of marine sediment samples is a significant challenge because of the presence of salt, which can interfere with sample analysis. Analytical methods need to identify the steps taken to control salt interference.

REPORTING REQUIREMENTS

The information provided in an analytical laboratory report should be sufficiently complete to allow an independent evaluation of the quality of the data, in addition to reporting the test values. Deliverable requirements and deadlines should be proposed by the Consultants prior to beginning the Assignment. Laboratory reports should include the following:

- name and location of the testing laboratory, and investigator(s)
- source of samples, method of collection, handling, shipping and storage, dates and times of sample collection and receipt at the testing laboratory
- dates of extraction and analysis
- summary of extraction or digestion procedures and analytical methods
- detection limits and quantification limits
- sample identification codes (if the lab has its own identification system)
- explanation of all data qualifier symbols
- tabulated sample results with units, including reporting basis (e.g. wet, dry, TOC normalized)
- summary of results and control limits for all QC analyses, such as blanks, spikes, surrogates, duplicates and CRMs
- explanations for all data quantifications
- tentatively identified compounds (if requested) and methods of quantification
- explanations for all departures from the analytical protocols and discussion of possible effects on the data
- reference methods
- copies of completed chain-of-custody records and sample analysis request forms.

In addition to the information provided in the laboratory report, records of supporting backup should be maintained on file by the laboratory, including: calibration results; method blanks; sample sizes and dilution factors; replicates and spikes; amounts spiked; control or reference samples; chromatograms; GC/MS tuning documentation; GC/MS supporting spectra; chain of custody and sampling records; and any anomalies in instrument performance or unusual instrument adjustments.

5. Toxicity Tests

Implementation of a clearly defined QA/QC program is an integral part of conducting laboratory toxicity tests. A thorough and effective QA Program is the principal means of maintaining the accuracy and precision of field and laboratory analyses to assure scientific credibility. It ensures complete documentation and also standardizes and minimizes possible errors in computation and reporting of results. It is important that standard laboratory procedures be followed for all testing and that any unusual

observations or deviations from established procedures be documented. The following general QA/QC guidelines (PSEP, 1995) apply.

Negative Controls – All tests must be conducted using well-established negative (clean) controls. For every toxicity test, one series of test chambers must only contain clean diluent water. The complete test series must be repeated if the mean control response does not meet the acceptability criteria for that test method.

Positive Controls (Reference Toxicants) – all toxicity tests must contain positive (toxic) controls which are conducted with well-established standard reference toxicants. Reference toxicants are used to provide insight into mortalities or changes in sensitivity that may occur as a result of acclimation, disease, loading density or handling stress. For organisms obtained from outside sources (either purchased or field-collected), a reference toxicant test must be run for each new batch of organisms obtained. For organisms obtained from in-house laboratory cultures, reference toxicant tests can be performed on a monthly basis. Control charts should be constructed for each species and reference toxicant used and the cumulative mean value and upper and lower control limits ($\pm$ 2SD) should be plotted on each chart. If the results of a reference toxicant test fall outside the control chart limits, the test procedures and health/source of the test organism should be reviewed; subject to those findings, the test may have to be repeated.

Test Organisms – Only healthy organisms of similar size and life history stage are used for toxicity tests. Taxonomic identifications should be confirmed by the qualified taxonomist. All test organisms used for a batch of tests must be from the same source. Records of collection, shipping and acclimation should be maintained for all species obtained from outside of the laboratory.

Blind Testing – All treatment containers should be randomized during testing, and samples should be coded so that laboratory personnel do not know the sample identities.

Replication – The number of replicates required varies from one test protocol to another, but should always be sufficient to account for variability in test organism response. Unless otherwise specified in the experimental design, each treatment must begin with the same number of replicates.

Instrument Calibration – Calibration of instruments is required to ensure that accurate measurements are made throughout a test and to ensure the equipment is operating correctly. Water quality instruments (dissolved oxygen, pH and conductivity meters, refractometers) must be calibrated at the start of each day (and any time the environmental conditions are changed), according to the manufacturer's instructions. Each piece of equipment should have a logbook for daily recording of calibrating information, repairs, replacement, etc.

Water Quality Measurement/Maintenance – Toxicity tests involving exposure of organisms in aqueous media require that the media be uncontaminated and that proper water quality conditions be maintained to ensure the survival of the organisms, and to ensure that undue stress is not exerted on the organisms, unrelated to the test materials.

Appropriate water quality parameters must be measured at the start and end of a test as a minimum (every 24 h is more appropriate). If acceptable limits are exceeded at any time, the data should be reviewed to determine whether the test should continue.

Standard Laboratory Procedures - Standard laboratory procedures must be followed in all testing. These include use of established methods, proper documentation, proper cleaning, avoidance of contamination and maintenance of appropriate test conditions. All unusual observations or deviations from established procedures must be documented.

GENERAL CONSIDERATIONS

In addition to the QA/QC guidelines described in the previous section, there are a number of general procedures which apply to all the bioassays described here. These include sample collection, sample storage and holding time, cleaning procedures, and preparation of bioassay seawater. Guidance pertaining to these procedures is provided below.

Sample Storage and Holding Time

Samples should be cooled in the field to about 4°C. It is important that samples also be kept cool (but never frozen) during shipment to the laboratory, and that they be packed securely to avoid breakage. All shipments should be accompanied by chain-of-custody documentation. They must not be frozen and no preservatives need to be added. The holding time between collection and test initiation should be as short as possible (preferably no longer than two weeks). If samples are to be stored longer than two weeks, they should be stored under a nitrogen atmosphere.

Cleaning Procedures

Prevention of contamination of samples is critical to the successful performance of any laboratory analysis. It is important that all equipment that might come in contact with the sediment samples or test organisms be cleaned properly prior to use. In general, this involves washing with detergent, following by rinses with acetone and dilute acid (10% nitric or hydrochloric acid) followed by repeated rinsing with distilled or deionized water.

Bioassay Seawater

Clean seawater from an uncontaminated source is required for use as the overlying water in the toxicity tests, and for use in the reference toxicant tests. This water can be either natural or reconstituted (use of natural seawater is general preferred). Seawater should not be collected from areas where algal blooms have occurred. The seawater should be filtered (0.45-μm pore size), aerated to ensure that the dissolve oxygen content is 90-100% saturation, and used within two days of collection. Depending on the species being tested, it may be necessary to adjust the salinity, by addition of either distilled water or hypersaline brine.

Water Quality Measurements

The type and frequency of water quality measurements required during sediment bioassays varies depending upon test protocols and study objectives. Temperature must be measured at least once a day. The other parameters that should be measured are salinity, pH and dissolved oxygen. It is important that water quality parameters be monitored frequently enough to be able to document exposure conditions. Two other parameters which have received increased attention in recent years are ammonia and sulfide. Measurement of these parameters at a minimum in the overlying water at the start of a test is recommended. If ammonia is suspected to be the cause of toxicity, it may be desirable to measure it more frequently or to modify the experimental design to allow for removal of interstitial ammonia prior to test initiation (EPA, 1994). It is important to consider what measurements to perform as part of the experimental design.

REPORTING REQUIREMENTS

The information provided in a toxicity testing report should be sufficiently complete to allow independent evaluation of the quality of the data and interpretation of the results. Deliverable requirements and deadlines should be proposed by the Consultants prior to beginning the Assignment. The following information should be included in the report:

- Type of test, test species, start and end dates of the test.
- Name and location of the testing laboratory, and investigator(s).
- Source of sample, method of collection, handling, shipping and storage, dates and times of sample collection and receipt at the testing facility.
- Source and characteristics of control seawater, including any pretreatment.
- Source, history and age of test organisms, including: date and location of collection (or purchase), taxonomic identification, age or life-stage used, size, holding/acclimation procedures, and any unusual observations.
- Source and composition of food (if applicable), procedure used to prepare food, feeding methods, frequency and ration.
- Description of the experimental design, test chambers, depth and volume of sediment and overlying water in the chambers, lighting and temperature control, numbers of replicates and test organisms, water quality measurements.