

吉寶西格斯 - 振華聯營公司  
KEPPEL SEGHERS - ZHEN HUA JOINT VENTURE

## Detailed Proposal on Enhancement of Air Quality Monitoring in Cheung Chau

(Clause 2.7, Further Environmental Permit No. FEP-01/429/2012/A)

### Document No.

<b>KSZHJV</b>	<b>/</b>	<b>312</b>	<b>/</b>	<b>DPEAQM</b>	<b>/</b>	<b>0001</b>	<b>/</b>	<b>S</b>
Issuer		Project Code		Type of Document		Sequential No.		Revision Index

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<b>Date:</b>	15 April 2025	24 April 2025	24 April 2025

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## Revision History

S	Updated Section 1.3 and Table 1	15 April 2025
R	Delete all sections by using portable air quality monitoring equipments and air quality monitoring carried out at Cheung Chau Transfer Facility	18 Nov 2024
P	Updated Tables 1 and 3	29 Apr 2024
O	Updated Section 2.7, 3.11, 3.12, 3.13, 3.14, 3.15, 4.4, 4.6, Tables 1, 2, 3, 4a, 4b, Appendices A, B	23 Jan 2024
N	Updated Section 1.3, Section 2.1, Section 2.3, Section 2.6, Section 3.11 – 3.15, Table 2, Table 3, Appendix A, Appendix B and Appendix C	27 Oct 2023
M	Updated monitoring duration in Section 2.6, Section 4.1, Table 2 and Section 4.4	2 Dec 2021
L	Revision based on EPD's comments	10 Sep 2021
K	Revision based on EPD's comments	28 July 2021
J	Revision based on EPD's comments	10 May 2021
I	Revision based on EPD's comments	3 Feb 2021
H	Revision based on EPD's comments	10 Mar 2020
G	Revision based on IEC's comments	17 Jul 2019
F	Revision based on KSZHJV's comments	28 Aug 2018
E	Revision based on EPD's comments	29 Mar 2018
D	Revision based on IEC's comments	26 Mar 2018
C	Revision based on IEC's comments	24 Mar 2018
B	Revision based on IEC's comments	22 Mar 2018
A	First submission	27 Feb 2018
<b>Rev.</b>	<b>Description of Modification</b>	<b>Date</b>

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## 1) Project Background

- 1.1) The Government of Hong Kong SAR will develop the Integrated Waste Management Facilities (IWMF) Phase 1 (hereafter referred to the “Project”) with incineration to achieve substantial bulk reduction for unavoidable Municipal Solid Waste (MSW) and to recover energy from incineration process. The IWMF will be on an artificial island to be formed by reclamation at the south-western coast of Shek Kwu Chau (SKC). An Environmental Impact Assessment (EIA) for the Project was conducted according to the EIA Study Brief No. ESB-184/2008. The EIA report (Register No: AEIAR-163/2012) was approved on 17 January 2012 under the Environmental Impact Assessment Ordinance (EIAO). An Environmental Permit (EP) (EP No.: EP-429/2012) was granted on 19 January 2012 for the construction and operation of the Project. A variation of environmental permit (VEP) was subsequently applied and the EP (EP No: EP-429/2012/A) was issued by the Environmental Protection Department (EPD) on 14 October 2016. Further Environmental Permit (FEP) to Construct and Operate (FEP-01/429/2012/A) was later on granted by the Director of Environmental Protection on 27 December 2017.
- 1.2) KEPPEL SEGHERS – ZHEN HUA Engineering Company Limited JOINT VENTURE (hereafter referred to the “Main Contractor”) has been awarded with the Project since November 2017 for the design, construction, operation and maintenance of the Integrated Waste Management Facilities (IWMF) Phase 1
- 1.3) According to the Condition 2.7 of FEP, a detailed proposal on enhancement of air quality monitoring in Cheung Chau shall be prepared and submitted to the Director of Environmental Protection Department for approval for the Project. The proposal shall include setting up of the air quality monitoring (AQM) station at Cheung Chau and devising air quality monitoring programme to keep track of the air quality baseline and impacts of the projects and their respective frequencies. The monitoring shall cover various air quality parameters, including but not be limited to, dioxins, Air Quality Objectives parameters and heavy metals. The location of the AQM station (i.e. Cheung Chau Municipal Services Building) is shown in **Appendix A**. As advised by Housing Department, the original AQMS point, Cheung Kwai Estate is not available for constructing AQMS and the AQMS is currently located at Cheung Chau Municipal Services Building (CCMSB). The distance between Cheung Wing House and CCMSB is approximately 680m. The AQM station will be in operation at least 1 year before commencement of the testing and commissioning of the Project. The air quality monitoring results shall be made

available to the public through a dedicated web site as required in Condition 3.6 of the FEP.

## **2) General Design Requirements of an Air Quality Monitoring Station**

- 2.1) The AQM station will be designed with reference to the QA/QC Manual on Station Design Guidelines Volume 2 Chapter 2.2 (hereafter referred to “the Manual”) issued by the Air Services Laboratory, Air Science Group of the Environmental Protection Department of HKSAR. A typical AQM station mainly consists of the following essential structures:
- a) Equipment Shelter;
  - b) Air Sample Intakes; and
  - c) Lightning Protection System (to provide sufficient protection for operators working, both indoor and outdoor at the station).
- 2.2) The following items shall be taken into account and properly installed in reference with the Manual for design and construction of the AQM station:
- a) Electricity Supply (Refer to the Section 3 of the Manual);
  - b) Air-conditioning (Refer to the Section 4 of the Manual);
  - c) Lighting (Refer to the Section 5 of the Manual);
  - d) Meteorology Sensors (Refer to the Section 7 of the Manual);
  - e) Telephone Lines and Signal Conduits (Refer to the Section 8 of the Manual);  
and
  - f) Station Access (Refer to the Section 10 of the Manual).
- 2.3) The following relevant drawings for design, setting up and construction of the AQM station at Cheung Chau Municipal Services Building (CCMSB) will be prepared and submitted to the Environmental Protection Department – Infrastructure Development Group (EPD – IDG) prior to the commencement of the construction of the AQM station. Also, relevant drawings will also be delivered to the user departments of the CCMSB for comment.

- a) Typical Layout of an AQM Station;
  - b) Design of the Shelter Door of the AQM Station;
  - c) Design of Working Platform on Roof of the Shelter of the AQM Station;
  - d) Internal Layout of the AQM Station;
  - e) Positions of Platforms for Samplers;
  - f) Design of Supporting Structures for Outdoor Equipment;
  - g) Mounting Pole for Temperature and Solar Radiation Sensors;
  - h) Construction of Sample Intake Pipes;
  - i) Recommended Design of Fastening Device for Telfon Tube Inlet;
  - j) Configuration of Sample Intakes; and
  - k) Standard Monitoring Station Manifold Configuration.
- 2.4) All structure erected, including outdoor equipment shelter, lighting rods, air sample intakes, supports for the solar radiation sensor and compact weather station unit, high volume samplers, continuous particulate monitors must be typhoon proof. Also, all metal parts must be painted and anti-rust treated.
- 2.5) Every effort will be given for all the liaison works with the premise's management, utilities and other Government Departments for setting up and construction of the AQM stations. The Main Contractor should appoint authorized persons to design and oversee the construction of the AQM station, and ensure that the AQM structure erected is stable with no adverse effect on any existing structure, especially the waterproofing at roof top. All working personnel shall not cause any nuisance and disturbance to the occupants of the premise during the course of the construction, e.g. removal of all refuse after completion of the construction. The tentative work programme for design and construction of the AQM station at Cheung Chau is attached in **Appendix B**.
- 2.6) For the AQM station to be constructed on roof of the Cheung Chau Municipal Services Building in Cheung Chau, the Main Contractor shall comply with the interfacing requirements stipulated in the Contract for carrying out the construction, setting up, operation and maintenance of the station and shall not cause any adverse impact to the structural integrity of Cheung Chau Municipal Services Building and the adjacent structures. The Main Contractor shall submit his design of the AQM station and relevant information to the user departments of the CCMSB for comment before commencement of any construction of the AQM station. After that, the Main Contractor shall inform the user departments of the

CCMSB in advance every time he makes entry to Cheung Chau Municipal Services Building. The Main Contractor shall be allowed to access the work area in Cheung Chau Municipal Services Building which are agreed with the user departments of the CCMSB in advance. Demarcation of work area and any works for the AQM station shall be carried out in the presence of representatives of the user departments of the CCMSB. The Main Contractor shall propose and agree the appearance and color facade of the AQM station shall be the same as that of the façade of Cheung Chau Municipal Services Building. The Main Contractor shall carry out the baseline air quality monitoring work at Cheung Chau 1 year before commencement of the testing and commissioning of the Integrated Waste Management Facilities on the Artificial Island. Air quality monitoring shall also be carried by the Main Contractor during the testing and commission period. The current arrangement for 1 year monitoring before testing and commission is shown in **Table 1**. Continuous monitoring shall also be conducted during the operational phase. The Main Contractor and appointed Subcontractor shall only be allowed to access the AQM station for the works, including but not limited to sampling, data recording, inspection, maintenance and repairing, from 9 am to 6 pm on Monday to Friday and from 9am to 12pm on Saturday excluding General Holiday. The Main Contractor shall agree the monthly schedule for accessing the AQM station with the user departments of the CCMSB at least one month in advance. The emergency repair access procedures shall be developed based on the need of project and details of the plan will be agreed by EPD-IDG.

**Table 1-Air Quality Monitoring before Testing and Commission Period**

Item	Location	Cheung Chau Municipal Services Building
	Period	21 Feb 24 – 20 Feb 25
	Parameters	
1	Gaseous and Vaporous Organic Substances, expressed as total organic carbon (TOC)	Every one hour
2	Hydrogen Chloride (HCl)	Continuous Monitoring
3	Hydrogen Fluoride (HF)	Continuous Monitoring
4	Sulphur Dioxide (SO <sub>2</sub> )	Continuous Monitoring
5	Nitrogen Oxides (NO <sub>x</sub> / NO / NO <sub>2</sub> )	Continuous Monitoring
6	Ozone (O <sub>3</sub> )	Continuous Monitoring

Item	Location	Cheung Chau Municipal Services Building
	Period	21 Feb 24 – 20 Feb 25
	Parameters	
7	Carbon Monoxide (CO)	Continuous Monitoring
8	Respirable Suspended Particles (PM <sub>10</sub> )	Continuous Monitoring
9	Fine Suspended Particles (PM <sub>2.5</sub> )	Continuous Monitoring
10	Dioxins & Furans	Once per month (24 hrs / month)
11	Heavy Metals (Aluminium, Antimony, Arsenic, Barium, Beryllium, Calcium, Cadmium, Cobalt, Chromium, Copper, Iron, Lead, Magnesium, Manganese, Mercury, Nickel, Selenium, Thallium, Vanadium and Zinc) in total suspended particulates (TSP) and respirable suspended particulates (RSP)	Once per month (24 hrs / month)
12	Heavy Metals (Hexavalent Chromium)	Once per month (24 hrs / month)
13	PAHs	Once per month (24 hrs / month)
14	PCBs (Dioxin-like PCBs)	Once per month (24 hrs / month)
15	PCBs (marker PCBs)	Once per month (24 hrs / month)

2.7) To ensure monitoring equipment are in good function status, routine servicing and maintenance of the system shall be carried out on the AQM station. The Operator shall agree the monthly schedule for accessing the AQM station with the the user departments of the CCMSB at least one month in advance.

2.8) All the design materials relating to the AQM construction works shall make reference with relevant specification of the British Standards Institution and the General Specification issued by the relevant government departments of Hong Kong Special Administrative Region (HKSAR) in particular the latest issue of the following:

- QA/QC Manual Volume 2 Chapter 2.1 Site Selection Criteria regarding the station design issued by the Air Services Laboratory, Air Science Group of the Environmental Protection Department of HKSAR;
- QA/QC Manual on Volume 2 Chapter 2.2 Station Design Guidelines issued by the

Air Services Laboratory, Air Science Group of the Environmental Protection Department of HKSAR;

- General Specification of Building 2007 Edition, together with corrigendum no. GS2007-01 and GS2007-02 as prepared by Architectural Services Department (ArchSD);
- General Specification for Electrical Installation in Government Buildings of the HKSAR, 2007 Edition (Incorporating corrigendum No. GSEE01) issued by ArchSD;
- General Specification for Fire Service Installation in Government Buildings of the HKSAR, 2007 Edition (Incorporating corrigendum No. GSF01) issued by ArchSD;
- General Specification for Air Conditioning, Refrigeration, Ventilation and Central Monitoring and Control System Installation in Government Buildings of the HKSAR, 2007 Edition (Incorporating corrigendum No. GSAC01) issued by ArchSD;
- BS1363 Standard: Sockets protected by individual MCB and RCCB;
- IEE Wiring Regulation for Electrical Installation (17th Edition).

### 3) Methods of Monitoring and Analysis of Required Air Quality Parameters

3.1) The monitoring work of the AQM station shall cover various air quality parameters, including but not be limited to, dioxins, Air Quality Objectives parameters and heavy metals. The AQM stations shall be provided with reference to the requirements in Quality Assurance/Quality Control (QA/QC) Manual issued by Air Services Laboratory of EPD (Spec C 7.1.1.2). Non-radioactive test methods shall be used for the AQM stations (Spec C 7.1.1.4). Heavy metals in both the RSP and TSP shall be monitored monthly (Spec D 9.3.1.1). The gas analyzers, air sampling and analysis systems and meteorological and solar radiation monitoring systems listed in **Table 2** shall be required in the AQM station at Cheung Chau and properly operated to enable monitoring of the air quality parameters:

**Table 2 - Methods of Monitoring and Analysis of Parameters at AQM station**

<b>Air Pollution Data</b>
<p>1) Gaseous and Vaporous Organic Substances, expressed as total organic carbon by Total Carbon Analyzer with combination with Aethalometer or Semi-Continuous Thermal / Optical Carbonaceous Aerosol Analyzer</p> <p>a.) Total Carbon Analyzer with combination with Aethalometer</p> <ul style="list-style-type: none"> <li>• Combustion Chamber analysis for Total Carbon and absorption analysis at 880nm for Elemental Carbon</li> <li>• 300 ng/m<sup>3</sup> to 300,000 ng/m<sup>3</sup> of Total Carbon and 0.01 to 100 µg/m<sup>3</sup> for Elemental Carbon</li> <li>• Organic Carbon = Total Carbon – Elemental Carbon</li> <li>• Resolution shall be 0.03 µg/m<sup>3</sup></li> </ul> <p>b.) Semi-Continuous Thermal / Optical Carbonaceous Aerosol Analyzer</p> <ul style="list-style-type: none"> <li>• Thermal Analysis method together with Non-Dispersive Infrared Detector</li> <li>• 0.4 to 200 µg/m<sup>3</sup> for Total Organic Carbon</li> </ul>
<p>2) Hydrogen Chloride (HCl) by HCl On-line Analyzer</p> <ul style="list-style-type: none"> <li>• Electrochemical sensor cell analysis</li> <li>• Range 0-6 ppm, resolution shall be 10 ppb</li> </ul>
<p>3) Hydrogen Fluoride (HF) by HF On-line Analyzer</p> <ul style="list-style-type: none"> <li>• Electrochemical sensor cell analysis</li> <li>• Range 0-9 ppm, resolution shall be 10 ppb</li> </ul>

<b>Air Pollution Data</b>
<p>4) Sulphur Dioxide by a SO<sub>2</sub> On-line Analyzer</p> <ul style="list-style-type: none"> <li>• Ultraviolet (UV) fluorescent radiation analysis</li> <li>• Range 0-20 ppm, resolution shall be 0.5 ppb</li> </ul>
<p>5) Nitrogen Oxides (NO<sub>x</sub>/NO/NO<sub>2</sub>) by a NO<sub>x</sub> On-line Analyzer</p> <ul style="list-style-type: none"> <li>• Chemiluminescence analysis</li> <li>• Range 0-20 ppm, resolution shall be 0.2 ppb</li> </ul>
<p>6) Ozone by O<sub>3</sub> On-line Analyzer</p> <ul style="list-style-type: none"> <li>• Non-dispersive ultraviolet (UV) absorption analysis</li> <li>• Range 0-20 ppm, resolution shall be 0.4 ppb</li> </ul>
<p>7) Carbon Monoxide by a CO On-line Analyzer</p> <ul style="list-style-type: none"> <li>• Non-dispersive infrared (NDIR) gas filter correlation analysis</li> <li>• Range 0-200 ppm, resolution shall be 0.04ppm</li> </ul>
<p>8) Respirable Suspended Particles (RSP i.e. PM<sub>10</sub>) by a RSP On-line Analyzer</p> <ul style="list-style-type: none"> <li>• Tapered element oscillating microbalance/ Light scattering method</li> <li>• Time resolution shall be around 1 hour</li> <li>• Range 0 – 1,000,000 µg/m<sup>3</sup>, resolution shall be 0.1 µg/m<sup>3</sup></li> </ul>
<p>9) Fine Suspended Particles (FSP i.e. PM<sub>2.5</sub>) by a FSP On-line Analyzer</p> <ul style="list-style-type: none"> <li>• Tapered element oscillating microbalance/ Light scattering method</li> <li>• Time resolution shall be around 1 hour</li> <li>• Range 0 – 1,000,000 µg/m<sup>3</sup>, resolution shall be 0.1 µg/m<sup>3</sup></li> </ul>
<p>10) Dioxins &amp; Furans</p> <ul style="list-style-type: none"> <li>• Sampling and analysis method: USEPA Method TO-9A</li> <li>• Sampling instrument: Graeseby GPS1 / Tisch TE-1000</li> <li>• Sampling media: Quartz fibre filter and polyurethane</li> <li>• Sampling period: once per month (24 hrs / month)</li> </ul>

<b>Air Pollution Data</b>
<p>11) Heavy Metals (Aluminium, Antimony, Arsenic, Barium, Beryllium, Calcium, Cadmium, Cobalt, Chromium, Copper, Iron, Lead, Magnesium, Manganese, Mercury, Nickel, Selenium, Thallium, Vanadium, and Zinc) in total suspended particulates (TSP) and respirable suspended particulates (RSP)</p> <ul style="list-style-type: none"> <li>• Sampling Instrument: USEPA 6070 series high-volume sampler</li> <li>• Sampling Period: once per month (24 hrs / month)</li> <li>• Sampling Rate: <ul style="list-style-type: none"> <li>○ Total suspended particulates (TSP): 1.146 m<sup>3</sup>/min</li> <li>○ Respirable suspended particulates (RSP): 1.13 m<sup>3</sup>/min</li> </ul> </li> <li>• Analysis method: <ul style="list-style-type: none"> <li>○ Inductively Coupled Plasma – Optical Emission Spectrometry (for Aluminium, Antimony, Barium, Beryllium, Calcium, Cadmium, Cobalt, Chromium, Copper, Iron, Lead, Magnesium, Manganese, Nickel, Selenium, Thallium, Vanadium and Zinc)</li> <li>○ Flow Injection-Metal Hydride/Cold Vapour Atomic Absorption Spectrometry. (for Arsenic and Mercury)</li> </ul> <p><b>Or</b></p> <ul style="list-style-type: none"> <li>○ Inductively Coupled Plasma/Mass Spectrometry (for Aluminium, Antimony, Arsenic, Barium, Beryllium, Cadmium, Cobalt, Chromium, Copper, Lead, Manganese, Nickel, Selenium, Thallium, Vanadium and Zinc)</li> <li>○ Inductively Coupled Plasma Spectroscopy (for Calcium, Iron and Magnesium)</li> <li>○ Cold Vapor Atomic Fluorescence Spectrometry (for Mercury)</li> </ul> </li> </ul>
<p>12) Heavy Metals (Hexavalent Chromium)</p> <ul style="list-style-type: none"> <li>• Sampling and analysis method: CARB SOP MLD 039</li> <li>• Alkaline-impregnated Filter</li> <li>• Sampling period: once per month (24 hrs / month)</li> </ul>
<p>13) PAHs</p> <ul style="list-style-type: none"> <li>• Sampling and analysis method: USEPA Method TO-13A</li> <li>• High Performance Liquid Chromatography (HPLC) analysis</li> <li>• Monitoring frequency: once per month (24 hrs / month)</li> </ul>

<b>Air Pollution Data</b>
<p>14) PCBs (Dioxin-like PCBs)</p> <ul style="list-style-type: none"> <li>• Sampling and analysis method: USEPA Method TO-9A</li> <li>• Sampling instrument: Graeseby GPS1 / Tisch TE-1000</li> <li>• Sampling media: Quartz fibre filter and polyurethane</li> <li>• Monitoring frequency: once per month (24 hrs / month)</li> </ul>
<p>15) PCBs (marker PCBs)</p> <ul style="list-style-type: none"> <li>• Sampling and analysis method: USEPA Method TO-4A</li> <li>• Sampling instrument: Graeseby GPS1 / Tisch TE-1000</li> <li>• Sampling media: Quartz fibre filter and polyurethane</li> <li>• Monitoring frequency: once per month (24 hrs / month)</li> </ul>
<p><b>Meteorological Data</b></p> <p>Indoor temperature and humidity, outdoor temperature and humidity, wind speed, wind direction, solar radiation and atmospheric pressure</p>

3.2) Methodology for Gaseous and Vaporous Organic Substances, expressed as total organic carbon

3.2.1) Instrumental Analysis

a.) By Total Carbon Analyzer with combination with Aethalometer or

Two identical flow channels for sampling and analysis. Sample is collected on quartz fiber filter in stainless steel combustion chamber. At the end of sampling time base, collection flow is switched to second channel while first channel is analyzed. Collected sample is flashed-heated to convert all Carbon to CO<sub>2</sub>. Ambient air is used as "analytical" carrier gas at low flow rate. The baseline level of CO<sub>2</sub> in ambient air is determined before and after the heating cycle. Large pulse of CO<sub>2</sub> in analytical flow is integrated over ambient baseline to determine Total Carbon content of sample. Timebase for sampling and analysis is adjustable from 20 minutes to 24 hours.

Real time monitoring of Element Carbon concentration measurement is defined by the absorption measurement at 880 nm.

To avoid Organic Carbon underestimation, the following optical detection and correction will be performed:

- Continuous collection of aerosol on filter with simultaneous measurement of attenuation of transmitted light at wavelengths of 370, 470, 520, 590, 660, 880 and 950 nm; and
- Simultaneous analysis of light absorption by aerosol deposits collected on 2 spots in parallel at different loading rates. Mathematical combination of data yields Element Carbon result independent of “spot loading effects” and provides additional information about aerosol composition.

#### b.) By Semi-Continuous Thermal / Optical Carbonaceous Aerosol Analyzer

Ambient air is passed through vertically mounted quartz fiber filters every 60 minutes. Upon completion of the sample collection the instrument front and back ovens are purged of ambient air using Helium. Once the oven is purged with helium, stepped temperature ramp increases the oven temperature to a maximum, thermally desorbing organic compounds and pyrolysis products into a manganese dioxide ( $\text{MnO}_2$ ) oxidizing oven. As the carbon fragments flow through the  $\text{MnO}_2$  oven they are quantitatively converted to  $\text{CO}_2$  gas. The  $\text{CO}_2$  then passes through a Non-Dispersive Infrared Detector (NDIR). The concentration of Total Organic Carbon can then be measured by NDIR.

### 3.3) Methodology for Hydrogen Chloride

#### 3.3.1) Instrumental Analysis

HCl electrochemical sensor detect real time gas concentration by measuring current based on the electrochemical principle, which utilizes the electrochemical oxidation process of target gas on the working electrode inside the electrolytic cell, the current produced in electrochemical reaction of the target gas are in direct proportion with its concentration while following Faraday law, then concentration of the gas could be get by measuring value of current.

### 3.4) Methodology for Hydrogen Fluoride

#### 3.4.1) Instrumental Analysis

HF electrochemical sensor detect real time gas concentration by measuring current based on the electrochemical principle, which utilizes the electrochemical oxidation process of target gas on the working electrode inside the electrolytic cell, the current produced in electrochemical reaction of the target gas are in direct proportion with its concentration while following Faraday law, then concentration of the gas could be get by measuring value of current.

### 3.5) Methodology for Dioxin/Furan Analysis

#### 3.5.1) Sample Preparation

The sample preparation and chemical analysis should be undertaken by an accredited laboratory. The selection of methods, sample preparation and chemical analysis shall be subject to confirmation engagement of accredited laboratory. The glass sample cartridges containing PUF plug and quartz filter shall be placed inside a Soxhlet extractor, and add 275 mL of benzene into a boiling flask which fits the extractor for extraction. Another 25 mL of benzene should be used to rinse the corresponding glass cylinder. The apparatus is placed on a heating mantel for 16 hours of extraction. After cooled down, a 3-bulb Synder column should be changed onto the boiling flask, and using heating mantel to concentrate the benzene extract to around 25 mL. Add 100 mL of hexane and concentrate again to around 25 mL. Add another 100 mL of hexane and concentrate again to 25 mL. The hexane extract should be transferred into separator funnel, with the flask washed by around 25mL of hexane, which should also be transferred into the separator funnel. Then wash the combined hexane using 30 mL of 2N NaOH solution, allow layers to separate and discard the aqueous layer. Repeat until no color is identified from the aqueous layer. Then carefully add 50 mL of concentrated sulfuric acid, mix the extract with acid vigorously for 1 minute. Allow the layers to separate, and discard the aqueous layer. Repeat acid wash until no color is identified from the aqueous layer. Then transfer the extract through a filter funnel containing a plug of glass wool and 3-cm of sodium sulfate into a concentrator. After removing the water in the hexane extract, concentrate the hexane extract into 1 to 2 mL. If necessary, silica column cleanup, alumina column cleanup or carbon column cleanup could be applied as follow-up cleanup procedures.

### 3.5.2) Instrumental Analysis

Hexane extract is analysed with the HRGC-HRMS system using the instrument parameters according to the instrument manual or related literatures. A SE-54 fused silica capillary column is used to determine the concentrations of total tetra-, penta-, hexa-, hepta- and octa-CDDs/CDFs to determine the minimum limits of detections (MLDs) for the compounds.

### 3.6) Methodology for Heavy Metals Analysis

#### 3.6.1) Sample Preparation

The sample preparation and chemical analysis should be undertaken by an accredited laboratory. The selection of methods, sample preparation and chemical analysis shall be subject to confirmation engagement of accredited laboratory. Adequate portion of filter sample is prepared and placed inside the test tubes. Add 20 mL of mixed acid solution as digestion fluid into test tubes, make sure the filter samples are immersed in the acid. For different digestion system, different mixed acid could be applied. Normally nitric acid (70% v/v) with hydrochloric acid (38% v/v) mixture, or nitric acid (70% v/v) with perchloric acid (60% v/v) mixture are applied. Using a vortex for mixing the mixture gently, and then place the test tubes into a heating block. Heating the test tubes with a programmed temperature series until the residual samples turned into light color and dry. Wash the test tube using 20 mL of 5% nitric acid, and ensure the residual filter samples are fully submerged after the test tubes cooled down. Mixing the sample using vortex, then heating the mixture again at 70°C for 1 hour. Mixing the sample using vortex after cooled down, then the sample could be transferred into plastic tubes for storage under low temperature. Before ICP analysis, the samples should be centrifuged at 3500 rpm for 10 minutes.

#### 3.6.2) Instrumental Analysis

Before the establishing standard curves and sample analysis, the system shall be washed by nitric acid solution (1.4% v/v). Set up the analysis wavelength for each target species according to the instrument manual and related literature. Prepare a series of standard solution with different concentrations, establish the standard curves for each individual element, with the concentrations as the x-axis and signal

as y-axis. During sample analysis, if the signal is exceeding the range of standard curve, then this sample should be diluted and analyzed again.

### 3.7) Methodology for PAHs

#### 3.7.1) Sample Preparation

The sample preparation and chemical analysis should be undertaken by an accredited laboratory. The selection of methods, sample preparation and chemical analysis shall be subject to confirmation engagement of accredited laboratory. Soxhlet apparatus is assembled and charged with 700 to 750 mL of 10% diethyl ether in hexane and refluxed for 2 hours. It is then cooled and disassembled. The diethyl ether in hexane is transferred to a clean glass container and retained as a blank for later analysis. The sorbent is placed and filtered together in the Soxhlet apparatus.

Appropriate laboratory surrogate standards are added to the Soxhlet solvent. A surrogate standard is added to each sample, blank and matrix spike sample prior to extraction or processing. Surrogate recovery is evaluated for acceptance by determining whether the measure concentration falls within the acceptance limits. 20  $\mu\text{L}$  of a 50  $\mu\text{g}/\text{mL}$  solution of the surrogates is spiked onto the PUF cartridge, prior to Soxhlet extraction, to yield a final concentration of 1  $\mu\text{g}$ . The laboratory surrogate compounds are added to the PUF cartridge. 700 mL of 10 percent diethyl ether in hexane is added to the apparatus and refluxed for 18 hours at a rate of at least 3 cycles per hour. The apparatus is cooled and disassembled.

The extract from the Soxhlet extraction is dried by passing it through a drying column containing about 10 grams of anhydrous sodium sulfate. The dried extract is collected in a K-D concentrator assembly. The extractor flask and sodium sulfate column are washed with 100-125 mL of 10% diethyl ether/hexane to complete the quantitative transfer. A K-D concentrator is assembled by attaching a 10 mL concentrator tube to a 500 mL evaporative flask.

Two boiling chips are added and a three-ball macro-Snyder column is attached to the K-D flask, and the extract is concentrated using a water bath at 60 to 65°C. The K-D apparatus is placed in the water bath so the concentrator tube is half immersed in the water and whole rounded surface of the flask is bathed with the water vapour.

The vertical position of the apparatus the water temperature is adjusted to complete the concentration within an hour. When the liquid has reached an appropriate volume of 5 mL, the K-D apparatus is removed from the water bath and the solvent is allowed to drain for 5 minutes while cooling.

The Snyder column is removed and the flask is rinsed and its lower joint joined into the concentrator tube with 5mL of cyclohexane. The 1mL calibrated K-D concentrator tube and an open micro-Snyder attachment are placed in a warm water bath (30 to 35°C) and the solvent is evaporated to below 1mL by blowing a gentle stream of clean, dry nitrogen above the extract. The internal wall of the concentrator tube is rinsed down several times with hexane during the operation. The tube solvent level should be kept below the water level of the bath. Finally, the final volume is increased to 1.0 mL with hexane. The extract is transferred to a Teflon<sup>®</sup>-sealed screw-cap amber vial, the vial is labeled, and stored at 4°C.

### 3.7.2) Instrumental Analysis

The GC/MS system is set up. All sample extracts are warmed to ambient temperature (up to 1 hour) before analysis. The internal standard spiking solution is added to the 1.0 mL extract. For sample dilutions, an appropriate amount of the internal standard spiking solution is added to maintain the concentration of the internal standards at 2 ng/ $\mu$ L in the diluted extract. 2.0  $\mu$ L of sample extract is injected into the GC/MS and data acquisition begins. When all semi-volatile target compounds have eluted from the GC, the MS data acquisition is terminated and data files are stored on the data system storage device. Appropriate data output software is used to display full range mass spectra and SICPs. These qualifiers are stored on the hard disk of the GC/MS data computer and used for identification of each chromatographic peak. The retention time qualifier is determined to be +0.10 minute of the library retention time of the compound. The acceptance level for relative abundance is determined to be  $\pm$ 15% of the expected abundance. Three ions are measured for most of the PAH compounds. When compound identification is made by the computer, any peak that fails any of the qualifying tests is flagged. The data should be manually examined by the analyst to determine the reason for the flag and whether the compound should be reported as found.

### 3.8) Methodology for hexavalent chromium

#### 3.8.1) Sample Preparation

The sample preparation and chemical analysis should be undertaken by an accredited laboratory. The selection of methods, sample preparation and chemical analysis shall be subject to confirmation engagement of accredited laboratory. Filters from original containers are removed and placed in individually labeled 50 mL weighing bottles. 15 mL of nanopure water is added to each weighing bottle. Samples in a sonicator are placed on the sonication rack. Tap water is added to the sonication tub. The sonicator water level should not reach the lids of the weigh bottles. Samples are sonicated for 3 hours.

#### 3.8.2) Instrumental Analysis

The process of instrumental analysis includes preparing extracts for analysis, loading the auto-sampler and ensuring the integrity of the results. Sampled filters are extracted by sonication in 15mL of nanopure water for 3 hours. The sonication tub was drained by opening the water valve. The weighing bottles containing the extracts is removed once the sonication tub has drained. Samples are homogenized by manually shaking, the bottle lids are then removed. Approximately 5mL of each extract is transferred to individually labeled sample tubes. Sample tubes are capped with filter-less caps. Samples are analyzed within 24 hours of extraction. To operate the IC, the instrument controller is programmed with the sample sequence and appropriate QC. Samples are loaded into the auto-sampler ensuring that their location matches the run sequence.

### 3.9) Methodology for Dioxins-like PCBs

#### 3.9.1) Sample Preparation

The sample preparation and chemical analysis should be undertaken by an accredited laboratory. The selection of methods, sample preparation and chemical analysis shall be subject to confirmation engagement of accredited laboratory. The glass sample cartridges containing PUF plug and quartz filter shall be placed inside a Soxhlet extractor, and add 275 mL of Dioxins-like PCBs into a boiling flask which fits

the extractor for extraction. Another 25 mL of Dioxins-like PCBs should be used to rinse the corresponding glass cylinder. The apparatus is placed on a heating mantel for 16 hours of extraction. After cooled down, a 3-bulb Synder column should be changed onto the boiling flask, and using heating mantel to concentrate the Dioxins-like PCBs extract to around 25 mL. Add 100 mL of Dioxins-like PCBs and concentrate again to around 25 mL. Add another 100 mL of Dioxins-like PCBs and concentrate again to 25 mL. The Dioxins-like PCBs extract should be transferred into separator funnel, with the flask washed by around 25 mL of hexane, which should also be transferred into the separator funnel. Then wash the combined Dioxins-like PCBs using 30 mL of 2N NaOH solution, allow layers to separate and discard the aqueous layer. Repeat until no color is identified from the aqueous layer. Then carefully add 50 mL of concentrated sulfuric acid, mix the extract with acid vigorously for 1 minute. Allow the layers to separate, and discard the aqueous layer. Repeat acid wash until no color is identified from the aqueous layer. Then transfer the extract through a filter funnel containing a plug of glass wool and 3-cm of sodium sulfate into a concentrator. After removing the water in the Dioxins-like PCBs extract, concentrate the Dioxins-like PCBs extract into 1 to 2 mL. If necessary, silica column cleanup, alumina column cleanup or carbon column cleanup could be applied as follow-up cleanup procedures.

### 3.9.2) Instrumental Analysis

Dioxins-like PCBs extract is analysed with the HRGC-HRMS system using the instrument parameters according to the instrument manual or related literatures. A SE-54 fused silica capillary column is used to determine the concentrations of dioxin-like PCBs to determine the minimum limits of detections (MLDs) for the compounds.

### 3.10) Methodology for marker PCBs

#### 3.10.1) Sample Preparation

All samples are extracted within 1 week after collection and stored at  $<4^{\circ}\text{C}$  until extracted. All glassware is washed with a suitable detergent, rinsed with deionized water, acetone, and hexane; rinsed again with deionized water and fired in an oven. ( $500^{\circ}\text{C}$ ). A spiking solution is prepared for determination of extraction efficiency. The

spiking solution contains one or more surrogate compounds. Octachloronaphthalene (OCN) and dibutylchloroendate are used as surrogates for determination of organochlorine pesticides by GC with an ECD. Tetrachloro-m-xylene and decachlorobiphenyl are used together to insure recovery of early and late eluting compounds. For organophosphate pesticides, tributylphosphate or triphenylphosphate are used as surrogates. The surrogate solution is prepared so that addition of 100 FL into the PUF plug results in an extract containing the surrogate compound at the high end of the instrument's calibration range.

The extracting solution (10% diethyl ether/hexane) is prepared by mixing 1800 mL of hexane and 200 mL of diethyl ether (preserved with ethanol) to a flask. Glassware, forceps, and other equipment to be used should be rinsed with 10% diethyl ether/hexane and placed on rinsed (10% diethyl ether/hexane) aluminum foil until use. The condensing towers should also be rinsed with 10% diethyl ether/hexane. Then 700 mL of 10% diethyl ether/hexane is added to the 1,000 mL round bottom flask and added up to three boiling granules. The filter/PUF cartridge is removed from the sealed container, the PUF is removed from the glass cartridge by using precleaned (i.e., 10% diethyl ether/hexane Soxhlet extracted) cotton gloves and the filter/PUF together are placed into the 300 mL Soxhlet extractor using prerinsed forceps. Before extraction begins, 100 µL of the OCN solution is added directly to the top of the PUF plug.

The Soxhlet extractor is connected to the 1,000 mL boiling flask and condenser. The glass is wet and jointed with 10% diethyl ether/hexane to ensure a tight seal between the fittings. The water flow to the condenser towers of the Soxhlet extraction assembly is checked and the heating unit turned on. As the samples boil, the Soxhlet extractors should be inspected to ensure that they are filling and siphoning properly (4 to 6 cycles/hour). Samples should cycle for at least 16 hours. At the end of the extracting process, the heating unit is turned off and the sample cooled to room temperature. The extracts are then concentrated to 5 mL using a Kuderna-Danish (K-D) apparatus. The K-D is set up, assembled with concentrator tubes, and rinsed. The lower end of the filter tube is packed with glass wool and filled with sodium sulfate to a depth of 40 mm. The filter tube is placed in the neck of the K-D. The Soxhlet extractors and boiling flasks are removed from the condenser towers and the remaining solvent is drained into each boiling flask.

Sample extract is poured through the filter tube into the K-D. Each boiling flask is rinsed three times by swirling hexane along the sides. Once the sample has drained, the filter tube is rinsed down with hexane. Each Snyder column is attached to the K-D and rinsed to wet the joint for a tight seal. The complete K-D apparatus is placed on a steam bath and the sample is evaporated to approximately 5mL.

### 3.10.2) Instrumental Analysis

A mass spectrometer operating in select ion monitoring (SIM) mode is used as a sensitive detector for multi-residue determination of pesticides. Mass spectrometers provide detection limits comparable to nitrogen-phosphorus and electron capture detectors. The mass spectrometer is operated using positive ion electron impact ionization (70eV). p-Terphenyl-d<sub>14</sub> is commonly used as a surrogate for GC/MS analysis. Quantification is performed using an internal standard method. 1,4-Dichlorobenzene, naphthalene-d<sub>8</sub>, acenaphthene-d<sub>10</sub>, phenanthrene-d<sub>10</sub>, chrysene-d<sub>12</sub> and perylene-d<sub>12</sub> are used as internal standards.

## 4) Baseline and Impact Air Quality Monitoring Frequencies

4.1) The Main Contractor shall be responsible for carrying out the baseline air quality monitoring of the AQM station at Cheung Chau 1 year before the commencement of testing and commissioning of the Project. Air quality monitoring shall also be carried by Main Contractor during the testing and commissioning period. Continuous monitoring shall also be conducted during the operational phase. The monitoring frequencies of the air parameters are proposed and summarized in **Table 3**.

**Table 3 – Monitoring Frequencies of Parameters at AQM station**

Parameters	Proposed Frequency (for 1 year Baseline Monitoring before commissioning and testing)	Proposed Frequency (for 1 year Monitoring throughout commissioning and testing and continuous monitoring after commissioning and testing)
	Cheung Chau Municipal Services Building	Cheung Chau Municipal Services Building
	21 Feb 24 – 20 Feb 25	From 21 Feb 25 onwards
Gaseous and Vaporous Organic Substances, expressed as total organic carbon (TOC)	Every one hour	Every one hour
Hydrogen Chloride (HCl)	Continuous Monitoring	Continuous Monitoring
Hydrogen Fluoride (HF)	Continuous Monitoring	Continuous Monitoring
Sulphur Dioxide (SO <sub>2</sub> )	Continuous Monitoring	Continuous Monitoring
Nitrogen Oxides (NO <sub>x</sub> / NO / NO <sub>2</sub> )	Continuous Monitoring	Continuous Monitoring
Ozone (O <sub>3</sub> )	Continuous Monitoring	Continuous Monitoring
Carbon Monoxide (CO)	Continuous Monitoring	Continuous Monitoring
Respirable Suspended Particles (PM <sub>10</sub> )	Continuous Monitoring	Continuous Monitoring
Fine Suspended Particles (PM <sub>2.5</sub> )	Continuous Monitoring	Continuous Monitoring
Dioxins & Furans	Once per month (24 hrs / month)	Once per month (24 hrs / month)
Heavy Metals (Aluminium, Antimony, Arsenic, Barium, Beryllium, Calcium, Cadmium, Cobalt, Chromium, Copper, Iron, Lead, Magnesium, Manganese, Mercury,	Once per month (24 hrs / month)	Once per month (24 hrs / month)

Parameters	Proposed Frequency (for 1 year Baseline Monitoring before commissioning and testing)	Proposed Frequency (for 1 year Monitoring throughout commissioning and testing and continuous monitoring after commissioning and testing)
	Cheung Chau Municipal Services Building	Cheung Chau Municipal Services Building
	21 Feb 24 – 20 Feb 25	From 21 Feb 25 onwards
Nickel, Selenium, Thallium, Vanadium and Zinc) in total suspended particulates (TSP) and respirable suspended particulates (RSP)		
Heavy Metals (Hexavalent Chromium)	Once per month (24 hrs / month)	Once per month (24 hrs / month)
PAHs	Once per month (24 hrs / month)	Once per month (24 hrs / month)
PCBs (Dioxin-like PCBs)	Once per month (24 hrs / month)	Once per month (24 hrs / month)
PCBs (marker PCBs)	Once per month (24 hrs / month)	Once per month (24 hrs / month)
Meteorological Data (Indoor temperature and humidity, outdoor temperature and humidity, wind speed, wind direction, solar radiation and atmospheric pressure)	Continuous Monitoring	Continuous Monitoring

4.2) The determination of the dioxin/furan and dioxin-like PCBs, marker PCBs, PAHs, Hexavalent Chromium samples will be carried out according to the USEPA method TO-9A, TO-4A, TO-13A and CARB SOP MLD 039 respectively while the analytical methods of the heavy metal samples in both TSP and RSP to be collected using the Hi-Volume sampling method as shown in **Table 4a** or **Table 4b**.

**Table 4a – Analytical Methods of Heavy Metal Samples (Using ICP-MS Method)**

<b>Method</b>	<b>Parameters</b>
Determination of Metals in Ambient Particulate Matter Using Inductively Coupled Plasma/Mass Spectrometry (ICP-MS)	Aluminium, Antimony, Arsenic, Barium, Beryllium, Cadmium, Cobalt, Chromium, Copper, Lead, Manganese, Nickel, Selenium, Thallium, Vanadium, and Zinc
Determination of Metals in Ambient Particulate Matter Using Inductively Coupled Plasma (ICP) Spectroscopy	Calcium, Iron, Magnesium
Standard Operating Procedure for the Determination of Hexavalent Chromium in Ambient Air by Ion Chromatography	Hexavalent Chromium
Sampling and Analysis for Vapor and Particle Phase Mercury in Ambient Air Utilizing Cold Vapor Atomic Fluorescence Spectrometry (CVAFS)	Mercury
Determination of Polycyclic Aromatic Hydrocarbons (PAHs) in Ambient Air Using Gas Chromatography/Mass Spectrometry (GC/MS)	PAHs
Determination of Polychlorinated, Polybrominated And Brominated/Chlorinated Dibenzo-p-Dioxins and Dibenzofurans In Ambient Air (High Resolution Gas Chromatography / High Resolution Mass Spectrometry (HRGC/HRMS))	Dioxins, Furans and Dioxin-like PCBs
Determination of Pesticides and Polychlorinated Biphenyls in Ambient Air Using High Volume Polyurethane Foam (PUF) Sampling Followed by Gas Chromatographic/Multi-Detector Detection (GC/MD)	Marker PCBs

**Table 4b – Analytical Methods of Heavy Metal Samples (Using ICP-OES Method)**

<b>Method</b>	<b>Parameters</b>
Determination of Metal in Airborne Particulates using Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES)	Aluminium, Antimony, Barium, Beryllium, Calcium, Cadmium, Cobalt, Chromium, Copper, Iron, Lead, Magnesium, Manganese, Nickel, Selenium, Thallium, Vanadium, and Zinc
Standard Operating Procedure for the Determination of Hexavalent Chromium in Ambient Air by Ion Chromatography	Hexavalent Chromium
Determination of Arsenic and Mercury in Airborne Particulate Matter by Flow Injection-Metal Hydride/Cold Vapour Atomic Absorption Spectrometry.	Arsenic, Mercury.
Determination of Polycyclic Aromatic Hydrocarbons (PAHs) in Ambient Air Using Gas Chromatography/Mass Spectrometry (GC/MS)	PAHs
Determination of Polychlorinated, Polybrominated And Brominated/Chlorinated Dibenzo-p-Dioxins and Dibenzofurans In Ambient Air (High Resolution Gas Chromatography / High Resolution Mass Spectrometry (HRGC/HRMS))	Dioxins, Furans and Dioxin-like PCBs
Determination of Pesticides and Polychlorinated Biphenyls in Ambient Air Using High Volume Polyurethane Foam (PUF) Sampling Followed by Gas Chromatographic/Multi-Detector Detection (GC/MD)	Marker PCBs

#### 4.3) Quality Control and Quality Assurance

4.3.1) Before carrying out baseline and impact air quality monitoring, all quality control activities including but not limited to zero/span check, precision check, dynamic

calibration, flow calibration, certification of calibration standards, certification of equipment and cleaning/replacement of parts for the equipment and its related parts at the AQM station will be conducted with reference to the QA/QC Manual issued by Air Services Laboratory of EPD. The data audits shall be carried out with reference to the EPD's QA/QC Manual. The performance checks on zero air units at the AQM station will be carried out using the certified cylinders by a HOKLAS accredited laboratory. The frequency of checks shall be with reference to the EPD's QA/QC Manual. Manual provided by manufacturers of the analyzers and monitoring equipment will also be followed for QA and performance check.

4.3.2) The data processing and validation, transmission error test and processing error test shall be undertaken and checked with reference to the EPD's QA/QC Manual. The test results should be documented for easy reference. Appropriate corrective actions including but not limited to emergency maintenance and replacement of analyzers shall be initiated as soon as practicable but not later than 24 hours of occurrence of any abnormal pollutant data.

#### 4.4) Reporting

The monitoring results, operational data and information in relation to the operation and maintenance of the AQM station at Cheung Chau shall be provided and presented in the form of Monthly Reports during the first year baseline monitoring period before commencement of testing and commissioning, monitoring during testing and commissioning of the Project, and continuous monitoring of the Project which the report format will be based on the need of the project and agreed by EPD-IDG, the monthly reports shall be submitted in duplicated to EPD-IDG by the 14<sup>th</sup> day of the month following the month to which the report relates:

- a) AQM station status and field activities;
- b) Calibration summary;
- c) 10 minutes data for real time monitoring for Sulphur Dioxide, Hourly data for real time monitoring parameters (excluded Sulphur Dioxide) and monthly-data for sampling and analysis parameters;
- d) Records of quality control activities for the equipment;
- e) Monthly data for an AQM station including the data capture rate;
- f) All updated AQM station layout plan and configurations, if any;

- g) Schedule of quality control activities and maintenance work planned for the next month which will be agreed by EPD-IDG.

#### 4.5) Safety, Security and Housekeeping

The Main Contractor or his representatives responsible for the AQM station at Cheung Chau shall be with reference to the environmental, safety and health practice given in the EPD's QA/QC Manual;

The Main Contractor shall cooperate with the owners or occupiers of the premises where the AQM station is located and comply with all the rules, regulations and management measures implemented in the premises. If the AQM station is located on roof of a premise, the Main Contractor shall not keep the keys to roof of the premise and shall be accompanied by staff of the premise every time when they need to enter the roof.

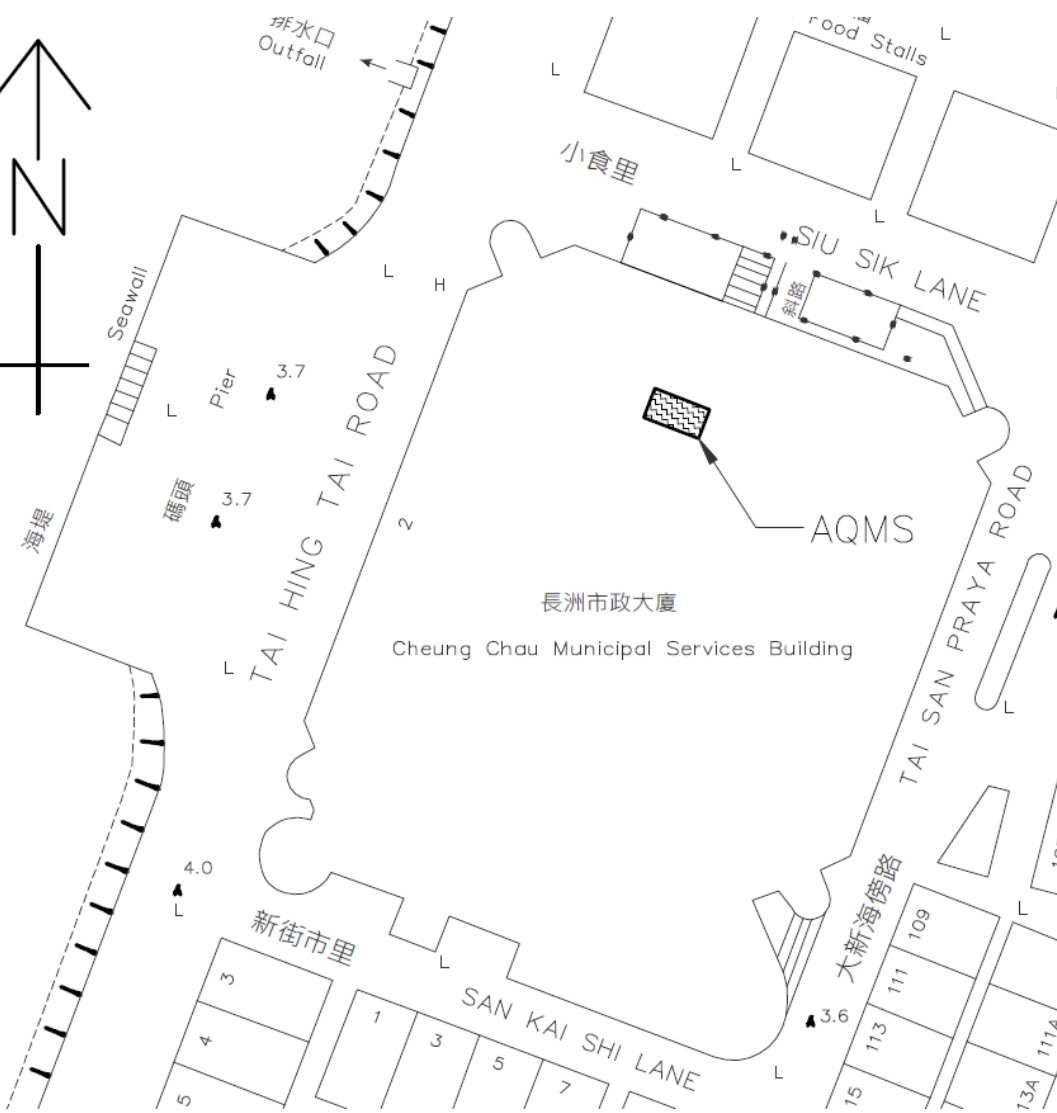
The Main Contractor shall be responsible for making good or replacing any damaged, lost or stolen items of the equipment.

- 4.6) The air pollutants will be monitored at the AQM station as proposed and summarized in **Table 3**.
- 4.7) An alarm system will be in place to notify Facility Duty Personnel in the event of a signal loss. If there is a signal loss, the Facility Duty Personnel will follow the approved emergency repair access procedure to troubleshoot and repair the equipment of the AQM station. The contact and details and access procedure will make known to the user departments of CCMSB.

# Appendix A

The location and layout of the AQM station at Cheung Chau

Municipal Services Building



# Appendix B

## Tentative Work Programme for Design and Construction of AQM Stations

<b>WBS</b>	<b>Tasks</b>	<b>Start</b>	<b>End</b>	<b>Duration (Days)</b>
<b>1</b>	<b>AQM Station at Cheung Chau Municipal Services Building</b>	<b>07/09/2023</b>	<b>20/02/2024</b>	<b>167</b>
1.1	Submission of AQM Station Drawings	07/09/2023	13/10/2023	37
1.2	Approval of AQM Station Drawings	14/10/2023	03/12/2023	51
1.3	Construction of Shelter	04/12/2023	10/02/2024	69
1.4	Delivery of Instrument	11/02/2024	15/02/2024	5
1.5	Installation of Instrument	16/02/2024	18/02/2024	3
1.6	Testing and Commissioning	19/02/2024	20/02/2024	2
1.7	Performance Audit	Once in 6 months after operation		
1.8	System Audit	Once in a year after operation		