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SPECIAL ADMINISTRATIVE REGION
ENVIRONMENTAL PROTECTION DEPARTMENT

Agreement No. CE 29/2008 (EP)
Engineering Investigation and Environmental Studies
for Integrated Waste Management Facilities
Phase 1 – Feasibility Study

Sediment / PFA Sampling and Testing Plan

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AECOM

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1 INTRODUCTION

1.1 Background

1.1.1 In November 2008, Environmental Protection Department (EPD) commissioned Metcalf & Eddy Ltd (M&EL) to carry out the engineering investigation (EI) and environmental impact assessment (EIA) studies for the two potential sites for the Phase 1 of an Integrated Waste Management Facilities (IWMF) so as to assess the overall feasibility and to facilitate selection of the preferred site. The locations of the two potential sites (Tsang Tsui Ash Lagoons site or the Shek Kwu Chau site) are shown in **Figure 1**.

1.1.2 The proposed IWMF Phase 1, occupying an area of approximately 10 ha, would have a total treatment capacity of about 3,000 tonnes per day (tpd) of mixed municipal solid waste (MSW) which comprises: (a) thermal incineration plant of about 2,800 tpd capacity; and (b) a sorting and recycling plant of a demonstration scale of about 200 tpd capacity. The mixed MSW would be delivered from various existing Refuse Transfer Stations in Hong Kong to the site by marine vessels.

1.2 Purpose of this Proposal

1.2.1 It is anticipated that the development of IWMF at Shek Kwu Chau Site will involve reclamation of approximately 10 hectares of area. If fully dredged approach were not adopted at Shek Kwu Chau Site, the reclamation works may also create potential biogas problem. For the submarine cable installations to nearby islands for electricity transmissions, the construction method would likely be jet blowing and would not require any sediment dredging.

1.2.2 For Tsang Tsui Lagoon Site, as foundation works will be carried out on the pulverized fuel ash (PFA), there may be potential of PFA-bounded metals releasing into the water environment.

1.2.3 As discussed above, sediment dredging will be anticipated at Shek Kwu Chau Site. Therefore, sediment sampling and testing in accordance with the requirements of the *Environmental, Transport and Works Bureau Technical Circular (Works) No. 34/2002 – Management of Dredged / Excavated Sediments (ETWB TCW No. 34/2002)* would be required at the proposed dredged area to characterize the sediment concerned and may be used to support future dumping permit application of dredged sediment, if applicable. However, as no sediment dredging are required for the submarine cable installations, the scope of this sampling and testing exercise would not cover the proposed cable alignments.

1.2.4 The scope of this *Sediment / PFA Sampling and Testing Plan* (SSTP) is also designed to provide information for the assessment of water quality impacts in relation to the potential release of sediment-bound contaminants into the water environment from the proposed dredging activities as well as the assessment of waste management implication for the proposed dredging works at Shek Kwu Chau Site, in particular to fulfill the requirement specified in Clause 3.7.3.5 (ii) and (xii) as well as 3.7.4.2 (iii)(a) and (iv) of the EIA Study Brief ESB-184/2008 for this Project. The scope has also extended to assess the pulverized fuel ash quality at Tsang Tsui Lagoon.

2 REVIEW OF HISTORICAL DATA

Marine Sediment Quality Data from EPD

2.1.1 EPD sediment monitoring station SS5 and SS6 are considered to be the closest sediment monitoring stations to the proposed dredging area at Shek Kwu Chau. The locations of the selected EPD sediment monitoring stations are shown in **Figure 2**. According to the routine sediment quality monitoring data from 2003 to 2007 at SS5 and SS6 collected by EPD, the average concentrations of all parameters were found to be complied with the Lower Chemical Exceedance Level (LCEL) of the *ETWB TCW No. 34/2002* and are considered to be of Category L.

Previous Sediment Quality Investigation Studies

2.1.2 A total of six sediment quality investigation studies[1] carried out around Lamma Navigation Channel and Lamma Island in the period of 1994 to 2008 were reviewed. Grab samples and core samples to depth of 6m have been collected among these studies. The analytical results generally indicated that the underlying sediments around Lamma Navigation Channel and Lamma Island were of Category L sediment.

Sediment Quality around the Proposed Site

2.1.3 Shek Kwu Chau, located southwest of Cheung Chau and south of Lantau Island, is mostly rural in nature with no existing or planned residential, commercial or industrial development other than a rehabilitation centre. No EPD routine sediment quality monitoring station is located within the proposed dredging area. In addition, no sediment quality investigations within the proposed dredging area were found available.

Previous Use of the Site

2.1.4 A review of the aerial photographs has been undertaken to evaluate the previous uses of the site. The aerial photographs reviewed are shown in **Table 2.1** below.

Table 2.1 Review of Aerial Photographs

Year	Height (Feet)	Photograph Reference Number
1962	30000	0123
1982	10000	44384
2009	20000	CW82471

Source: Survey and Mapping Office, Lands Department

2.1.5 According to the aerial photographs reviewed from Lands Department, Shek Kwu Chau was a rural area with the rehabilitation centre as the only human establishments. The rehabilitation centre consisted of a number of scattered buildings and as observed in the 1962 and 1982 aerial photographs, there were some small-scale extension (eg construction of the access

1
(a) **Axis Environmental** (1995), Sediment Quality Report, HEC Lamma Power Station; Jetty & Navigation channel Modification Works
(b) **Hyder Consulting Limited** (1997), Sediment Quality Report, HEC Lamma Power Station; Turning Basin Enlargement Works
(c) **ERM** (1998), Sediment Quality Report, Environmental Impact Assessment of a 1,800MW Gas-fired Power Station at Lamma Extension
(d) **The Hongkong Electric Co Ltd Projects Division** (2002), Environmental Impact Assessment Report, Contract No 01/8216 Lamma Power Station Navigation Channel Improvement.
(e) **Hong Kong Productivity Council** (2003), Preliminary Sediment Quality Report, HEC Lamma Power Station Extension, Submarine Gas Pipeline Sediment Sampling and Testing for Dredging
(f) **ENSR** (2008), Lamma Power Station Improvement Dredging for Navigation Channel, Chemical Screening for Determination of Sediment Quality

roads and low-rise buildings) of the rehabilitation centre. No major changes were observed since 1982.

2.1.6 In addition, there were no apparent changes within the proposed dredged area and existing shorelines in the reviewed aerial photographs.

Available Site Specific Information

2.1.7 A review of relevant previous reports / data had been undertaken at the Civil Engineering and Development Department's (CEDD) Geotechnical Information Library. No available reports / data were found within the proposed dredged area.

Summary of Historical Data Review

2.1.8 Based on the review of available information, the sediment contamination levels in the region (ie area south of Lantau Island, Lamma Island and Navigation Channel) are generally low. According to the aerial photographs reviewed, there were little human activities at/near Shek Kwu Chau Site and the potential degree of sediment contamination (in comparison to say Lamma Island), is anticipated to be minimal. Given the above, it is likely that the sediment found within the Subject Site is Category L.

2.1.9 However, as there were no available sediment quality data within the Shek Kwu Chau Site, sampling and testing, as discussed in **Section 3** below, are recommended to be conducted under this Study in order to categorise the sediment within the proposed dredged area.

3 SAMPLING AND TESTING SCHEDULE

3.1 Sampling Locations

Tsang Tsui Ash Lagoon Site

3.1.1 A total of **three (3)** numbers of grab samples (namely TT1 to TT3) of pulverized fuel ash (PFA) are proposed within the Tsang Tsui Ash Lagoon Site. The locations and coordinates of the sampling locations are shown in **Figure 3**. The exact sampling locations will be confirmed on site and subject to fine adjustment due to possible site constraints.

Shek Kwu Chau Site

3.1.2 A total of **twenty-five (25)** numbers of sediment sampling locations (namely MI1 to MI25) are proposed offshore of southwestern Shek Kwu Chau. The sediment samples shall be taken using gravity grab at the 25 locations for the Tier II chemical testing as stipulated in the *ETWB TCW 34/2002.* The sediment sampling locations are determined through a grid spacing of approximately 200m. The 200m sampling grid is considered sufficient given that the expected sediment contamination is low in the area as discussed above and with reference to *ETWB TCW 34/2002*. Of the 25 locations, sediment grab samples collected at 7 locations (i.e. MI1, MI3, MI5, MI7, MI16, MI18 and MI20) will also be selected for additional chemical testing, ambient water and elutriate testing for the purpose of water quality assessment. The 7 sampling locations are proposed based on a grid spacing of about 400m. It should be noted that similar grid spacing had also been adopted for water quality assessment in previous EIA studies including the *Wan Chai Development Phase II and Central-Wan Chai Bypass* as well as the *Dredging Works for Proposed Cruise Terminal at Kai Tak.*

3.1.3 Vibrocore sampling will be conducted at 3 of the 25 locations (i.e. MI5, MI11 and MI13) for biogas generation potential testing. Given that the actual extent of reclamation had yet to be confirmed at the time of reporting, MI11 and MI13 are proposed at the centre region of the Shek Kwu Chau Site to provide sufficient data for biogas generation potential. Furthermore, although sediment samples collected at MI11 and MI13 are considered sufficient for biogas generation potential assessment, MI5 is also proposed in order to supplement the data in the area of vicinity as reclaimed land is *most likely* to be constructed in the eastern portion of the subject site (see **Figure 4**) In addition, in order to indicate the general vertical sediment contamination profile of the subject site, vibrocore subsamples collected at MI11 and MI13 would also be subjected to Tier II, Tier III (if required), additional chemical testing and ambient water and elutriate testing. The selection of vibrocore subsamples from MI11 and MI13 for assessing the vertical contamination profile is considered sufficient given that (i) sediment contamination within the area is expected to be low and (ii) additional sampling and testing, as discussed below, would be carried out anyway if Category M or H sediments were indeed identified within the subject site.

3.1.4 The locations and coordinates of the sampling locations are shown in **Figure 4** and summarized in **Appendix A**. It should however be noted that the above sampling strategy was formulated based on the assumption that the sediment contamination levels were low. If, based on the testing results under this SSTP, the sediment within the subject site were found to be Category M or H, additional sampling and testing, at denser grids and at various sampling depths, would be necessary. Details are discussed in **Section 5.**

3.1.5 In addition to the above, a grab sample shall also be collected from EPD's routine sediment monitoring station PS6 at Port Shelter (850234E, 820057N) as the reference sediment sample.

3.1.6 The exact sampling locations will be confirmed on site and subject to fine adjustment due to possible site constraints.

3.2 Sampling Method

Sediment / PFA Sampling Method

3.2.1 Prior to sampling at each location, the sampling location shall be set out with the aid of a differential global positioning system (DGPS) or equivalent device with similar accuracy. After the setting out, the depth of water, in metres below the Principal Datum (mPD), shall be measured.

3.2.2 The sediment / PFA sampling exercise shall be supervised by the Engineer's Representative on site so as to ensure correct sampling procedures were taken.

3.2.3 The surface sediment / PFA samples shall then be taken by a closed grab sampler. The grab sampler shall need to be thoroughly washed with seawater prior to each sampling attempt.

3.2.4 The surface sediment / PFA samples shall be recovered on site and placed in laboratory-provided clean high density polyethylene containers, wide mouth borosilicate glass bottles with Teflon lined lids or other appropriate containers and sealed to prevent leakage. Containers will be first obtained from the designated chemical laboratory before field work commences. Only new or pre-cleaned sample containers shall be used to hold the sediment samples. The containers shall be labelled with station number, sample depth, sampling date and time, together with full description of the sample. If the contents are hazardous, this shall be clearly marked on the container and precautions taken during transport.

3.2.5 A total of **three (3)** sampling locations (namely MI5, MI11 and MI13) shall use vibrocoring method to collect sediment. The vibrocoring shall be continuous and shall terminate at 1m below the alluvium layer or at depth as instructed by the Engineer's Representative on-site. The minimum sample recovery shall be at least 80% of the vibrocore length for each sampling attempt.

3.2.6 The vibrocore sample shall be sub-sampled and cut on-site into 1m sections except the first sub-sample which should be 0.0-0.9m. The top levels of these sub-samples shall be seabed (0m), 0.9m down, 1.9m down, 2.9m down and every 1m down. Both cut ends of each vibrocore sub-sample shall then be sealed up with tightly fitting rubber caps and duct-taped in place. Each vibrocore sub-sample shall be clearly labeled 'top' and 'bottom' and with sample identify (e.g., station number, sample depth, sampling date and time, together with full description of the sample).

Sample Handling

3.2.7 The samples shall be stored, transported and maintained at 4°C or lower without being frozen in the dark prior to any laboratory testing. All samples shall be packed and transported in such a manner as to avoid shock, vibration or any other disturbance of the samples. Samples shall be delivered to laboratory within 24 hours after collection and analyzed within 14 days of delivery for chemical testing. The chain-of-custody procedure shall be followed to record the flow of sample handling, from collection of samples to delivery of samples to the designated Laboratory.

Sample Size

3.2.8 Prior to sampling, the laboratory responsible for analysis should be consulted for the particular sample size for chemical / biological testing. According to the *ETWB TCW No. 34/2002*, the recommended sample sizes for each parameter and test are as follows:

Table 3.1 Recommended Sample Size

Parameters to be tested	Sample Size
Metals and metalloid	0.5 L
Others	0.5 L
Biological response	6 L

3.3 In-Situ Composite Water Sampling Method

3.3.1 Ambient water samples will be taken at 9 sampling stations (ie MI1, MI3, MI5, MI7, MI16, MI18 and MI20 for grab samples and MI11 and MI13 for vibrocore subsamples) as discussed in **Section 3.1** above. Ambient marine water samples shall be collected from 1m below the

surface, mid-depth and 1m above seabed, and pooled to form a composite water sample. Containers will be first obtained from the designated chemical laboratory before field work commences. The water sample collection shall commence before the sediment collection in order to avoid disturbance to the seabed which would potentially affect the quality of the water samples. The composite water samples shall then be poured into the pre-labelled sample storage containers and maintained in a chilled (around 4^{o}C) condition in the dark. The sample shall be delivered to the laboratory in an expedient manner and shall be kept chilled (at about 4^{o}C) but not frozen and stored in the dark prior to chemical analysis.

4 LABORATORY ANALYSIS

4.1 Tsang Tsui Ash Lagoon Site

4.1.1 For the purpose of assessing the quality of PFA and the potential of release of PFA bounded metals into surrounding water environment during foundation works, the 3 grab samples collected at Tsang Tsui Ash Lagoon shall be subject to the Toxicity Characteristic Leaching Procedure (TCLP) as shown below.

Table 4.1 TCLP for PFA Samples at Tsang Tsui Ash Lagoon

Parameters	Testing Method
TCLP	
Aluminum	USEPA Method 6020 or equivalent
Cadmium	
Chromium	
Copper	
Nickel	
Iron	
Lead	
Zinc	
Mercury	
Manganese	
Tin	
Silver	
Antimony	
Arsenic	
Beryllium	
Thallium	
Vanadium	
Selenium	
Barium	

4.2 Shek Kwu Chau Site

Chemical Testing (Tier II)

4.2.1 All surface grab samples and selected number of vibrocore subsamples collected at MI11 and MI13 of Shek Kwu Chau Site will be tested for parameters stated in Table 1 – Analytical Methodology in Appendix B of *ETWB TCW No. 34/2002*. The top levels of the vibrocore subsamples to be tested for Tier II shall be seabed (0m), 0.9m down, 1.9m down, 2.9m down and every **3m** down until the bottom of marine deposit layer. The parameters to be analyzed, methodology used and detection limits are presented in **Table 4.2**. **Appendix A** summarized the parameters to be analyzed for each sampling location and depth.

Table 4.2 Chemical Testing Parameters

Parameters	Reporting Limit	Preparation Method USEPA Method	Determination Method USEPA Method
Metals (mg/kg dry weight)			
Cadmium (Cd)	0.2	3050B	6020A or 7000A or 7131A
Chromium (Cr)	8	3050B	6010C or 7000A or 7190
Copper (Cu)	7	3050B	6010C or 7000A or 7210
Mercury (Hg)	0.05	7471A	7471A
Nickel (Ni)	4	3050B	6010C or 7000A or 7520
Lead (Pb)	8	3050B	6010C or 7000A or 7420
Silver (Ag)	0.1	3050B	6020A or 7000A or 7761
Zinc (Zn)	20	3050B	6010C or 7000A or 7950
Metalloid (mg/kg dry weight)			

Parameters	Reporting Limit	Preparation Method USEPA Method	Determination Method USEPA Method
Arsenic	1	3050B	6020A or 7000A or 7061A
Organic-PAHs (µg/kg dry weight)			
Low Molecular Weight PAHs+	55	3550B or 3540C and 3630C	8260B or 8270C
High Molecular Weight PAHs++	170	3550B or 3540C and 3630C	8260B or 8270C
Organic-non-PAHs (µg/kg dry weight)			
Total PCBs+++	3	3550B or 3540 C and 3665A	8082
Organometallics (µg TBT/L in interstitial water)			
Tributytin	0.015	Krone et al. (1989)* - GC/MS UNEP/IOC/IAEA**	Krone et al. (1989)* - GC/MS UNEP/IOC/IAEA**

Note:

+ Low molecular weight PAHs include acenaphthene, acenaphthylene, anthracene, fluorene, naphthalene, and phenanthrene.

++ High molecular weight PAHs include benzo(a)anthracene, benzo(a)pyrene, chrysene, dibenzo(a,h)anthracene, fluoranthene, pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, indeno(1,2,3-c,d)pyrene and benzo(g,h,i)perylene.

+++ The reporting limit is for individual PCB congeners. Total PCBs include 2,4' diCB, 2,2',5 triCB, 2,4,4' triCB, 2,2',3,5' tetraCB, 2,2',5,5' tetraCB, 2,3',4,4' tetraCB, 3,3',4,4' tetraCB, 2,2',4,5,5' pentaCB, 2,3,3',4,4' pentaCB, 2,3',4,4',5 pentaCB, 3,3',4,4',5 pentaCB, 2,2',3,3',4,4' hexaCB, 2,2',3,4,4',5' hexaCB, 2,2',4,4',5,5' hexaCB, 3,3',4,4',5,5' hexaCB, 2,2',3,3',4,4',5 heptaCB, 2,2',3,4,4',5,5' heptaCB, 2,2',3,4',5,5',6 heptaCB (ref: the "summation" column of Table 9.3 of Evaluation of Dredged Material Proposed for Discharge in Waters of the U.S. - Testing Manual (The Inland Testing Manual) published by USEPA).

* Krone et al. (1989), A method for analysis of butyltin species and measurement of butyltins in sediment and English Sole livers from Puget Sound, Marine Environmental Research 27 (1989) 1-18. Interstitial water to be obtained by centrifuging the sediment and collecting the overlying water.

** UNEP/IOC/IAEC refers to IAEA's Marine Environment Laboratory reference methods. Interstitial water to be obtained by centrifuging the sediment and collecting the overlying water.

Biological Testing (Tier III)

4.2.1 According to *ETWB TCW No. 34/2002*, Tier III screening will be required if Category M and certain Category H sediment were identified. For the latter, Tier III screening is required if one or more contaminant levels exceeded 10 times the LCEL. If such sediments were identified in the chemical screening, a biological testing proposal, together with the Tier II results, will be submitted to EPD for approval prior to the commencement of the Tier III screening. The biological testing proposal will include the following information:

- the number of biological tests;
- the arrangement for preparing the composite samples; and
- the test species and test conditions.

4.2.2 Subject to EPD's approval of the biological testing proposal, the following toxicity test will be carried out on the composite and reference samples. Composite sample is prepared by mixing up to 5 samples of the same category (M or H) which are continuous in vertical or horizontal profile.

- a 10-day burrowing amphipod toxicity test ; and
- a 20-day burrowing polychaete toxicity test; and
- a 48-96 hour larvae (bivalve or echinoderm) toxicity test.

4.2.3 For sediment sample that were classified in the chemical screening as Category H with one or more contaminant levels exceeding 10 times the Lower Chemical Exceedance Level (LCEL), the toxicity tests for that particular composite sample will be conducted in a diluted manner (dilution test) in accordance with *ETWB TCW No. 34/2002*.

4.2.4 The species to be used for each type of biological test will be selected from **Table 4.3** below. **Appendix A** summarized the parameters to be analyzed for each sampling location and depth.

Table 4.3 Testing Parameters for Biological Screening (Tier III) for Composite Samples

Test Type	Species	Reference Test Condition*
10-day burrowing amphipod toxicity test	*Ampelisca abdita*	USEPA (1994) / PSEP (1995)
	Leptocheirus plumulosus	USEPA (1994)
	Eohaustorius estuaries	USEPA (1994) / PSEP (1995)
20-day burrowing polychaete toxicity test	*Neanthes arenaceodentata*	PSEP (1995)
48-96 hour larvae (bivalve or echinoderm) toxicity test	Bivalve: *Mytilus spp.* *Crassostrea gigas*	PSEP (1995)
	Echinoderm: *Dendraster excentricus* *Strongylocentrotus spp.*	

* Note:
(i) U.S.EPA (U.S. Environmental Protection Agency) 1994. Methods for assessing the toxicity of sediment-associated contaminants with estuarine and marine amphipods. Office of Research and Development. U.S. Environmental Protection Agency, Cincinnati, OH. EPA/600/R94/025.
(ii) PSEP (Puget Sound Estuary Program) 1995. Recommended guidelines for conducting laboratory bioassays on Puget Sound sediments.

4.2.5 Ancillary test, including porewater salinity, ammonia, TOC, grain size and moisture content will also be tested on the composite and reference samples. The ancillary test will provide necessary information on the general characteristics of the sediment. Test organisms will be selected based on their application limits for sediment grain size and porewater salinity. When ammonia level is found to be higher than the tolerance limit (ie > 20 mg/L), sediment samples will be flushed (purged) by frequent renewal of the overlying water, after test set-up, until the ammonia level drops below the tolerance limit.

4.2.6 The test endpoints and decision criteria are summarized in Table 2 in Appendix B of *ETWB TCW No. 34/2002* and shown in **Table 4.4** below. The sediment is deemed to have failed the biological test if it fails in any one of the three toxicity tests.

Table 4.4 Test Endpoints and Decision Criteria for Tier III Biological Testing

Toxicity test	Endpoints measured	Failure criteria
10-day amphipod	Survival	Mean survival in test sediment is significantly different ($p \leq 0.05$)[1] from mean survival in reference sediment **and** mean survival in test sediment < 80% of mean survival in reference sediment.
20-day polychaete	Dry Weight[2]	Mean dry weight in test sediment is significantly different ($p \leq 0.05$)[1] from mean dry weight in reference sediment **and** mean dry weight in test sediment < 90% of mean dry weight in reference sediment.
48-96 hour bivalve larvae	Normality Survival[3]	Mean normality survival in test sediment is significantly different ($p \leq 0.05$)[1] from mean normality survival in reference sediment **and** mean normality survival in test sediment < 80% of mean normality survival in reference sediment.

[1] Statistically significant differences should be determined using appropriate two-sample comparisons (e.g., *t-tests*) at a probability of $p \leq 0.05$.
[2] Dry weight means total dry weight after deducting dead and missing worms.
[3] Normality survival integrates the normality and survival end points, and measures survival of only the normal larvae relative to the starting number.

4.3 Biogas Generation Potential Assessment

4.3.1 In case where sediment / mud is to be left in place within the reclamation area, potential generation of biogas might be of concern. For the purpose of assessing the potential biogas generation from the future reclaimed land, all the vibrocore subsamples collected at MI5, MI11 and MI13 shall also be subject to the test as shown in **Table 4.5.** The top levels of the vibrocore subsamples to be tested for biogas generation potential assessment shall be seabed (0m), 0.9m down, 1.9m down, 2.9m down and every **1m** down until the bottom of marine deposit layer.

Table 4.5 Testing Parameters for Biogas Generation Assessment

Parameters
Moisture Content (%)
Density
Total Organic Carbon
20-day Sediment Oxygen Demand

4.4 Additional Chemical Testing for Water Quality Assessment

4.4.1 In addition to the above chemical and biological testing under *ETWB TCW No. 34/2002*, additional chemical testing for the parameters as shown in **Table 4.6** will be conducted on the sediment grab samples collected at 7 sampling stations (ie MI1, MI3, MI5, MI7, MI16, MI18 and MI20) and all the vibrocore subsamples collect at 2 sampling stations (ie MI11 and MI13). The sampling locations are shown in **Figure 4**. The purpose of the additional chemical testing is to allow for the evaluation of sediment contamination by nutrient, bioavailability and physiochemical properties.

Table 4.6 Additional Chemical Testing Parameters

Type of Contaminants	**Parameters**
Nutrient	Total Kjeldahl Nitrogen
	Ammonia Nitrogen
	Nitrate Nitrogen
	Nitrite Nitrogen
	Total Phosphorus
Bioavailability / Physiochemical Properties	Acid Volatile Sulphide (AVS)
	Grain Size
	Moisture Content

4.5 Ambient Water and Elutriate Testing for Water Quality Assessment

4.5.1 The grab sediment samples and vibrocore subsamples collected at the abovementioned sampling stations (i.e. MI1, MI3, MI5, MI7, MI16, MI18 and MI20 for grab sediment samples; MI11 and MI13 for vibrocore subsamples) will also be used for elutriate test. The sediment samples will be mixed with the composite water collected in the same station in a sediment-to-water ratio of 1:4. The mixture is mechanically shaken vigorously for 30 minutes and then settled undisturbed for 1 hour. The liquid phase is then centrifuged to remove all suspended particulate matter. The extracted liquid filtrate is the elutriate to be used for further testing.

4.5.2 All the composite water samples and elutriate shall be tested for parameters in **Table 4.2** as well as the nutrient parameters in **Table 4.6**. The parameters and the corresponding reporting limits and testing methods are summarized in **Table 4.7** below. All the samples not analyzed immediately shall be maintained in a chilled but not frozen (~4^{o}C) condition in the dark in the laboratory.

Table 4.7 Testing Parameters and Reporting Limits for Ambient Water Samples and Elutriates

Type of Contaminants	Parameters	Recommended Reporting Limit^	Recommend Testing Method^
Nutrient	Total Kjeldahl Nitrogen	0.1 mg N /L	APHA 4500 N_{org}: A,B,D
	Ammonia Nitrogen	0.1 mg NH_3-N /L	APHA 4500 NH_3 G,H
	Nitrate Nitrogen	0.1 mg NO_3^--N /L	APHA 4500 NO_3: F
	Nitrite Nitrogen	0.1 mg NO_2^--N /L	APHA 4500 NO_2 B
	Total Phosphorus	0.1 mg P /L	APHA 4500 P:B,E,F,H
Metals	Cadmium (Cd)	0.1 µg/L	USEPA 6020A
	Chromium (Cr)	0.2 µg/L	USEPA 6020A
	Copper (Cu)	0.2 µg/L	USEPA 6020A
	Mercury (Hg)	0.2 µg/L	USEPA 6020A
	Nickel (Ni)	0.2 µg/L	USEPA 6020A
	Lead (Pb)	0.2 µg/L	USEPA 6020A
	Silver (Ag)	0.2 µg/L	USEPA 6020A
	Zinc (Zn)	0.4 µg/L	USEPA 6020A
Metalloid (mg/L)	Arsenic	0.2 µg/L	USEPA 6020A
Organic-PAHs	Low Molecular Weight PAHs+	0.02 µg/L	USEPA 8260B or 8270C
	High Molecular Weight PAHs++	0.02 µg/L	USEPA 8260B or 8270C
Organic-non-PAHs	Total PCBs+++	0.004 µg/L	USEPA 3550B or 3665A and 8270C
Organometallics	Tributytin	0.015 µg/L	Krone et al. (1989)* - GC/MS UNEP/IOC/IAEA**

Note:
^ Reporting Limit / Testing Method to be confirmed with the Laboratory
\+ Low molecular weight PAHs include acenaphthene, acenaphthylene, anthracene, fluorene, naphthalene, and phenanthrene.
++ High molecular weight PAHs include benzo(a)anthracene, benzo(a)pyrene, chrysene, dibenzo(a,h)anthracene, fluoranthene, pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, indeno(1,2,3-c,d)pyrene and benzo(g,h,i)perylene.
+++ The reporting limit is for individual PCB congeners. Total PCBs include 2,4' diCB, 2,2',5 triCB, 2,4,4' triCB, 2,2',3,5' tetraCB, 2,2',5,5' tetraCB, 2,3',4,4' tetraCB, 3,3',4,4' tetraCB, 2,2',4,5,5' pentaCB, 2,3,3',4,4' pentaCB, 2,3',4,4',5 pentaCB, 3,3',4,4',5 pentaCB, 2,2',3,3',4,4' hexaCB, 2,2',3,4,4',5' hexaCB, 2,2',4,4',5,5' hexaCB, 3,3',4,4',5,5' hexaCB, 2,2',3,3',4,4',5 heptaCB, 2,2',3,4,4',5,5' heptaCB, 2,2',3,4',5,5',6 heptaCB (ref: the "summation" column of Table 9.3 of Evaluation of Dredged Material Proposed for Discharge in Waters of the U.S. - Testing Manual (The Inland Testing Manual) published by USEPA).
* Krone et al. (1989), A method for analysis of butyltin species and measurement of butyltins in sediment and English Sole livers from Puget Sound, Marine Environmental Research 27 (1989) 1-18. Interstitial water to be obtained by centrifuging the sediment and collecting the overlying water.
** UNEP/IOC/IAEC refers to IAEA's Marine Environment Laboratory reference methods. Interstitial water to be obtained by centrifuging the sediment and collecting the overlying water.

4.6 QA/QC Requirements

4.6.1 All tests shall be conducted by laboratories accredited by Hong Kong Laboratory Accreditation Scheme (HOKLAS) or, in case of overseas laboratories, by equivalent national accreditation for these tests.

4.6.2 For chemical screening, the following QC plan shall be implemented for the laboratory testing:

- Method Blank
- Duplicate (at 5% level i.e. one for every 20 samples)
- Matrix Spike (at 5% level i.e. one for every 20 samples)

4.6.3 The proposed data quality objectives are shown in **Table 4.8**.

Table 4.8 Data Quality Objectives for Chemical Screening

Quality Controls	Acceptance Criteria
Method Blank	Less than method detection limit (MDL)
Duplicate	Agree within ±25% of the mean of duplicate results
Matrix Spike	Agree within ±25% of the recovery of spike concentration

4.6.4 For biological screening, negative and positive control shall be included as appropriate quality assurance/quality control.

5 INTERPRETATION OF RESULTS AND WAY FORWARD

5.1.1 Data obtained from the chemical testing, additional chemical testing, ambient water and elutriate testing and biological testing (if any) in this SSTP would be used to assess the waste implications and water quality impacts associated with the construction works for the Project by identifying and quantifying the dredging / excavation, transportation, disposal arrangements and impacts due to dredging for sediment / mud in the EIA Study (as per Clause 3.7.3.5 (xii), 3.7.4.2 (iii)(a) of the ESB). In addition, the data obtained from biogas generation potential would be used to assess the potential biogas problem (as per Clause 3.7.4.2(iv))

5.1.2 The sediment quality for Tier II screening should be assessed according to ETWB TCW No. 34/2002. As specified in the ETWB TCW, sediments are classified into three categories based on their contaminant levels. The classification is as follows:

Category L: Sediment with all contaminant levels not exceeding the Lower Chemical Exceedance Level (LCEL). The materials must be dredged, transported and disposed of in a manner which minimizes the loss of contaminants either into solution or by resuspension.

Category M: Sediment with any one or more contaminant levels exceeding the Lower Chemical Exceedance Level (LCEL) and none exceeding the Upper Chemical Exceedance Level (UCEL). The material must be dredged and transported with care, and must be effectively isolated from the environment upon final disposal unless appropriate biological tests demonstrate that the material will not adversely affect the marine environment.

Category H: Sediment with any one or more contaminant levels exceeding the Upper Chemical Exceedance Level (UCEL). The material must be dredged and transported with great care, and must be effectively isolated from the environment upon final disposal.

5.1.3 The sediment quality criteria for the classification of sediment are shown in **Table 5.1** below.

Table 5.1 Sediment Quality Criteria for the Classification of Sediment

Contaminants	Lower Chemical Exceedance Level (LCEL)	Upper Chemical Exceedance Level (UCEL)
Metals (mg/kg dry wt.)		
Cadmium (Cd)	1.5	4
Chromium (Cr)	80	160
Copper (Cu)	65	110
Mercury (Hg)	0.5	1
Nickel (Ni)*	40	40
Lead (Pb)	75	110
Silver (Ag)	1	2
Zinc (Zn)	200	270
Metalloid (mg/kg dry wt.)		
Arsenic	12	42
Organic-PAHs (μg/kg dry wt.)		
Low Molecular Weight PAHs	550	3160
High Molecular Weight PAHs	1700	9600
Organic-non-PAHs (μg/kg dry wt.)		
Total PCBs	23	180
Organometallics (μg TBT/L in Interstitial water)		
Tributyltin*	0.15	0.15

* The contaminant level is considered to have exceeded the UCEL if it is greater than the value shown.

5.1.4 Tier III biological screening will be conducted for further analysis of Category M and Category H sediment with one or more contaminant levels exceeding 10 times the LCEL. If Tier III biological screening were to be conducted for Category H sediment with one or more

contaminant levels exceeding 10 times LCEL, the test shall be conducted in a diluted manner (dilution test). The methods will follow the requirements of *ETWB TCW No. 34/2002*.

5.1.5 Based on the available sediment quality data, the identification of Category M or H sediments as discussed above were considered unlikely within Shek Kwu Chau Site. However, if based on the analytical results, Category M or H sediments were indeed identified within the Subject Site, additional sampling and testing, at denser sampling grid and at various depths, will need to be conducted where appropriate. The additional sampling and testing, if required, will be agreed with EPD prior to commencement of the site investigation works.

Appendix A

Summary Table of Sampling Locations And Methods, Sample Details and Testing Parameters for Tier II and III Testing under *ETWB TCW No. 34/2002*

Table A.1 Summary Table of Sampling Locations and Methods, Sample Details and Testing Parameters for Chemical Screening (Tier II Testing)

Sampling Location I.D.	Coordinates of Sediment Location		Type and Methods of Sampling[1]	Depth of Sediment Sample	Estimated Number of Sediment Samples per Location	Testing Parameters[4]												Sample Preservation / Storage
						Metals / Metalloid									Organic-PAHs		Organic-non-PAHs	Organometallics	
	Easting	Northing				Cd	Cr	Cu	Hg	Ni	Pb	Ag	Zn	As	LW[5]	HW[6]	Total PCBs[7]	Tributytin[8]	
MI1	816139	806112	Grab	Surface	1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	Grab samples tested for metals and metalloid shall be stored in high density polyethylene containers. Grab samples tested for organics shall be stored in wide mouth Borosilicate glass containers with Teflon lined lid. Vibrocore subsamples shall be stored in vibrocore plastic liner tube. All collected samples shall be kept at 4℃ in the dark without being frozen.
MI2	816298	805994	Grab	Surface	1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
MI3	816452	805877	Grab	Surface	1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
MI4	816611	805757	Grab	Surface	1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
MI5	816769	805640	Grab	Surface	1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
MI6	816926	805521	Grab	Surface	1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
MI7	817068	805415	Grab	Surface	1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
MI8	815917	806065	Grab	Surface	1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
MI9	816035	805975	Grab	Surface	1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
MI10	816192	805854	Grab	Surface	1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
MI11	816347	805735	Grab	Surface	6[2]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
			Vibrocore	0 – 0.9m bsl[2,3]		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
				0.9 – 1.9m bsl[2,3]		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
				1.9 – 2.9m bsl[2,3]		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
				2.9 – 3.9m bsl[2,3]		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
				5.9 – 6.9m bsl[2,3]		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
MI12	816503	805615	Grab	Surface	1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
MI13	816659	805495	Grab	Surface	6[2]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
			Vibrocore	0 – 0.9m bsl[2,3]		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
				0.9 – 1.9m bsl[2,3]		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
				1.9 – 2.9m bsl[2,3]		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
				2.9 – 3.9m bsl[2,3]		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
				5.9 – 6.9m bsl[2,3]		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
MI14	816818	805376	Grab	Surface	1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
MI15	816971	805258	Grab	Surface	1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
MI16	815912	805816	Grab	Surface	1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
MI17	816069	805695	Grab	Surface	1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
MI18	816225	805576	Grab	Surface	1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
MI19	816382	805456	Grab	Surface	1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
MI20	816537	805336	Grab	Surface	1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
MI21	816717	805245	Grab	Surface	1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
MI22	815851	805662	Grab	Surface	1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
MI23	815947	805536	Grab	Surface	1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
MI24	816105	805416	Grab	Surface	1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
MI25	816280	805342	Grab	Surface	1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
PS6	850234	820057	Grab	Surface	1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	

Note:

1 Please refer to Section 3.2 of SSTP for procedure of grab and vibrocore sampling.
2 Actual sampling depths and number of sediment samples are subject to the thickness of the marine deposit layer and site conditions.
3 m bsl: metres below seabed level.
4 Please refer to Table 4.2 of SSTP for laboratory testing methods.
5 LW: Low molecular weight PAHs, including acenaphthene, acenaphthylene, anthracene, fluorene, naphthalene, and phenanthrene.
6 HW: High molecular weight PAHs, including benzo(a)anthracene, benzo(a)pyrene, chrysene, dibenzo(a,h)anthracene, fluoranthene, pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, indeno(1,2,3-c,d)pyrene and benzo(g,h,i)perylene.
7 Total PCBs include 2,4' diCB, 2,2',5 triCB, 2,4,4' triCB, 2,2',3,5' tetraCB, 2,2',5,5' tetraCB, 2,3',4,4' tetraCB, 3,3',4,4' tetraCB, 2,2',4,5,5' pentaCB, 2,3,3',4,4' pentaCB, 2,3',4,4',5 pentaCB, 3,3',4,4',5 pentaCB, 2,2',3,3',4,4' hexaCB, 2,2',3,4,4',5' hexaCB, 2,2',4,4',5,5' hexaCB, 3,3',4,4',5,5' hexaCB, 2,2',3,3',4,4',5 heptaCB, 2,2',3,4,4',5,5' heptaCB, 2,2',3,4',5,5',6 heptaCB (ref: the "summation" column of Table 9.3 of Evaluation of Dredged Material Proposed for Discharge in Waters of the U.S. - Testing Manual (The Inland Testing Manual) published by USEPA).
8 TBT analysis would be subject to the availability of interstitial water in sediment samples.

Table A.2 Summary Table of Sampling Locations and Methods, Sample Details and Testing Parameters for Biological Screening (Tier III Testing)

Sampling Location I.D.	Coordinates of Sediment Location		Type and Methods of Sampling[1]	Depth of Sediment Sample	Estimated Number of Sediment Samples per Location	Testing Parameters[4]			Sample Preservation / Storage
	Easting	Northing				10-day burrowing amphipod toxicity test	20-day burrowing polychaete toxicity test	48-96 hour larvae (bivalve or echinoderm) toxicity test	
MI1	816139	806112	Grab	Surface	1	To be confirmed[5].	To be confirmed[5].	To be confirmed[5].	Grab samples shall be stored in high density polyethylene containers. Vibrocore subsamples shall be stored in plastic liner tube. All collected samples shall be kept at 4℃ in the dark without being frozen.
MI2	816298	805994	Grab	Surface	1				
MI3	816452	805877	Grab	Surface	1				
MI4	816611	805757	Grab	Surface	1				
MI5	816769	805640	Grab	Surface	1				
MI6	816926	805521	Grab	Surface	1				
MI7	817068	805415	Grab	Surface	1				
MI8	815917	806065	Grab	Surface	1				
MI9	816035	805975	Grab	Surface	1				
MI10	816192	805854	Grab	Surface	1				
MI11	816347	805735	Grab	Surface	6[2]				
			Vibrocore	0 – 0.9m bsl[2,3]					
				0.9 – 1.9m bsl[2,3]					
				1.9 – 2.9m bsl[2,3]					
				2.9 – 3.9m bsl[2,3]					
				5.9 – 6.9m bsl[2,3]					
MI12	816503	805615	Grab	Surface	1				
MI13	816659	805495	Grab	Surface	6[2]				
			Vibrocore	0 – 0.9m bsl[2,3]					
				0.9 – 1.9m bsl[2,3]					
				1.9 – 2.9m bsl[2,3]					
				2.9 – 3.9m bsl[2,3]					
				5.9 – 6.9m bsl[2,3]					
MI14	816818	805376	Grab	Surface	1				
MI15	816971	805258	Grab	Surface	1				
MI16	815912	805816	Grab	Surface	1				
MI17	816069	805695	Grab	Surface	1				
MI18	816225	805576	Grab	Surface	1				
MI19	816382	805456	Grab	Surface	1				
MI20	816537	805336	Grab	Surface	1				
MI21	816717	805245	Grab	Surface	1				
MI22	815851	805662	Grab	Surface	1				
MI23	815947	805536	Grab	Surface	1				
MI24	816105	805416	Grab	Surface	1				
MI25	816280	805342	Grab	Surface	1				
PS6	850234	820057	Grab	Surface	1				

Note:

1 Please refer to Section 3.2 of SSTP for procedure of grab and vibrocore sampling.
2 Actual sampling depth and number of sediment samples are subject to the thickness of the marine deposit layer and site conditions.
3 m bsl: metres below seabed level.
4 Please refer to Table 4.3 of SSTP for laboratory testing methods.
5 Tier III biological screening is only required for Category M and Category H (>10 LCEL) sediment sample identified under Tier II chemical screening. The actual number of samples for Tier III screening would be determined by (i) the Tier II chemical screening results, (ii) the number of composite samples and (iii) EPD's approved biological testing proposal. Please refer to S.4.2 – Biological Testing (Tier III) for details.

Table A.3 Summary Table of Sampling Locations and Methods, Sample Details and Testing Parameters for Water Quality Assessment at Shek Kwu Chau Site

Sampling Location I.D.	Coordinates of Sampling Location		Type and Methods of Sampling[1]	Depth of Sample	Estimated Number of Samples per Location	Testing Parameters										Sample Preservation / Storage
						Additional Chemical Testing[2]								Chemical Screening (Tier II)[4]	Elutriate Test[5]	
	Easting	Northing				TKN[3]	$NH_4 - N$[3]	$NO_2 - N$[3]	$NO_3 - N$[3]	Total P[3]	AVS	Grain Size	Moisture Content			
MI1	816139	806112	Grab	Surface	1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Grab and composite water sample shall be stored in high density polyethylene containers and wide mouth Borosilicate glass containers with Teflon lined lid. Sulfuric acid shall be added as preservative in the composite water sample to be tested for nutrient. Vibrocore subsamples shall be stored in vibrocore plastic liner tube. All collected samples shall be kept at 4℃ in the dark without being frozen.
			Composite water sample	See Note 6	1	✓	✓	✓	✓	✓				✓		
MI3	816452	805877	Grab	Surface	1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
			Composite water sample	See Note 6	1	✓	✓	✓	✓	✓				✓		
MI5	816769	805640	Grab	Surface	1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
			Composite water sample	See Note 6	1	✓	✓	✓	✓	✓				✓		
MI7	817068	805415	Grab	Surface	1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
			Composite water sample	See Note 6	1	✓	✓	✓	✓	✓				✓		
MI11	816347	805735	Vibrocore	0 – 0.9m bsl[7,8]	7[7]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
				0.9 – 1.9m bsl[7,8]		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
				1.9 – 2.9m bsl[7,8]		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
				2.9 – 3.9m bsl[7,8]		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
				3.9 – 4.9m bsl[7,8]		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
				4.9 – 5.9m bsl[7,8]		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
				5.9 – 6.9m bsl[7,8]		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
			Composite water sample	See Note 6	1	✓	✓	✓	✓	✓				✓		
MI13	816659	805495	Vibrocore	0 – 0.9m bsl[7,8]	7[7]	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
				0.9 – 1.9m bsl[7,8]		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
				1.9 – 2.9m bsl[7,8]		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
				2.9 – 3.9m bsl[7,8]		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
				3.9 – 4.9m bsl[7,8]		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
				4.9 – 5.9m bsl[7,8]		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
				5.9 – 6.9m bsl[7,8]		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
			Composite water sample	See Note 6	1	✓	✓	✓	✓	✓				✓		
MI16	815912	805816	Grab	Surface	1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
			Composite	See Note 6	1	✓	✓	✓	✓	✓				✓		

			water sample													
MI18	816225	805576	Grab	Surface	1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
			Composite water sample	See Note 6	1	✓	✓	✓	✓	✓				✓		
MI20	816537	805336	Grab	Surface	1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
			Composite water sample	See Note 6	1	✓	✓	✓	✓	✓				✓		

Note:
1 Please refer to Section 3.2 and 3.3 of SSTP for procedure of grab, vibrocore and water sampling.
2 Please refer to Table 4.7 of SSTP for laboratory testing methods.
3 TKN: Total Kjeldahl Nitrogen. NH_4 – N: Ammonia Nitrogen. NO_2 – N: Nitrite Nitrogen. NO_3 – N: Nitrate Nitrogen. Total P: Total Phosphorus
4 Please refer to Table 4.2 of SSTP for testing parameters and methods for chemical screening.
5 Please refer to Section 4.5 and Table 4.7 of SSTP for elutriate preparation and laboratory testing methods respectively. .
6 Ambient water sample will be collected from 1m below surface, mid-depth and 1m above seabed.
7 Sampling to bottom of the marine deposit layer. Actual sampling depth and number of sediment samples are subject to the thickness of the marine deposit layer and site conditions.
8 m bsl: metres below seabed level.

Appendix B

Comments and Response

Agreement No. CE 29/2008 (EP)
Engineering Investigation and Environmental Studies
for Integrated Waste Management Facilities
Phase 1 – Feasibility Study

Sediment Sampling and Testing Plan

Comments & Responses

From : EPD (Mr. Thomas To)
Ref : ( ) in Ax (1) to EP2/G/G131
Date : 27 March 2008

Comments Received	**Responses**
Water	
(a) S.1.2 - Please include in the testing plan the chemical analysis of sediment samples collected at various depths of the proposed dredged layers, in order to provide necessary site specific information if a fully dredged approach is finally adopted at Shek Kwu Chau	As discussed in our historical data review in Section 2 of the SSTP and as per response to comment (l) below, sediment contamination level within the site is expected to be low. As a result, samples will only be collected at surface level and at 200 x 200 m grid in accordance with ETWB TCW No. 34/2002. Please also see response to comment (l) below. Nevertheless (although not likely), if the laboratory results from the sampling and testing exercises indicate that the sediment is Category M or H, additional sampling and testing, at denser grid and at various depths, will be proposed in the vicinity of the contaminated area. Additional sampling and testing, if required, will be agreed with EPD prior to commencement.
(b) S.3.2.3 - Please give more details on the collection of PFA samples, i.e. indicating whether grab sampler is to be used. Please also state whether the PFA samples would be collected from the surface or at certain depth below the surface.	Please note that the PFA will be collected using closed grab sampler and at surface. Text will be revised accordingly.
(c) S.4.3 - Please note that the aspect of biogas generation assessment does not fall within the scope of water quality impact assessment at Shek Kwu Chau.	Agreed. However, please note that the assessment of biogas generation is to fulfill the requirements of EIA Study Brief under Clause 3.7.4.2 - Waste Management Implications.
(d) S.4.5.1 – 2nd last sentence – Please delete from the sentence “or filtered through a 45 um filter”	Noted. The sentence will be revised accordingly.
(e) S.4.5.2 – The reference methods and reporting limits proposed for testing the parameter concerned in the marine sediment elutriates should be provided as appropriate.	Noted. The reference methods and reporting limits will be provided in the revised SSTP.

Comments Received	**Responses**
(f) S.5.11 – Please explain how the TCLP results for the PFA would be used to assess the water quality impacts.	The TCLP results will provide information on the quality of PFA leachate, which will be compared to the water quality assessment criteria to evaluate the potential impacts from the release of PFA leachate to the nearby aquatic environment due to any proposed piling work within the ash lagoon area. This assessment approach has also been adopted under the approved EIA for Sludge Treatment Facilities for evaluation of the water quality impacts from PFA leachate due to piling activities.
Waste	
General Comments	
(g) As revealed from S.4.1.1, there may be potential release of PFA-bounded metals into surrounding water environment during foundation works. The consultants need to justify whether TCLP is a suitable testing method to assess this potential Impact on water environment.	The TCLP results will provide information on the quality of PFA leachate, which will be compared to the water quality assessment criteria to evaluate the potential impacts from the release of PFA leachate to the nearby aquatic environment due to any proposed piling work within the ash lagoon area. This assessment approach has also been adopted under the approved EIA for Sludge Treatment Facilities for evaluation of the water quality impacts from PFA leachate due to piling activities.
(h) Since this report is focusing on the sediment sampling and testing plan (SSTP), we presume that the consultants will submit the sampling and testing of pulverized fuel ash in a separate submission. As such, please delete the irrelevant part in this SSTP.	Please note that the purpose of the plan is to discuss the details of sediment and PFA sampling and testing in order to fulfill the EIA Study Brief Clause 3.7.3.5 (ii) and (xii) - Water Quality Assessment and Clause 3.7.4.2 (iii)(a) and (iv) – Waste Management Implications. To avoid confusion, the report will be renamed as Sediment / PFA Sampling and Testing Plan.
(i) As indicated in S.2.1.5.2 of the EIA Inception Report, the need of handling and dumping of marine sediment will arise from the submarine cable construction works. Hence, the consultants need to confirm whether additional sampling locations and associated testing programme are required.	Additional sampling locations and associated testing programme will be proposed along the proposed alignment of the submarine cable. Kindly note that we are agreeing with our client and relevant parties the suitable destination for electricity export and the alignment of the submarine cable. The potential destinations would be the outlying islands close to Shek Kwu Chau. Based on the preliminary investigation, the potential destinations under consideration include Chi Ma Wan Peninsula, Cheung Sha, and Lamma Island. To finalize this Sediment Sampling and Testing Plan, it is suggested to first agree the methodology for the sampling locations for the submarine cable. From the historical data and land uses review (see responses to comment (k) and (l)), the contamination level of sediment in the region is

Comments Received	**Responses**
	likely to be low and as such samples are proposed to be collected at surface level and at 200 x 200 m grid in accordance with ETWB TCW No. 34/2002. Nevertheless (although not likely), if the laboratory results from the sampling and testing exercises indicate that the sediment is Category M or H, additional sampling and testing, at denser grid and at various depths, will be proposed in the vicinity of the contaminated area. Additional sampling and testing, if required, will be agreed with EPD prior to commencement.
Specific Comment	
(j) The project proponent and their consultants should bear in mind that the aforesaid SSTP will only serve the purpose of fulfilling the EIA Study for this project under the EIAO (including the compliance with the EIA-TM and EIA study brief), i.e. the SSTP will provide information of the sediment quality and the preliminary estimated amount of different type of sediments, arising from this project, to be dealt with/disposed of. The project proponent should also be aware of the different relevant requirements when applying for the dumping permit under DASO, i.e. they are required to submit separate sediment sampling and testing plan to EPD's TCO when applying for the dumping permit under DASO.	Noted.
(k) **S.2** According to the requirement specified in Appendix B of ETWB TCW No.34/2002 (Management of Dredged/Excavated Sediment), the consultants should include the following documents in the plan: ● previous use of the site (e.g. historical aerial photos); and ● other available site specific information (e.g. geotechnical data, previous testing results, etc.).	Previous land use within the site will be studied by reviewing the relevant historical aerial photos. Other site specific information will be provided if available.

Comments Received	**Responses**
(l) **S.2.1.3 and S.2.1.4** (i) The project proponent and their consultants should note that any data, findings, results and conclusions presented in previous study reports (in particular for studies completed many years ago) should not be used directly for this project without adequate justification of their applicability and suitability with respect to the current environmental conditions. (ii) As the distance between the proposed site and Lamma Navigation Channel and Lamma Island is more than 10km, the consultants need to justify whether the sediment quality investigations around the Lamma Island could still be representative. If not, please review whether only surface sample taken at 15 sampling locations are sufficient to determine the category of sediment to be dredged	Your comments are noted. However, the previous study reports (the most recently prepared is in the year 2008) and EPD routine monitoring data (most recently quoted was 2007) are used as reference in the SSTP to support the idea that the contamination level of sediment in the region are generally low. It is logical to expect that if the sediment contamination near Lamma Island (which are closer to human establishments and thus possible source of pollution) are low, sediment contamination that are further away from human establishments / pollution sources (ie our Subject Site) would likely to be low as well. Indeed, as based on our recent aerial photographs review in April 2009, the only human establishment observed near the Subject Site over the years is the rehabilitation centre. Review of the aerial photographs will be included in the revised SSTP (please also see response to comment (k) above). Based on the above, samples were proposed to be collected at surface level and at 200 x 200 m grid in accordance with ETWB TCW No. 34/2002. Nevertheless, we appreciate that given the distance of the sites in the previous study reports, it may not be appropriate to directly use the data to categorize the sediment within the Subject Site. Categorization of sediment would therefore be based on the sampling and testing carried out under this SSTP. Moreover, if the laboratory results from the sampling and testing exercises indicate that the sediment is Category M or H (although not likely) additional sampling and testing, at denser grid and at various depths, will be proposed in the vicinity of the contaminated area. Additional sampling and testing, if required, will be agreed with EPD prior to commencement. The above will be incorporated into the text.
(m) **Table 4.2 (Paragraph 4.2.1)** (i) Typo: "~~6010C~~ 6020A or 7000A….." as appeared in the row of "Arsenic". (ii) Typo: "3540C and ~~3630C~~ 3665A" as appeared in the row of "Total PCBs".	Noted. Text will be revised accordingly.

Comments Received	Responses
(n) **S.4.4.2** Since the maximum holding/storage time of sediment samples for biological test may not be adequate to cover the time required for chemical testing and EPD's approval of a separate biological testing proposal, an outline biological testing proposal is suggested to be included in the SSTP. Please provide the relevant information accordingly.	A simple outline of the biological testing proposal will be included in the SSTP.
(o) **Table 4.4 (Paragraph 4.2.6)** Typo: "(~~p>0.05~~) (p≤0.05).....:	Noted. The text will be revised accordingly.
(p) **S.5.1.6** Please refer to "Comments on S.1.2.2" above.	Noted. Section 5.1.6 will be deleted accordingly.

Sediment Sampling and Testing Plan

Further Comments & Responses

From : EPD (Mr. Thomas To)
Ref : (59) in Ax (1) to EP2/G/G131)
Date : 28 April 2008

Comments Received	Responses
I refer to Maunsell's letter of 9 April 2009, addressed to us and copied to you, responding to our previous comments on the sediment sampling and testing plan (SSTP). (a) Regarding the consultants' responses in item (a) under "Water", we note the consultants' view that the sediment contamination level in the study area would be low. However, as the dredging works may cover an area of 10 ha for the Shek Kwu Chau site if a fully dredged approach is to adopted, it is considered necessary to carry out some studies on the vertical profile of the sediment contamination level to fully address the water quality impact from such as extensive dredging on the sensitive receivers in the vicinity, in particular, view that vibrocore sampling will be carried out at MI7 and MI9, chemical tests at various depths for the sediment sampled from these two vibrocore sampling points should be included in the SSTP to give a general indication of the vertical contamination profile of the sediment of the potential dredging site.	Noted. Sediment samples at deeper depths will be proposed to be collected in order to give an indication of the vertical contamination profile of the sediment. The tests to be carried out on these samples would include: - Chemical testing (Tier II); - Biological testing (Tier III) (If required); - Additional chemical testing; and - Elutriate testing. The above will be incorporated into the revised SSTP.

Comments Received	**Responses**
Should chemical test results indicate that sediment of the area is more contaminated than Category L, additional sampling and testing will be required.	
Please request the consultants to amend the plan accordingly in light of our comments and re-submit for our agreement.	Noted.

From : EPD (Mr. Thomas To)
Ref : ( ) in Ax (1) to EP2/G/G131
Date : 29 May 2008

Comments Received	**Responses**
I refer to my telecon. with Miss Priscilla Yuen of AECOM and AECOM's letter of 12 May 2009, addressed to us and copied to you. The following are our comments on the sediment sampling and testing plan:	
(a) Please include a plan showing the location of the proposed reclamation area and the EPD sediment monitoring location stations SS5 and SS6.	The plans were included in the SSTP accordingly. It should however be noted that the reclamation area as shown on the plan were tentative and would be subjected to change. In addition, as there would also be sediment dredging for the construction of the breakwaters within the site boundary (locations to be confirmed), our sampling locations were evenly distributed over the whole of the Project Area.
(b) S.3.1.3 We note that vibrocore sampling will be conducted at 3 locations MI5, MI11 and MI13 for biogas generation potential testing. In connection with this, please explain why only MI11 and MI13, rather than all 3 locations, are chosen for collecting vibrocore subsamples. Similar clarifications should also be made for allowing denser sampling grids only at location MI5 and MI13 instead of all 3 locations.	Please note that all 3 locations (i.e. MI5, MI11 and MI13) will be chosen for collecting vibrocore subsamples for biogas generation potential testing. As based on the most updated proposed reclamation area, MI5 was added to the SSTP as the area that MI5 represented is likely to be reclaimed. Although sediment samples collected at M11 and M13 are considered sufficient for the biogas generation assessment, additional data collected from MI5 might be useful in supplementing the data collected from MI13. The most up to date proposed reclamation area was included in the SSTP for reference (please also refer to response to comment (a) above). We would also like to highlight the fact that only vibrocore subsamples collected from MI13 and MI15 will be tested for Tier II, Tier III (if required), additional chemical testing and ambient water /

Comments Received	Responses
	elutriate testing. This is considered sufficient given that (i) the sediment contamination within the area is expected to be low and (ii) additional sampling and testing will be carried out anyway if category M or H were indeed identified.
	The above will be discussed in S.3.1.3 accordingly.
(c) For our ease of reference, please include a table summarizing the following for: (1) Chemical Testing (Tier II); and (ii) Biological Testing (Tier III) at Shek Kwu Chau site based on the requirements set out in the EIA study brief: ● Ranges of parameters to be analysed ● Number of sediment ● Locations of sediment ● Depth of sediment ● Type and methods of sampling ● Sample preservation ● Laboratory test methods to be adopted	Tables summarising the said information will be included in Appendix A of the SSTP.
(d) S.4.3.1 Please describe at what depths would the potential biogas generation be assessed.	Vibrocore subsamples collected from MI5, MI11 and MI13 for biogas generation potential assessment will be from seabed to the bottom of the marine deposit layer (ie above the alluvium layer). The depths of subsamples to be tested at each location will be seabed, 0.9m down, 2.9m and every 1m down until reaching the bottom of the marine deposit. Please also refer to S.3.2.5 and S.3.2.6 of SSTP. The above will be included in S4.3.1.
(e) S.4.4.1 Please explain why additional chemical testing will be carried out at only 7 sampling stations instead of all sampling stations.	The testing for water quality assessment (ie additional chemical testing and ambient water / elutriate testing) are based on a grid spacing of 400 m (rather than 200m grid spacing for Tier II and III testing). The 400 m grid spacing is considered sufficient for the purpose of conducting the water quality assessment. This rationale will be included in S.3.1.2.
(f) S.5.1.5 last para We suggest amending the sentence "additional sampling and testing…will need to be conducted at area where Category M or H sediments were identified." To "additional sampling and testing…will need to be conducted where appropriate."	Please note that the text will be revised accordingly.

Comments Received	**Responses**
Please request the consultants to amend the plan accordingly in light of our comments and re-submit for our agreement. Please also remind the consultants to send us 5 copies of the revised submission for internal circulation and public access subsequent to our agreement.	Noted.

From : EPD (Mr. Thomas To)
Ref : -
Date : 12 June 2008

Comments Received	**Responses**
Re. your message below, our telecon. and my telecon. with your Mr. Lawrence Tso. We have the following comments on the draft sediment sampling and testing plan:- (a) S.3.1.2 - Please explain why 7 sampling locations and a grid of 400m spacing are proposed for water quality assessment.	The 7 sampling locations were proposed based on a grid spacing of 400m. Please note that similar grid spacing had also been adopted in previous approved EIA Studies (e.g. *Wan Chai Development Phase II and Central-Wan Chai Bypass* as well as the *Dredging Works for Proposed Cruise Terminal at Kai Tak).* The above will be elaborated in the text.
(b) S.3.1.3 - Please explain why only sampling locations MI11 and MI13 are proposed for biogas generation potential testing.	Please note that MI5, MI11 and MI13 are proposed for biogas generation testing. Given that the actual extent of reclamation had yet to be confirmed at the time of reporting, MI11 and MI13 are proposed at the centre region of the Shek Kwu Chau Site to provide sufficient data for biogas generation potential. The above will be elaborated in the text.
(c) S.4.5 - For our ease of reference, please provide a table summarising the following for the water quality assessment: (i) Ranges of parameters to be analysed (ii) Number of sediment (iii) Locations of sediment (iv) Depth of sediment (v) Type and methods of sampling (vi) Sample preservation (vii) Laboratory test methods to be adopted	Table summarising the said information will be included in Appendix A of the SSTP.
Please let us know in case of queries.	-

N

TSANG TSUI ASH LAGOONS SITE

NEW TERRITORIES

KOWLOON

LANTAU ISLAND

HONG KONG ISLAND

SHEK KWU CHAU SITE

AECOM

AGREEMENT NO. CE 29/2008 (EP)
ENGINEERING INVESTIGATION AND ENVIRONMENTAL STUDIES FOR INTEGRATED WASTE MANAGEMENT FACILITIES PHASE 1 - FEASIBILITY STUDY

LOCATION PLAN OF THE PROPOSED SITES

SCALE	A3 1:200,000	DATE	JUN 2009
CHECK	LTSH	DRAWN	POHM
JOB No.	60051470	DRAWING No.	FIGURE 1
		REV	

P:\60051470\ 1.01\Deliverables\SSTP\figures\FIGURES 1-3\FIGURE 1.DGN

LEGEND

PROPOSED SHEK KWU CHAU SITE

EPD SEDIMENT MONITORING STATION

AECOM

AGREEMENT NO. CE 29/2008 (EP)
ENGINEERING INVESTIGATION AND ENVIRONMENTAL STUDIES FOR INTEGRATED WASTE MANAGEMENT FACILITIES PHASE 1 - FEASIBILITY STUDY

LOCATIONS OF EPD SEDIMENT MONITORING STATIONS

SCALE	A3 1:40,000	DATE	JUN 2009
CHECK	LTSH	DRAWN	POHM
JOB No.	60051470	DRAWING No.	FIGURE 2
		REV	-

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N

SAMPLING LOCATION ID	CO-ORDINATES	
	EASTING	NORTHING
TT1	809726	831311
TT2	809907	831386
TT3	810083	831454

LEGEND

⊕ PROPOSED SAMPLING LOCATION

AECOM

AGREEMENT NO. CE 29/2008 (EP)
ENGINEERING INVESTIGATION AND ENVIRONMENTAL STUDIES FOR INTEGRATED WASTE MANAGEMENT FACILITIES PHASE 1 - FEASIBILITY STUDY

PROPOSED SAMPLING LOCATIONS AT TSANG TSUI ASH LAGOON SITE

SCALE	A3 1:15000	DATE	JUN 2009
CHECK	LTSH	DRAWN	POHM
JOB No.	60051470	DRAWING No.	FIGURE 3
		REV	-

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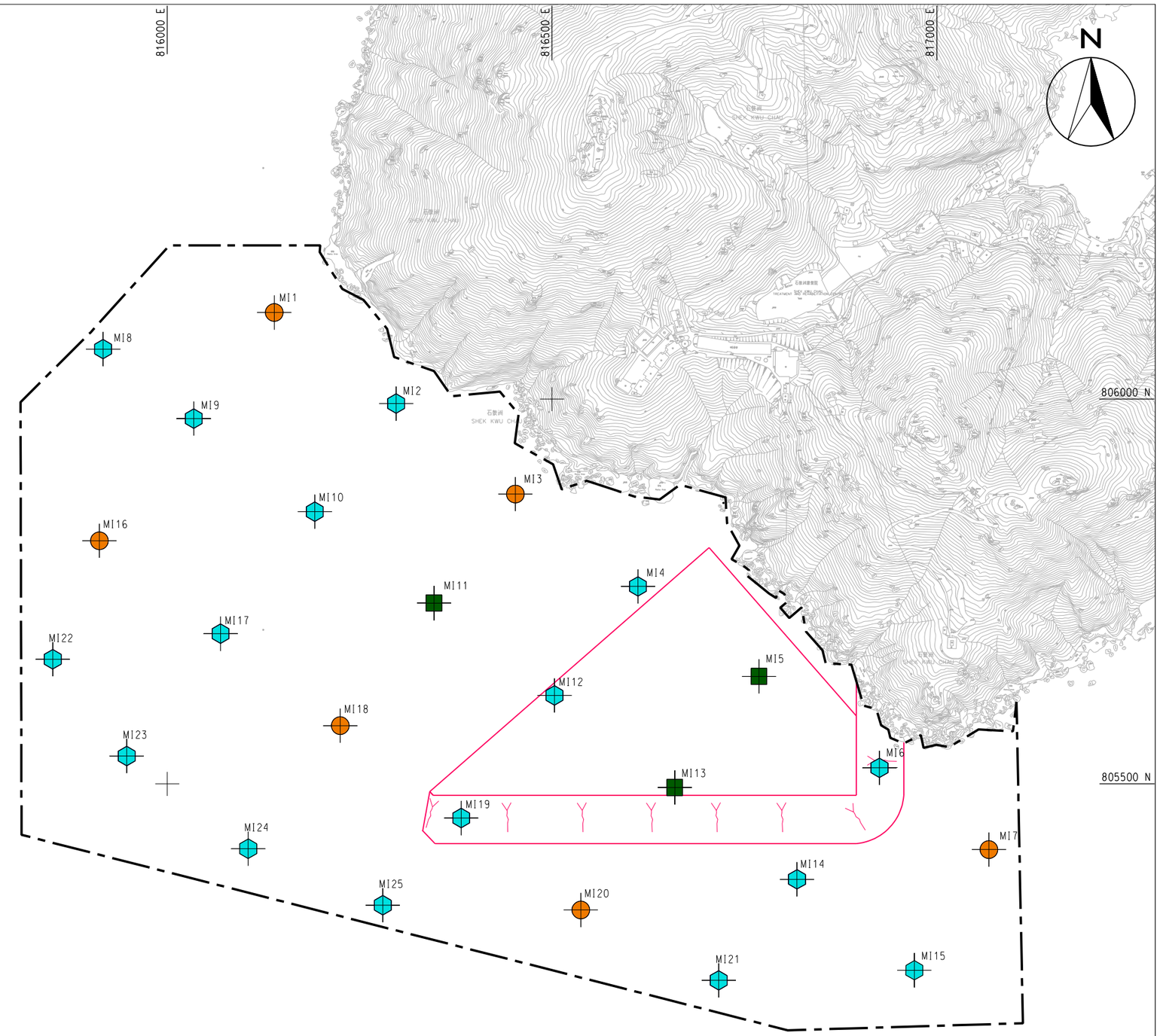
SAMPLING LOCATION ID	CO-ORDINATES		TESTING SCHEDULE					
			GRAB SAMPLES		VIBROCORESUBSAMPLES			COMPOSITE WATER SAMPLES
	EASTING	NORTHING	TIER II / TIER III	ADDITIONAL CHEMICAL & ELUTRIATE TESTING	TIER II / TIER III	ADDITIONAL CHEMICAL & ELUTRIATE TESTING	BIOGAS GENERATION POTENTIAL TESTING	ADDITIONAL CHEMICAL & NUTRIENT TESTING
MI1	816139	806112	✓	✓				✓
MI2	816298	805994	✓					
MI3	816452	805877	✓	✓				✓
MI4	816611	805757	✓					
MI5	816769	805640	✓	✓			✓	✓
MI6	816926	805521	✓					
MI7	817068	805415	✓	✓				✓
MI8	815917	806065	✓					
MI9	816035	805975	✓					
MI10	816192	805854	✓					
MI11	816347	805735	✓		✓	✓	✓	✓
MI12	816503	805615	✓					
MI13	816659	805495	✓		✓	✓	✓	✓
MI14	816818	805376	✓					
MI15	816971	805258	✓					
MI16	815912	805816	✓	✓				✓
MI17	816069	805695	✓					
MI18	816225	805576	✓	✓				✓
MI19	816382	805456	✓					
MI20	816537	805336	✓	✓				✓
MI21	816717	805245	✓					
MI22	815851	805662	✓					
MI23	815947	805536	✓					
MI24	816105	805416	✓					
MI25	816280	805342	✓					



LEGEND:

- SITE BOUNDARY
- TENTATIVE LOCATION OF RECLAMATION AREA (SUBJECT TO CHANGE)
- MI1 — PROPOSED GRAB AND IN-SITU COMPOSITE WATER SAMPLING LOCATION
- MI2 — PROPOSED GRAB SAMPLING LOCATION ONLY
- MI5 — PROPOSED GRAB, VIBROCORE AND IN-SITU COMPOSITE WATER SAMPLING LOCATION

AECOM

AGREEMENT NO. CE 29/2008 (EP)
ENGINEERING INVESTIGATION AND ENVIRONMENTAL STUDIES FOR INTEGRATED WASTE MANAGEMENT FACILITIES PHASE 1 - FEASIBILITY STUDY

PROPOSED SAMPLING LOCATIONS AT SHEK KWU CHAU SITE

SCALE	A3 1:6000	DATE	JUN 2009
CHECK	LSHT	DRAWN	LLHY
JOB No.	60051470	DRAWING No. FIGURE 4	REV –

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+852 2147 0894

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Metcalf & Eddy Ltd.
Received 24 JUN 2009
Project Eng. ELIM
Others
Copied To
Reply Date

By Fax: 2318 1877

23 June, 2009

GO, 6005114 & Echo

Environmental Protection Department
88 Victoria Road
Kennedy Town
Hong Kong
(Attn.: Dr. Stephen Lam)

Dear Dr. Lam,

Integrated Waste Management Facilities Phase 1
Sediment Sampling and Testing Plan

We refer to to AECOM's letter of 16 June 2009 addressed to us and copied to you on the above subject.

We have no comment on the Sediment Sampling and Testing Plan (SSTP) proposed by your consultants for the Shek Kwu Chau site in accordance with S.3.7.3.5(xii), S.3.7.4.2(iii)(a) and S.3.7.4.2(iv) of the EIA Study Brief No. ESB-184/2008.

Incidentally, according to S.4.2.1 of the SSTP, we understand that you will provide us with a biological testing proposal for agreement prior to the commencement of the relevant testing if Category M or Category H sediments are identified.

We also note that the current proposed reclamation extent is only tentative in nature. In view of this, please be reminded to review the SSTP if there is any change in the reclamation extent and advise us accordingly your review findings together with any necessary changes proposed for the SSTP.

Yours sincerely,

(Lawrence K K NGO)
Senior Environmental Protection Officer
for Director of Environmental Protection

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c.c. **External**

AECOM (Attn: Ms. Echo Leung) Fax: 2691 2649

Internal

S(RA)2, S(RA)4, S(MA)5

ID: IWMFltr23.6.09