



土木工程拓展署  
Civil Engineering and Development Department  
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Agreement No. CE 42/2008 (CE)

**Tseung Kwan O – Lam Tin Tunnel  
and Associated Works  
– Investigation**

**Draft Sediment Sampling and Test Plan (Issue 3)**

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**AECOM ASIA CO. LTD.**

**Agreement No. CE 42/2008 (CE)  
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**Table of Contents**

	<u>Page</u>
<b>1 INTRODUCTION.....</b>	<b>1</b>
1.1 Background .....	1
1.2 The Assignment.....	1
1.3 Scope of Sediment Sampling and Testing.....	2
<b>2 REVIEW OF HISTORICAL DATA.....</b>	<b>3</b>
2.1 Sediment Quality Assessment Criteria.....	3
2.2 Historic Sediment Quality Data .....	5
<b>3 SEDIMENT SAMPLING AND TESTING SCHEDULE.....</b>	<b>9</b>
3.1 Sediment Sampling Location .....	9
3.2 Sampling Procedure .....	10
3.3 Testing Requirements for Marine Sediment for EIA Study and Marine GI for DASO .....	12
3.4 Ambient Water and Elutriate Testing for Water Quality Assessment .....	16
3.5 Quality Assurance / Quality Control Requirements.....	17

## LIST OF TABLES

Table 2.1	Sediment Quality Criteria for the Classification of Sediment
Table 2.2	Summary of Historical Sediment Quality in JS2
Table 2.3	Sediment Analysis Result from Marine Ground Investigation Works under IETKO
Table 2.4	Sediment Analysis Result from Marine Ground Investigation Works under FDTKO
Table 3.1	Recommended Sampling Arrangement in ETWB TCW NO. 34/2002
Table 3.2	Recommended Sample Sizes for each Parameter to be tested
Table 3.3	Testing Parameters for Tier II Chemical Screening
Table 3.4	Sample Preparation for Sediment with >10 x LCEL
Table 3.5	Testing Parameters for Tier III Biological Screening
Table 3.6	Test Endpoints and Decision Criteria for Tier III Biological Testing
Table 3.7	Parameters for Elutriate Testing
Table 3.8	Acceptance Criteria for Quality Control

## LIST OF APPENDICES

Appendix A	Testing Methods, QA/QC Procedures and Reporting Limits
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## LIST OF FIGURES

Figure 1.1	General Layout Plan
Figure 1.2	Tentative Dredging Area
Figure 2.1	Location of EPD Marine Sediment Monitoring Station, JS2
Figure 2.2	Location of Previous Sediment Sampling Locations
Figure 3.1	Proposed Vibrocore Locations

## 1 INTRODUCTION

### 1.1 Background

1.1.1 In 2002, CEDD commissioned an integrated planning and engineering study under the Agreement No. CE 87/2001 (CE) “Further Development of Tseung Kwan O – Feasibility Study” (the “TKO Study”) to formulate a comprehensive plan for further development of TKO New Town. It recommends to further develop TKO to house a total population of 450,000 besides the district’s continuous commercial and industrial developments.

1.1.2 At present, the Tseung Kwan O Tunnel is the main connection between Tseung Kwan O (TKO) and other areas in the territory. According to the traffic impact assessment of the TKO Study, the existing TKO Tunnel would experience serious congestion after 2016 if an alternative external road connection is not provided. To cope with the anticipated transport need, the TKO Study recommended the provision of Tseung Kwan O – Lam Tin Tunnel (TKO-LT Tunnel) and Cross Bay Link (CBL) to meet the long-term traffic demand between TKO and the external areas.

1.1.3 The TKO-LT Tunnel, together with the proposed Trunk Road T2 in Kai Tak Development (KTD) and Central Kowloon Route (CKR), will form Route 6 in the strategic road network. Route 6 will provide an east-west express link between Kowloon and TKO areas. Upon completion in 2016, this strategic route will also provide the necessary relief to the existing heavily trafficked road network in the central and eastern Kowloon areas, and reduce the related environmental impacts on these areas. The outlined scope of the Project under this Assignment is to provide a highway connecting TKO at Po Yap Road in the east and Trunk Road T2 in the west with the associated interchange as shown in **Figure 1.1**.

1.1.4 Based on the current proposed alignment scheme of the TKO-LT Tunnel, the project is a designated project under the Schedule 2 of the Environmental Impact Assessment Ordinance (EIAO, Cap 499) that an Environmental Impact Assessment (EIA) study is needed to provide information on the nature and extent of environmental impacts arising from the construction and operation of the Project and related activities taking place concurrently. Project profile was submitted to the Director of Environmental Protection (DEP) and an EIA Study Brief (No. ESB-195/2008) was issued on 26 August 2008.

### 1.2 The Assignment

1.2.1 AECOM Asia Co., Ltd (formerly known as Maunsell Consultants Asia Ltd.) was appointed by Civil Engineering and Development Department to carry out the Assignment on Tseung Kwan O – Lam Tin Tunnel and Associated Works – Investigation under Agreement No. CE 42/2008 (CE). One major task of the Assignment is to conduct EIA Studies in accordance with the EIA Study Brief.

### 1.3 Scope of Sediment Sampling and Testing

- 1.3.1 The scope of works covered under this Sediment Sampling and Testing Plan (SSTP) include sediment removal at the seabeds of the Junk Bay. In accordance with Clause 3.4.4.2 (iii) (a) of the EIA Study Brief, the project is required to conduct field investigation, sampling and chemical and biological laboratory tests to characterize the sediment/mud concerned.
- 1.3.2 Therefore, sediment sampling and testing will be required at the proposed dredged area in order to characterize the quality of the dredged sediments and estimate their quantities. This will be used to assess the waste implications associated with the construction works for the Project by identifying and quantifying dredging/excavation, transportation, disposal arrangements and impacts due to dredging for sediment / mud.
- 1.3.3 The sampling and testing results may also be used to support future dumping permit application of dredged sediment under the requirements of DASO, if applicable. Therefore, the sediment sampling and testing works should be carried out in accordance with Environmental, Transport and Works Bureau Technical Circular (Works) No. 34/2002 – Management of Dredged / Excavated Sediments (ETWB TCW No. 34/2002). The final designs of the reclamation and dredging works will be submitted to EPD for agreement prior to commencement of marine sediment sampling and testing works.
- 1.3.4 It is anticipated that the development of TKO-LT Tunnel will involve reclamation of approximately 12 hectares (ha) of area at Junk Bay for forming land for the toll plaza and associated administration buildings. Dredging of marine sediments will be required for the proposed reclamation works. Moreover, sediment dredging may also be required at the locations of the piers of the elevated roads / bridge section over the Junk Bay. The tentative dredging areas are given in **Figure 1.2**.
- 1.3.5 The dredging volumes will be subject to refinement under further engineering and environmental assessments to be carried out at a later stage of this Assignment and will be minimized to the amount necessary to meet the Project needs. The refined volumes of dredged marine sediment will be provided at a later stage and presented in the upcoming Sediment Quality Report.

## **2 REVIEW OF HISTORICAL DATA**

### **2.1 Sediment Quality Assessment Criteria**

2.1.1 The ETWB TCW No. 34/2002 outlines the requirements to be followed in assessing and classifying the sediment. Sediments are categorized with reference to the Lower Chemical Exceedance Level (LCEL) and Upper Chemical Exceedance Level (UCEL), as follows:

- Category L - Sediment with all contaminant levels not exceeding the LCEL. The material must be dredged, transported and disposed of in a manner that minimises the loss of contaminants either into solution or by suspension.
- Category M - Sediment with any one or more contaminant levels exceeding the LCEL and none exceeding the 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 UCEL. The material must be dredged and transported with great care, and must be effectively isolated from the environment upon final disposal.

2.1.2 The sediment quality criteria for the classification of sediment are presented in **Table 2.1** below.

**Table 2.1 Sediment Quality Criteria for the Classification of Sediment**

Contaminants	LCEL	UCEL
<b>Heavy Metal (mg/kg dry weight)</b>		
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
<b>Metalloid (mg/kg dry weight)</b>		
Arsenic	12	42
<b>Organic-PAHs (µg/kg dry weight)</b>		
PAHs (Low Molecular Weight)	550	3160
PAHs (High Molecular Weight)	1700	9600
<b>Organic-non-PAHs (µg/kg dry weight)</b>		
Total PCBs	23	180
<b>Organometallics (µg TBT/L in Interstitial Water)</b>		
Tributyltin*	0.15	0.15

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

Note: LCEL – Lower Chemical Exceedance Level  
 UCEL – Upper Chemical Exceedance Level

Source: Appendix A of ETWB TCW No. 34/2002 Management of Dredged / Excavated Sediment

## 2.2 Historic Sediment Quality Data

2.2.1 Land uses of Junk Bay within this catchment comprise residential premises in Tiu Keng Leng and Hang Hau, and the industrial zone in Tseung Kwan O industrial Estate.

2.2.2 The EPD tests sediment in different parts of Hong Kong in accordance with ETWB TCW No. 34/2002. A total of 45 sediment monitoring stations were established over the whole Hong Kong water zone. Sediments are sampled twice a year and data is usually based on mean five-year values, and results are published on EPD's Marine Water Quality Report (MWQR) on an annual basis. The closest sampling location to the project boundary is located in Junk Bay (JS2, **Figure 2.1**). However, JS2 is not located within the current proposed reclamation area of the project. Five years of summary statistics for of JS2 are showed in **Table 2.2**.

**Table 2.2 Summary of Historical Sediment Quality in JS2**

Contaminants	2003-2007	2002-2006	2001-2005	2000-2004	1999-2003
<b>Heavy Metal (mg/kg dry weight)</b>					
Cadmium (Cd)	0.2	0.2	0.2	0.2	0.2
Chromium (Cr)	50	52	53	53	54
Copper (Cu)	<b><u>120</u></b>	<b><u>123</u></b>	<b><u>128</u></b>	<b><u>133</u></b>	<b><u>137</u></b>
Mercury (Hg)	57	56	55	54	47
Nickel (Ni)	0.26	0.30	0.25	0.24	0.25
Lead (Pb)	25	24.5	2.5	25	24
Silver (Ag)	<b><u>2.3</u></b>	<b><u>2.0</u></b>	<b><u>2.5</u></b>	<b><u>2.3</u></b>	<b><u>2.2</u></b>
Zinc (Zn)	160	153	150	145	142
<b>Metalloid (mg/kg dry weight)</b>					
Arsenic	7.5	7.7	7.9	7.8	7.9
<b>Organic-PAHs (µg/kg dry weight)</b>					
PAHs (Low Molecular Weight)	96	96	94	92	91
PAHs (High Molecular Weight)	210	220	196	172	183
<b>Organic-non-PAHs (µg/kg dry weight)</b>					
Total PCBs	18	18	18	18	18

Sources: EPD's Marine Water Quality Report 2003 - 2007

Note: Data presented are arithmetic means over a five years monitoring period.

Value in **Bold** indicate exceedances of UCEL under ETWB TCW No. 34/2002

Value in Underline indicate exceedance of LCEL under ETWB TCW No. 34/2002



2.2.3 As revealed in Marine Water Quality Report (MWQR), the average value of sediment contamination monitoring results from JS2 exceeded UCEL for copper and silver consistently. Thus, sediment in this area of Junk Bay could be classified as Category H as compared with the sediment quality criteria for the classification of sediment in accordance with ETWB TCW No. 34/2002. The MWQR also explained that the exceedances are related to previous pollution from printed circuit board, electroplating industries and photo-developing business in the 60s to 80s before pollution control legislation was introduced. Sediment data derived from JS2 should be considered indicative only as it is outside of the study area and has the potential to have different sources of pollution.

2.2.4 Marine sediment sampling and quality analysis was conducted for the Feasibility Study for Intensification and Extension of Tseung Kwan O (IETKO) and EIA of the Further Development of Tseung Kwan O (FDTKO). As shown in Figure 2.2, a total of seven marine sediment sampling locations (G1, G2, VC3, VC7, VC8, VC9, VC10 and VC18) were located within the current proposed reclamation areas of this project. Sediment analysis results conducted in IETKO and FDTKO were presented in Table 2.3 and Table 2.4 respectively. These results, together with MWQR results for JS2 discussed in Section 2.2.2, should be considered indicative only.

**Table 2.3 Sediment Analysis Result from Marine Ground Investigation Works under IETKO**

Sampling Location	Sampling Depth		Metals and Metalloid Content (mg/kg)									Category
	From	To	Cd	Cr	Cu	Ni	Pb	Zn	Hg	As	Ag	
G1	NA	NA	<0.6	26	42	10	<u>90</u>	<b>590</b>	0.2	11	<1	H
G2	NA	NA	<0.6	30	56	10	38	130	0.1	8	<1	L
VC3	0.90	1.00	<0.5	7	<10	<6	<15	42	<0.4	NA	NA	L
VC3	1.90	2.00	<0.5	16	<10	9	<15	35	<0.4	NA	NA	L
VC3	2.90	3.00	<0.5	16	<10	9	<15	35	<0.4	NA	NA	L
V18	0.90	1.00	<0.6	35	57	20	63	<b>300</b>	0.1	10	<1	H
V18	1.90	2.00	0.9	43	<u>93</u>	10	<b>160</b>	<b>950</b>	0.2	10	<1	H
V18	2.90	3.00	<0.6	<u>130</u>	7	<u>71</u>	20	39	<0.1	6	<1	H
V18	5.75	5.85	<0.6	42	9	24	20	71	<0.1	7	<1	L
V18	8.90	9.00	<0.6	32	9	20	24	63	<0.1	7	<1	L
V18	11.75	11.85	0.9	<10	<5	<10	<b>180</b>	20	<0.1	<u>13</u>	<1	H

Source: FDTKO

Note: Value in **Bold** indicate exceedances of UCEL under ETWB TCW No. 34/2002

Value in Underline indicate exceedances of LCEL under ETWB TCW No. 34/2002

**Table 2.4 Sediment Analysis Result from Marine Ground Investigation Works under FDTKO**

Sampling Location	Sampling Depth		Metals and Metalloid Content (mg/kg)									PAHs, PCBs, TBT	Category
	From	To	Cd	Cr	Cu	Ni	Pb	Zn	Hg	As	Ag		
VC7	0.16	0.90	0.1	9.8	22	4.3	31	74	0.1	3.8	0.2	<LCEL	L
VC7	0.90	1.80	<0.1	3.7	2.3	2.8	8.8	<10	0.06	1.3	<0.1	<LCEL	L
VC8	0.20	0.90	<0.1	15	6.1	7.4	29	46	0.2	3.9	0.1	<LCEL	L
VC8	0.90	1.90	<0.1	5.0	1.3	4.0	8.3	<10	0.1	1.0	<0.1	<LCEL	L
VC8	1.90	2.90	<0.1	5.6	1.5	4.4	5.9	13	0.1	1.3	<0.1	<LCEL	L
VC8	2.90	3.90	<0.1	8.3	2.6	6.3	8.0	17	0.1	2.0	<0.1	<LCEL	L
VC8	6.00	6.90	<0.1	11	3.4	8.4	11	22	0.1	2.4	<0.1	<LCEL	L
VC8	8.90	9.90	<0.1	6.9	2.3	4.4	11	15	0.2	3.8	<0.1	<LCEL	L
VC9	0.00	0.90	<0.1	8.5	13	4.25	23	44	0.09	4.7	0.2	<LCEL	L
VC9	0.90	1.90	<0.1	5.0	3.5	3.9	15	23	0.08	4.4	<0.1	<LCEL	L
VC9	1.90	2.90	<0.1	5.6	2.5	3.8	11	15	<0.05	2.6	<0.1	<LCEL	L
VC9	2.90	3.15	<0.1	1.3	1.2	1.4	8.6	<10	0.1	3.9	<0.1	<LCEL	L
VC10	0.00	0.55	0.1	9.1	13	5.3	32	44	0.09	3.2	0.2	<LCEL	L

Source: IETKO

Note: Value in **Bold** indicate exceedances of UCEL under ETWB TCW No. 34/2002

Value in Underline indicate exceedances of LCEL under ETWB TCW No. 34/2002

2.2.5 Sediment analysis results undertaken as a part of this study revealed that sediment quality at G1 and VC18 were classified as Category H due to high contaminant level of Ni, Pb and Zn. However, sediments at all the other locations were classified as Category L.

2.2.6 Although this investigation was undertaken for a different project approximately 7 years, the similar sampling location and analytical parameters make the data relevant for inclusion in this report. However, again these results should be considered indicative only, as the potential for subsequent contamination to have occurred between 2002 and the present day.



### 3 SEDIMENT SAMPLING AND TESTING SCHEDULE

#### 3.1 Sediment Sampling Location

3.1.1 Based on the current available project information, approximately 12 ha of area at Junk Bay will be reclaimed for forming land for the toll plaza and associated administration buildings. Dredging of marine sediments will be required for the proposed reclamation works. As only limited historical sediment quality result is available and preliminary review indicated that certain proportion of sediment is likely to exceed UCEL (i.e. area around G1 and VC18), further sediment sampling and testing is needed for the appropriate arrangements in future.

3.1.2 The sediment sampling locations are determined through a grid spacing of approximately 100m within the proposed reclamation area where dredging of marine sediments is anticipated. The 100m sampling grid is proposed as the expected contamination level of sediment would be from Low to High in the reclamation area based on the review of the aforementioned EIA reports, EPD's 2007 Marine Water Quality Report and with reference to the recommended sampling arrangement in ETWB TCW No. 34/2002.

**Table 3.1 Recommended Sampling Arrangement in ETWB TCW NO. 34/2002**

Expected Contaminated Level	Recommended Sampling Arrangement
Low	200 X 200m grid, surface sample only
High	100 X 100m grid, vertical profile of samples
Very high (e.g. near outfalls, or nullahs)	50 X 50 grid, vertical profile of samples

3.1.3 A total of 37 sediment sampling locations (namely TKO-VC501 to TKO-VC526 and TKO-VCC501 to TKO-VCC511) are preliminary proposed offshore of the Junk Bay as shown in **Figure 3.1**. The sediment samples shall be taken using vibrocore at each of the locations.

3.1.4 In addition, it is anticipated that dredging works will also be required at locations where the construction of piers will be required for the elevated roads/ bridge section over the Junk Bay. Therefore, sediment sampling at the locations of the piers will also be required and the final sampling locations will be subject to the final design of the Project. These sampling locations will be proposed and detailed in the SSTP to be submitted for EPD approval prior to commencement of marine sampling and testing works.

3.1.5 The scope of marine sediment quality sampling for EIA study 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, in particular to fulfill the requirement specified in Clause 3.4.3.5 (ix) of the ESB-195/2008.

- 3.1.6 Therefore, of the 37 locations, sediment samples collected at 11 locations (i.e. TKO-VCC501 to TKO-VCC511) will also be selected for elutriate testing. Moreover, for the purpose of water quality impact assessment, ambient water samples will also be collected at these locations.
- 3.1.7 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.
- 3.1.8 Based on the proposed sampling plan, 37 stations would be sampled for chemical and biological screening. The sampling locations are shown in **Figure 3.1**. The exact sampling locations will be confirmed on site and subject to fine adjustment due to possible site constraints.

## 3.2 Sampling Procedure

- 3.2.1 Prior to sampling at each location, the sampling location should be set out with the aid of a differential global positioning system (DGPS) or equivalent device. After the setting out, the depth of water, in metres below the Principal Datum (mPD) shall be measured.
- 3.2.2 The sediment sampling exercise shall be supervised by the Engineer's Representative on site so as to ensure correct sampling procedures are taken.
- 3.2.3 Sediment samples shall be collected using a vibrocore drilling rig. The vibrocore shall be continuous and shall terminate at either:
- (i) the bottom of the dredged layers,
  - (ii) at 1m below the alluvium layer, or;
  - (iii) at a depth as instructed by the Engineer's Representative on-site.
- 3.2.4 The minimum sample recovery shall be at least 80% of the vibrocore length for each sampling attempt.
- 3.2.5 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 3m to the bottom of the dredged layers or at depth as instructed by the Engineer's Representative on-site. 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).
- 3.2.6 The first sub-sample of sediment at seabed (0.0-0.9m) may not meet the 80% minimum sample recovery. This sub-sample shall then be taken by a closed grab sampler at surface level. The grab sampler shall need to be thoroughly washed with seawater prior to each sampling attempt.

- 3.2.7 The surface sediment samples by grab sampler 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 labeled 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.
- 3.2.8 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 7 days of delivery for chemical testing. The maximum holding time for chemical and biological test are 2 weeks and 8 weeks respectively according to ETWB TCW No. 34/2002. 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.
- 3.2.9 Prior to sampling, the laboratory responsible for analysis should be consulted for the particular sample size for chemical / biological testing. The recommended sample sizes for each parameter and test are show in **Table 3.2** according to the ETWB TCW No. 34/2002.

**Table 3.2 Recommended Sample Sizes for each Parameter to be tested**

Parameters to be tested	Sample Size
Metals and metalloid	0.5 L
Organics	0.5 L
Biological response	6.0 L

- 3.2.10 For the ambient marine water sampling 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°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°C) but not frozen and stored in the dark prior to chemical analysis.

### 3.3 Testing Requirements for Chemical Screening (Tier II)

3.3.1 All sediment samples collected will be tested for parameters as stated in Appendix A of ETWB TCW No. 34/2002 for Tier II chemical screening. The parameters to be analyzed, methodology used and reporting limits are presented in **Table 3.3** below.

**Table 3.3 Testing Parameters for Tier II Chemical Screening**

Parameters	Reporting Limit	Preparation Method USEPA Method	Determination Method USEPA Method
<b>Metals (mg/kg dry weight)</b>			
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
<b>Metalloid (mg/kg dry weight)</b>			
Arsenic	1	3050B	6010C or 7000A or 7061A
<b>Organic-PAHs (µg/kg dry weight)</b>			
Low Molecular Weight PAHs <sup>+</sup>	55	3550B or 3540C and 3630C	8260B or 8270C
High Molecular Weight PAHs <sup>++</sup>	170	3550B or 3540C and 3630C	8260B or 8270C
<b>Organic-non-PAHs (µg/kg dry weight)</b>			
Total PCBs <sup>+++</sup>	3	3550B or 3540 C and 3665A	8082
<b>Organometallics (µg TBT/L in interstitial water)</b>			
Tributyltin	0.015	Krone et al. (1989)* - GC/MS UNEP/IOC/IAEA**	Krone et al. (1989)* - GC/MS UNEP/IOC/IAEA**

Notes:

- + 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)*

- 3.3.2 Tier III Biological Testing will be required to determine the most appropriate disposal options for some samples which exceed criteria requiring the further biological analysis. AECOM will request a fast turn-around time from the contracted laboratory and will immediately submit samples for biological testing that exceed the chemical testing criteria in order to have the biological testing undertaken within the maximum holding/storage time.
- 3.3.3 The following toxicity tests will be carried out on the composite and reference samples:
  - (i) a 10-day burrowing amphipod toxicity test ;
  - (ii) a 20-day burrowing polychaete toxicity test; and
  - (iii) a 48-96 hour larvae (bivalve or echinoderm) toxicity test.
- 3.3.4 In accordance with the requirements of ETWB TCW No. 34/2002, Tier III biological screening is necessary for all Category M and certain Category H sediment samples in which one or more contaminants exceed 10 times of Lower Chemical Exceedance Level (LCEL).



3.3.5 The biological tests should be conducted on composite samples. A 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. Sediment classified as Category H and with one or more contaminant levels exceeding 10 times LCEL shall also be subjected to the above three toxicity tests but in a diluted manner (dilution test). The samples shall be prepared prior to toxicity testing as displayed in **Table 3.4** below:

**Table 3.4 Sample Preparation for Sediment with >10 x LCEL**

Sediment Characteristics	Preparation Method
Category H sediment (>10 x LCEL)	Sample to be mixed with 9 portions of reference sediment
Category M sediment or Category H sediment (>10 LCEL) suspected of ammonia contamination	Additional set of sample (after dilution for Category H sediment) to be purged# for ammonia removal (for amphipod test only).

# If the ammonia concentration in the overlying water of the test system is  $\geq 20$  mg/L, purging of sediment is required. This is performed by replacing the overlying water at a rate of 6 volume replacements/24 h for 24 hours, and replaced once only if the ammonia level still exceeds 20 mg/L.

3.3.6 The species to be used for each type of biological test will be selected from **Table 3.5** below.

**Table 3.5 Testing Parameters for Tier III Biological Screening**

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

\* 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.

- 3.3.7 For sediment samples that are classified in the chemical screening as Category H with one or more contaminant levels exceeding 10 times the 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.
- 3.3.8 Ancillary test, including pH, 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 concentrations are found to be higher than the tolerance limit (i.e.  $\geq 20$  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.

3.3.9 The test endpoints and decision criteria are summarized in Appendix B of ETWB TCW No. 34/2002. The sediment is deemed to have failed the biological test if it fails in any one of the three toxicity tests. A summary of the test endpoints and decision criteria for Tier III Biological Testing is shown in **Table 3.6** below.

**Table 3.6 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 ( $p < 0.05$ ) <sup>1</sup> from mean survival in reference sediment and mean survival in test sediment $< 80\%$ of mean survival in reference sediment.
20-day polychaete	Dry Weight <sup>2</sup>	Mean dry weight in test sediment is significantly different ( $p < 0.05$ ) <sup>1</sup> 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 <sup>3</sup>	Mean normality survival in test sediment is significantly different ( $p < 0.05$ ) <sup>1</sup> from mean normality survival in reference sediment and mean normality survival in test sediment $< 80\%$ of mean normality survival in reference sediment.

Notes:

<sup>1</sup> Statistically significant differences should be determined using appropriate two-sample comparisons (e.g., t-tests) at a probability of  $p > 0.05$ .

<sup>2</sup> Dry weight means total dry weight after deducting dead and missing worms.

<sup>3</sup> Normality survival integrates the normality and survival end points, and measures survival of only the normal larvae relative to the starting number.

### 3.4 Ambient Water and Elutriate Testing for Water Quality Assessment

3.4.1 In addition to the above chemical and biological testing under ETWB TCW No. 34/2002, elutriate testing for the parameters as shown in **Table 3.7** below will be conducted on the sediment samples collected at 11 sampling stations: TKO-VCC501 to TKO-VCC511 as shown in **Figure 3.1**. The purpose of the elutriate testing is to allow for the evaluation of sediment contamination by nutrient, bioavailability and physiochemical properties for the water quality impact assessment under the EIA study of the Project.

**Table 3.7 Parameters for Elutriate Testing**

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

3.4.2 The sediment samples will be mixed with the composite water samples 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 or filtered through a 45 µm filter to remove all suspended particulate matter. The extracted liquid filtrate is the elutriate to be used for further testing.

3.4.3 All the composite water samples and elutriate shall be tested for the parameters in the **Table 3.7** as well as the Tier II chemicals also listed in **Table 3.3** above. All the samples not analyzed immediately shall be maintained in a chilled but not frozen (~4°C) condition in the dark in the laboratory.

**3.5 Quality Assurance / Quality Control Requirements**

3.5.1 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. The details of HOKLAS accreditation requirement for each testing parameter are summarized in **Appendix A**.

3.5.2 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); and
- Matrix Spike (at 5% level i.e. one for every 20 samples).

3.5.3 The proposed data quality objectives are shown in **Table 3.8** below.

**Table 3.8 Acceptance Criteria for Quality Control**

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

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

3.5.5 Laboratory analytical results of marine sediment samples for Tier II chemical screening and Tier III biological screening will be used as an initial an screening in assessing both the waste implication including quantities of dredging / excavation sediments, transportation, disposal arrangements and impacts due to dredging for sediment / mud, and supporting of the application for dumping permit of marine sediments under the requirements of DASO. However, when applying for the dumping permit under DASO separate sediment sampling and testing plans will also be submitted to EPD.

3.5.6 The results of elutriate and ambient marine water testing will used in assessing water quality impacts in relation. In particular the potential release of sediment-bound contaminants into the water environment from the proposed dredging activities will be assessed.

*Appendix A*  
*Testing Methods, QA/QC Procedures and Reporting Limits*

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Appendix A: Testing Methods, Detection Limit, Reporting Limits and QA/QC Procedures

Parameters for Sediment Quality Testing

Parameter	Sample Preparation / Determination Method	HOKLAS Accreditation	Lowest Detection Limit	Reporting Limit	QA/QC Procedures
Cadmium	APHA 19e 3030F 3b* In-house method SOP053, SOP093 & 094 based on USEPA Method 6010B (ICP-ES) and 6020A (IPC-MS)*	Yes	0.01 mg/kg	0.05 mg/kg	5% QC samples, including method blank, control sample, matrix spike and sample duplicate, will be done for each batch of samples.
Chromium			0.02 mg/kg	0.1 mg/kg	
Copper			0.04 mg/kg	0.2 mg/kg	
Mercury			0.01 mg/kg	0.05 mg/kg	
Nickel			0.04 mg/kg	0.2 mg/kg	
Lead			0.02 mg/kg	0.1 mg/kg	
Silver			0.02 mg/kg	0.1 mg/kg	
Zinc			0.04 mg/kg	0.2 mg/kg	
Metalloid (Arsenic)			0.02 mg/kg	0.1 mg/kg	
Low Molecular Weight PAHs Naphthalene Acenaphylene Acenaphthene Fluorene Phenanthrene Anthracene	3550B* 8270C*	Yes	N/A	55µg/kg	5% QC samples, including blank, duplicate, spike/control sample
High Molecular Weight PAHs Benzo(a)anthracene Benzo(a)pyrene Chrysene Dibenzo(ah)anthracene Fluoranthene Pyrene Benzo(b)fluoranthene Benzo(k)fluoranthene Indeno(1,2,3-cd)pyrene Benzo(ghi)perylene	3550B* 8270C*	Yes	N/A	170µg/kg	5% QC samples, including blank, duplicate, spike/control sample
Total PCBs (for each PCB congener) 2,4' dichlorobiphenyl (PCB 8) 2,2',5' trichlorobiphenyl (PCB 18) 2,4,4' trichlorobiphenyl (PCB 28) 2,2',3,5' tetrachlorobiphenyl (PCB 44) 2,2',5,5' tetrachlorobiphenyl (PCB 52) 2,3',4,4' tetrachlorobiphenyl (PCB 66) 3,3',4,4' tetrachlorobiphenyl (PCB 77) 2,2',4,5,5' pentachlorobiphenyl (PCB 101) 2,3,3',4,4' pentachlorobiphenyl (PCB 105) 2,3',4,4',5' pentachlorobiphenyl (PCB 118) 3,3',4,4,5' pentachlorobiphenyl (PCB 126) 2,2',3,3',4,4' hexachlorobiphenyl (PCB 128) 2,2',3,4,4',5' hexachlorobiphenyl (PCB 138) 2,2',4,4',5,5' hexachlorobiphenyl (PCB 153) 3,3',4,4',5,5' hexachlorobiphenyl (PCB 169) 2,2',3,3',4,4',5' heptachlorobiphenyl (PCB 170) 2,2',3,4,4',5,5' heptachlorobiphenyl (PCB 180) 2,2',3,4',5,5',6 heptachlorobiphenyl (PCB 187)	3550B, 3620B, 3660B & 3665A* 8270C*	Yes	N/A	3 µg /kg	5% QC samples, including blank, duplicate, spike/control sample
Tributyltin (TBT)	UNEP/IOC/IAEA**	Yes	N/A	0.015µg TBT/L <sup>Note 1</sup>	5% QC samples, including blank, duplicate, spike/control sample
Ammoniacal Nitrogen	In-house method based on APHA 20e 4500 NH <sub>3</sub> -H (FIA)**	No	0.05mg NH <sub>3</sub> -N/kg	0.25mg NH <sub>3</sub> -N/kg	5% QC samples, including method blank, control sample, matrix spike and sample duplicate, will be done for each batch of samples.
TKN	In-house method based on APHA 20e 4500 Norg A,B,D (FIA)**	No	20mg N/kg	100mg N/kg	
Nitrate Nitrogen	In-house method based on APHA 20e 4500 NO <sub>3</sub> -F (FIA)**	No	0.05 mg NO <sub>3</sub> -N/kg	0.25 mg NO <sub>3</sub> -N/kg	
Nitrite Nitrogen	In-house method based on APHA 20e 4500 NO <sub>2</sub> -B (FIA)**	No	0.01mg NO <sub>2</sub> -N/kg	0.05mg NO <sub>2</sub> -N/kg	
Total Phosphorus	In-house method based on APHA 20e 4500 P B,E,F,H (FIA)**	No	2 mg P/kg	10 mg P/kg	
Sediment Oxygen Demand	In-house method based on APHA 19e 5210B**	No	60 mg-O <sub>2</sub> /kg	300 mg-O <sub>2</sub> /kg	
Electrochemical Potential	In House Method based on APHA 20e 2510**	No	2 µS/cm	10 µS/cm	
Total Organic Carbon	EPA SW-846 Method 9060**	No	0.02%	0.10%	
Total Sulphide	EPA 821/R-91-100**	No	0.2mg/kg	1 mg/kg	
Acid Volatile Sulphide	EPA 821/R-91-100**	No	0.2mg/kg	1 mg/kg	
Moisture Content	APHA 19e 2540G**	Yes	0.20%	1%	
Particle Size Distribution	GEOSPEC 3:2001 Test 8.1**	No	0.02%	0.10%	

Note 1: For 1L sample for 100mL reported at MDL.

\* Method for sample preparation

# Method for sample determination

\*\* Method for both sample preparation and determination

Appendix A: Testing Methods, Detection Limit, Reporting Limits and QA/QC Procedures

Parameters for Water Quality / Elutriate Testing

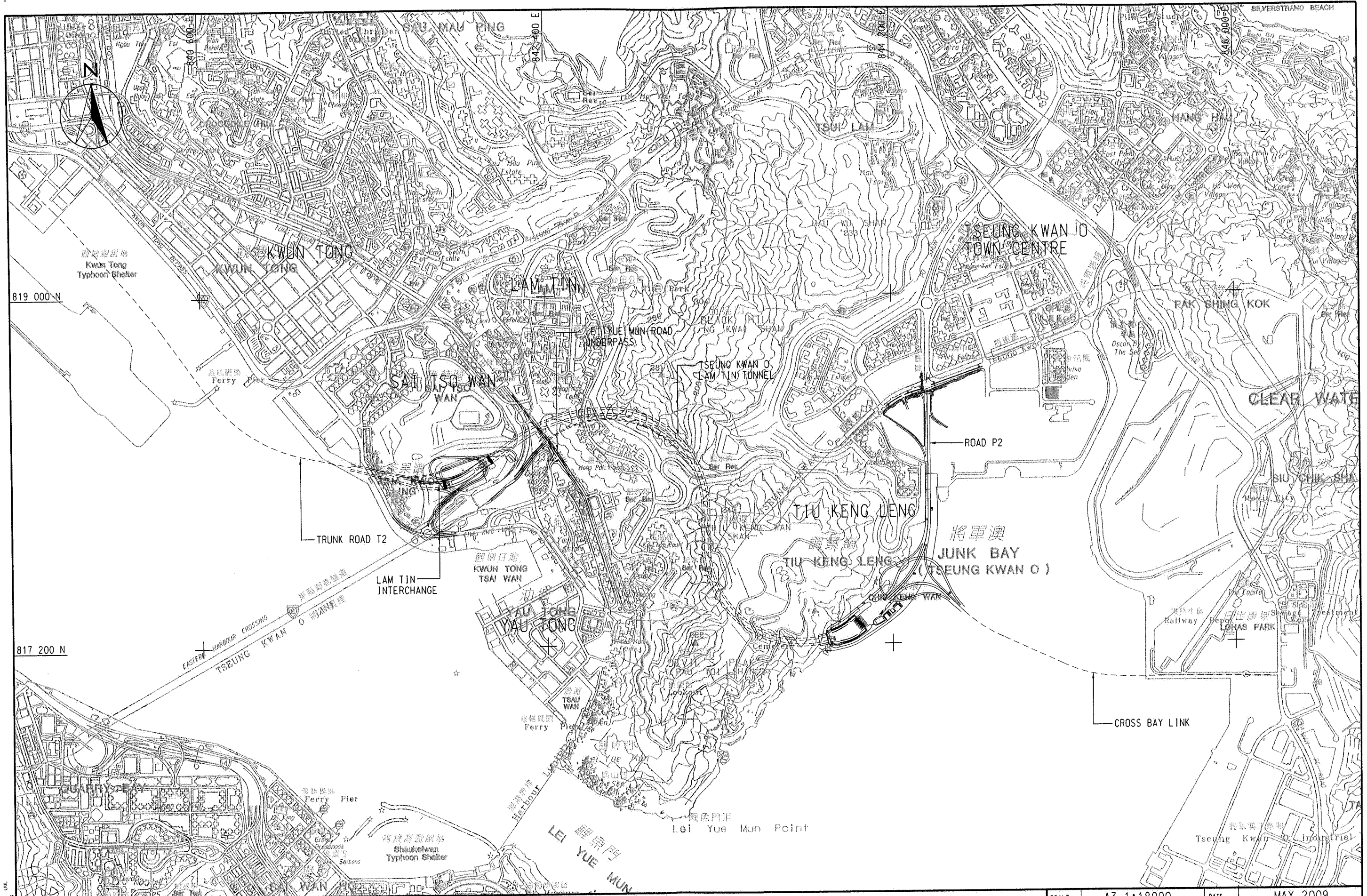
	Sample Preparation / determination Method	HOKLAS Accreditation	Lowest Detection Limit	Reporting Limit	QA/QC Procedures
Cadmium	In-house method SOP053,	Yes	0.1µg/L	0.5µg/L	5% QC samples, including method blank, control sample, matrix spike and sample duplicate, will be done for each batch of samples.
Chromium	SOP076 based on USEPA Method		0.2µg/L	1µg/L	
Copper	6010B (ICP-ES) and 6020A (IPC-MS) **		0.2µg/L	1µg/L	
Mercury			0.2µg/L	1µg/L	
Nickel			0.2µg/L	1µg/L	
Lead			0.2µg/L	1µg/L	
Silver			0.2µg/L	1µg/L	
Zinc			0.4µg/L	2µg/L	
Metalloid (Arsenic)			0.2µg/L	1µg/L	
Low Molecular Weight PAHs Naphthalene Acenaphthylene Acenaphthene Fluorene Phenanthrene Anthracene	In-house method SOP087, SOP091 based on USEPA Method 8270 (GC/MSD) **	No	0.02µg/L	0.1µg/L	5% QC samples, including method blank, control sample, matrix spike and sample duplicate, will be done for each batch of samples.
High Molecular Weight PAHs Benzo(a)anthracene Benzo(a)pyrene Chrysene Dibenzo(ah)anthracene Fluoranthene Pyrene Benzo(b)fluoranthene Benzo(k)fluoranthene Indeno(1,2,3-cd)pyrene Benzo(ghi)perylene	In-house method SOP087, SOP091 based on USEPA Method 8270 (GC/MSD) **	No	0.02µg/L	0.1µg/L	5% QC samples, including method blank, control sample, matrix spike and sample duplicate, will be done for each batch of samples.
Total PCBs (for each PCB congener) 2,4' dichlorobiphenyl (PCB 8) 2,2',5' trichlorobiphenyl (PCB 18) 2,4,4' trichlorobiphenyl (PCB 28) 2,2',3,5' tetrachlorobiphenyl (PCB 44) 2,2',5,5' tetrachlorobiphenyl (PCB 52) 2,3',4,4' tetrachlorobiphenyl (PCB 66) 3,3',4,4' tetrachlorobiphenyl (PCB 77) 2,2',4,5,5' pentachlorobiphenyl (PCB 101) 2,3,3',4,4' pentachlorobiphenyl (PCB 105) 2,3',4,4',5 pentachlorobiphenyl (PCB 118) 3,3',4,4,5 pentachlorobiphenyl (PCB 126) 2,2',3,3',4,4' hexachlorobiphenyl (PCB 128) 2,2',3,4,4',5' hexachlorobiphenyl (PCB 138) 2,2',4,4',5,5' hexachlorobiphenyl (PCB 153) 3,3',4,4',5,5' hexachlorobiphenyl (PCB 169) 2,2',3,3',4,4',5 heptachlorobiphenyl (PCB 170) 2,2',3,4,4',5,5' heptachlorobiphenyl (PCB 180) 2,2',3,4',5,5',6 heptachlorobiphenyl (PCB 187)	In-house method SOP087, SOP089 based on USEPA Method 8270 (GC/MSD) **	No	0.004µg/L	0.02µg/L	5% QC samples, including method blank, control sample, matrix spike and sample duplicate, will be done for each batch of samples.
Ammoniacal Nitrogen	In-house method SOP057 based on APHA 20e 4500 NH <sub>3</sub> -H (FIA)**	Yes	0.01mg NH <sub>3</sub> -N/L	0.05mg NH <sub>3</sub> -N/L	5% QC samples, including method blank, control sample, matrix spike and sample duplicate, will be done for each batch of samples.
TKN	In-house method SOP058 based on APHA 20e 4500 Norg A,B,D	Yes	0.1mg N/L	0.5mg N/L	
Nitrate Nitrogen	In-house method SOP056 based on APHA 20e 4500 NO <sub>3</sub> -F (FIA)**	Yes	0.01 mg NO <sub>3</sub> <sup>-</sup> -N/L	0.05 mg NO <sub>3</sub> <sup>-</sup> -N/L	
Nitrite Nitrogen	In-house method SOP068 based on APHA 20e 4500 NO <sub>2</sub> -B (FIA)**	Yes	0.002mg NO <sub>2</sub> <sup>-</sup> -N/L	0.01mg NO <sub>2</sub> <sup>-</sup> -N/L	
Total Phosphorus	In-house method SOP055 based on APHA 20e 4500 P B,E,F,H	Yes	0.01 mg P/L	0.05 mg P/L	

\*\* Method for both sample preparation and determination



*Figures*

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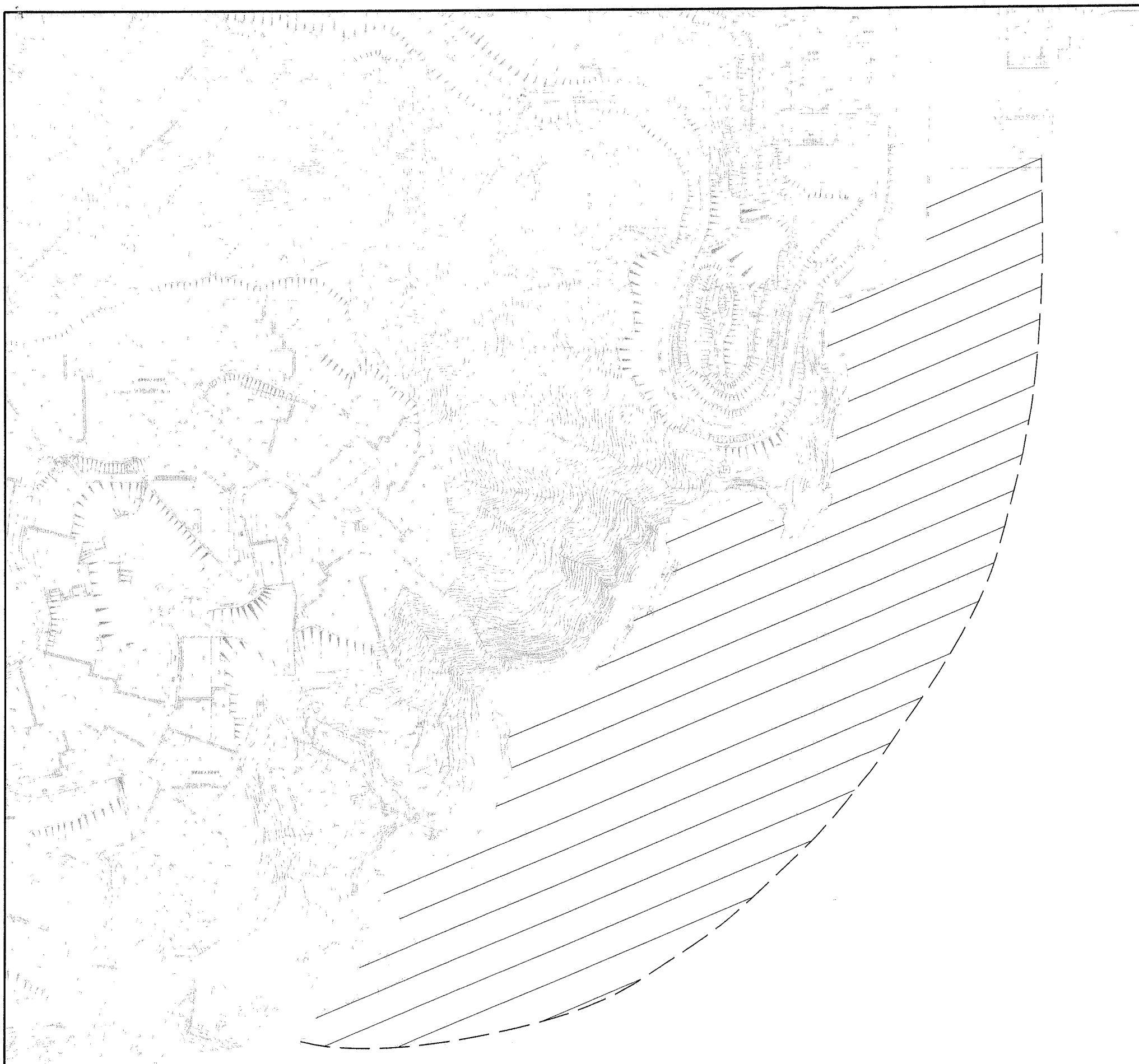
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AGREEMENT NO. CE 42/2008 (CE)  
TSEUNG KWAN O - LAM TIN TUNNEL AND ASSOCIATED WORKS - INVESTIGATION

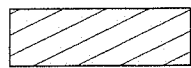
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LUK  
 PLOT SCALE  
 2009-6-19  
 ESCALATIONS



**LEGEND:**

 TENTATIVE DREDGING AREA

 PROPOSED DREDGING EXTENT

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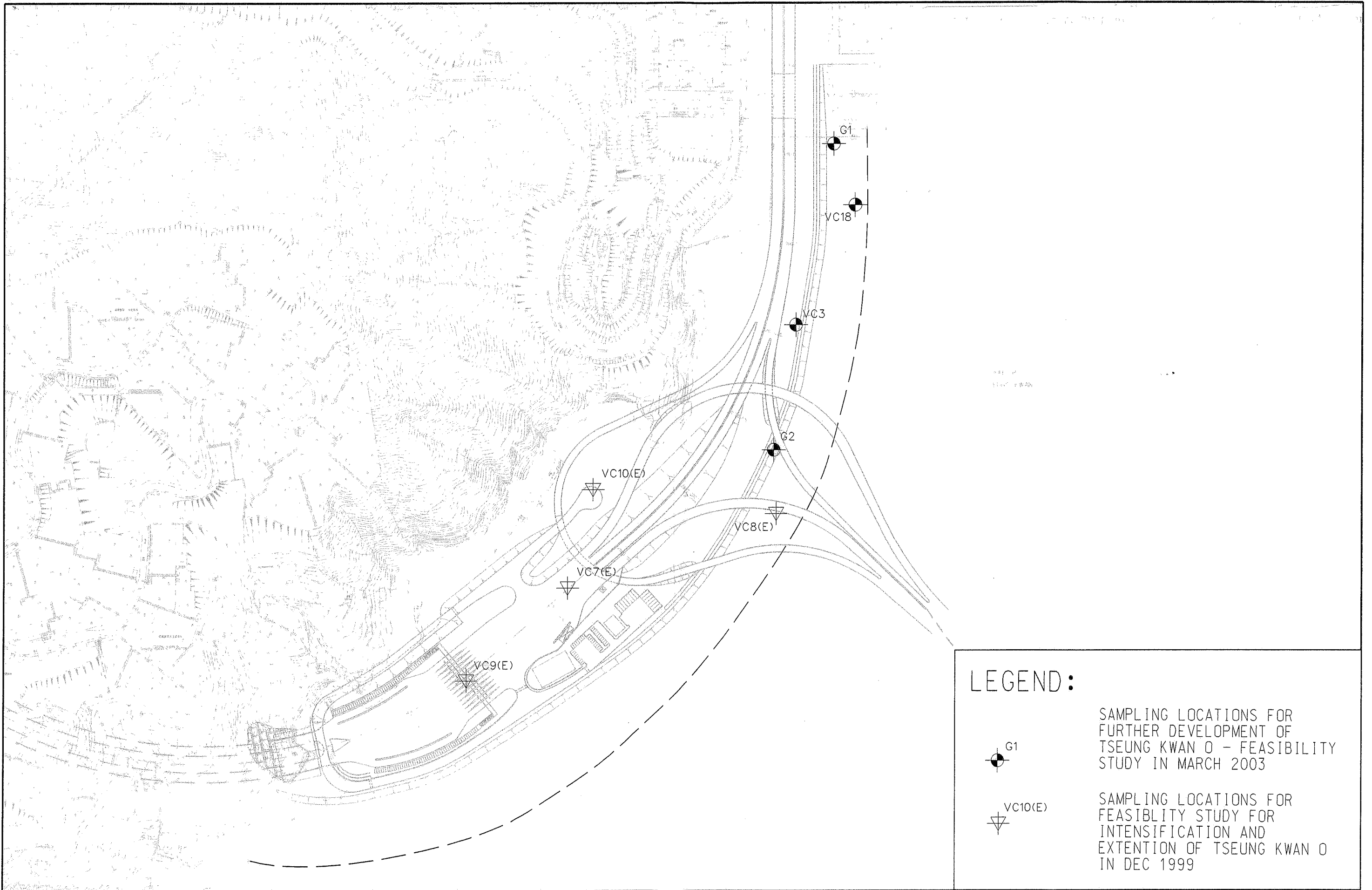
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	LATITUDE	LOGITUDE
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**AECOM**

AGREEMENT NO. CE 42/2008(CE) - TSEUNG KWAN O - LAM TIN TUNNEL AND ASSOCIATED WORKS - INVESTIGATION

LOCATION OF EPD MARINE SEDIMENT MONITORING STATION, JS2

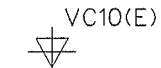
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		REV	A



**LEGEND:**



SAMPLING LOCATIONS FOR FURTHER DEVELOPMENT OF TSEUNG KWAN O - FEASIBILITY STUDY IN MARCH 2003



SAMPLING LOCATIONS FOR FEASIBILITY STUDY FOR INTENSIFICATION AND EXTENSION OF TSEUNG KWAN O IN DEC 1999

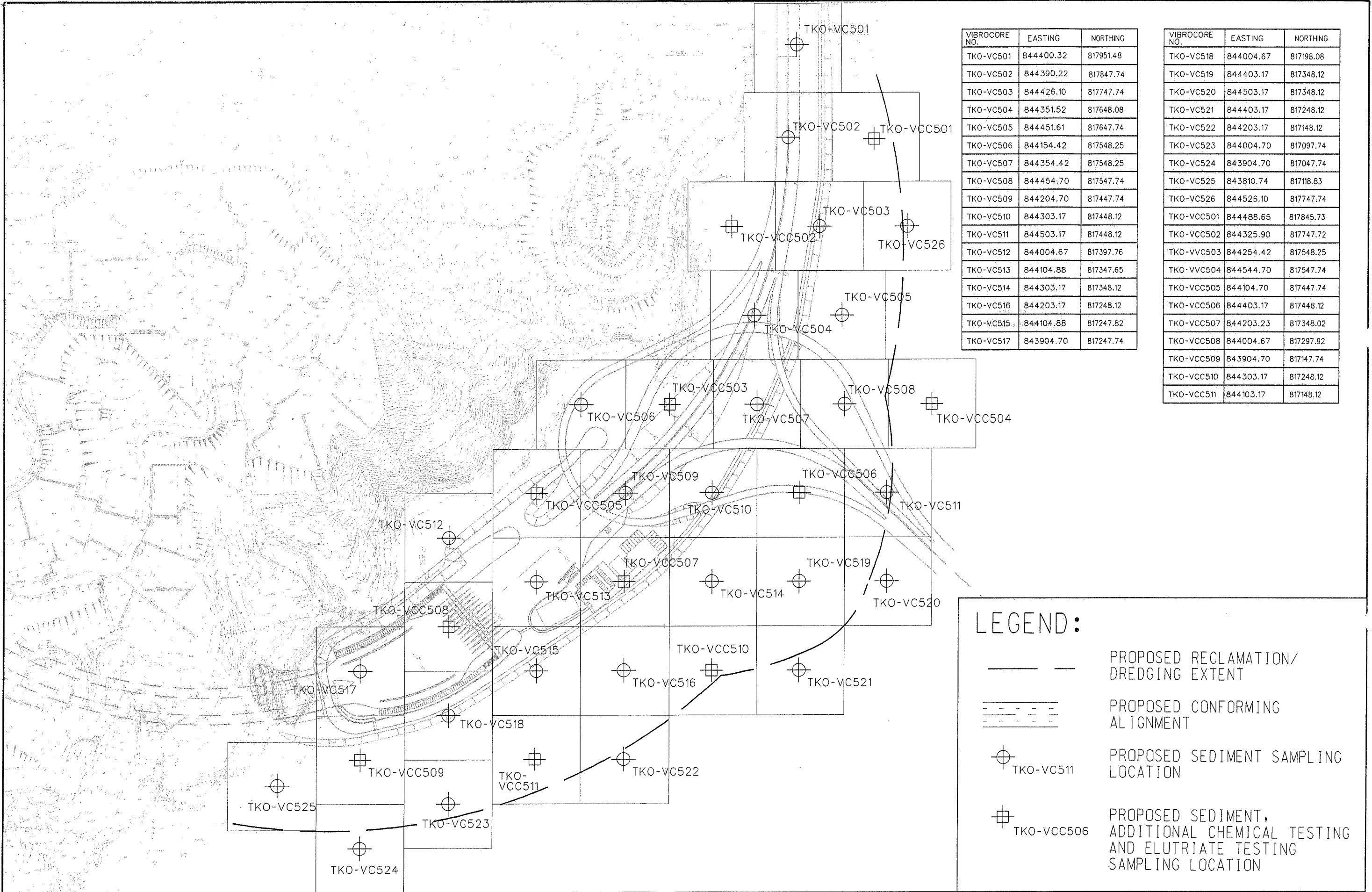
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AGREEMENT NO. CE 42/2008(CE) - TSEUNG KWAN O - LAM TIN TUNNEL AND ASSOCIATED WORKS - INVESTIGATION

**LOCATION OF PREVIOUS SEDIMENT SAMPLING LOCATIONS**

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		REV	A





VIBROCORE NO.	EASTING	NORTHING
TKO-VC501	844400.32	817951.48
TKO-VC502	844390.22	817847.74
TKO-VC503	844426.10	817747.74
TKO-VC504	844351.52	817648.08
TKO-VC505	844451.61	817647.74
TKO-VC506	844154.42	817548.25
TKO-VC507	844354.42	817548.25
TKO-VC508	844454.70	817547.74
TKO-VC509	844204.70	817447.74
TKO-VC510	844303.17	817448.12
TKO-VC511	844503.17	817448.12
TKO-VC512	844004.67	817397.76
TKO-VC513	844104.88	817347.65
TKO-VC514	844303.17	817348.12
TKO-VC515	844203.17	817248.12
TKO-VC516	844104.88	817247.82
TKO-VC517	843904.70	817247.74

VIBROCORE NO.	EASTING	NORTHING
TKO-VC518	844004.67	817198.08
TKO-VC519	844403.17	817348.12
TKO-VC520	844503.17	817348.12
TKO-VC521	844403.17	817248.12
TKO-VC522	844203.17	817148.12
TKO-VC523	844004.70	817097.74
TKO-VC524	843904.70	817047.74
TKO-VC525	843810.74	817118.83
TKO-VC526	844526.10	817747.74
TKO-VCC501	844488.65	817845.73
TKO-VCC502	844325.90	817747.72
TKO-VCC503	844254.42	817548.25
TKO-VCC504	844544.70	817547.74
TKO-VCC505	844104.70	817447.74
TKO-VCC506	844403.17	817448.12
TKO-VCC507	844203.23	817348.02
TKO-VCC508	844004.67	817297.92
TKO-VCC509	843904.70	817147.74
TKO-VCC510	844303.17	817248.12
TKO-VCC511	844103.17	817148.12

**LEGEND:**

- PROPOSED RECLAMATION/DREDGING EXTENT
- PROPOSED CONFORMING ALIGNMENT
- PROPOSED SEDIMENT SAMPLING LOCATION
- PROPOSED SEDIMENT, ADDITIONAL CHEMICAL TESTING AND ELUTRIATE TESTING SAMPLING LOCATION

**AECOM**

AGREEMENT NO. CE 42/2008(CE) - TSEUNG KWAN O - LAM TIN TUNNEL AND ASSOCIATED WORKS - INVESTIGATION

**PROPOSED VIRBOCORE LOCATIONS**

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