Cheung Hing Construction Co., Ltd

Contract No. SSW 327

Reprovisioning of Cape Collinson Crematorium

Supplementary Contamination Assessment Plan

(Version 6.0)

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Approved By	(Environmental Team Leader)

REMARKS:

The information supplied and contained within this report is, to the best of our knowledge, correct at the time of printing.

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1. INTRODUCTION

BACKGROUND

1.1 Cinotech Consultants Limited (Cinotech) was commissioned by the Cheung Hing Construction Co. Ltd (CH) (hereinafter the Contractor) to undertake the Environmental Team (ET) and prepare Supplementary Contamination Assessment Plan (SCAP) for the "Reprovisioning of Cape Collinson Crematorium" Project.

1.1 The general layout plan of the Project is shown in **Figure 1**.

1.2 According to the Environmental Impact Assessment Report (EIA Report) (Register No. AEIAR-137/2009) Section 5, Contamination Assessment Plan (CAP) and Contamination Assessment Report/Remediation Action Plan (CAR/RAP) for the Project were submitted to EPD, endorsed and approved on 2 and 23 April 2008, respectively.

1.3 As reported in the CAP and CAR, 10 locations were proposed for investigate the potential contamination and Site Investigation (SI) was carried out from 15 March to 20 March 2008. Boreholes sampling were carried out at 4 locations, namely BH1 to BH4, and surface soil sampling were taken at 5 locations, namely S1 to S5. For the proposed Trial Pit Location 1 (TP1) which is underneath the pipeline of the underground storage tank system, no site investigation work was conducted since it was possessed by Civil Engineering and Development Department (CEDD) for 10- Year Extended Landslip Preventive Measures (LPM) Project, and access to the TP-1 for SI works was prohibited in year 2008.

1.4 In addition to the above-said 10 locations selected for site investigation, potential contamination was also suspected at Cremation Room 1 and 2, where the fuel spillage and leakage from the cremators. However, the cremators were operating in year 2008 and SI works could not be carried out at that stage.

1.5 According to Environmental Permit (EP-335/2009) and further EP (FEP – 01/335/2009) Clause 3.3 (a), the Permit Holder shall submit Supplementary Contamination Assessment Plan (SCAP), no later than two months before demolition of the existing crematorium, to the Director of EPD for approval. Site assessments would be required at the locations specified in the FEP, which is listed below before commencement of the works:

i) Existing Cremator Room 1 and 2, and

ii) Trial Pit Location (TP1).

1.6 Prior to the commencement of the site investigation work, a Supplementary Contamination Assessment Plan (SCAP) is required to be prepared, certified by the ET Leader and verified by the Independent Environmental Checker (IEC) then submitted to EPD for endorsement.

OBJECTIVES:

1.7 The objective of this SCAP is to:

i) Summarize the information of site appraisal and environmental information made available at the time of EIA report preparation and the information obtained during the site inspection in June and October 2012;

ii) Identify potential contamination activity and land contaminated area at TP1, CR1 and CR2; and

iii) Propose sampling and design for the site investigation for TP1 and CR1 and CR2, after the decommissioning of the existing and No.1 to 12 Cremator.

1.8 Based on the endorsed SCAP, a contamination site investigation would be conducted and a Supplementary Contamination Assessment Report (SCAR) will be complied to document the findings. If the findings confirm that the site is contaminated, a Supplementary Remediation Action Plan (SRAP) will be drawn up to recommend remedial actions.

1.9 This SCAP is prepared by Cinotech in accordance with the following guidance documents:-

i) EPD's *Guidance Note for Contaminated Land Assessment and Remediation*(GN);

ii) EPD's *Practice Guide for Investigation and Remediation of Contaminated Land;*(PG)

iii) EPD's *Guidance Manual for Use of Risk-based Remediation Goals for Contaminated Land Management'* (GM).

2. INFORMATION IN THE APPRVODED CONTAMINATION ASSESEMENT PLAN

2.1 According to the approved CAP in the EIA Report(Register No. AEIAR-137/2009) Appendix 5.1, site inspection was conducted at Cape Collinson Crematorium in year 2008 to inspect and identify any potential contamination, to form part of the EIA report. The detailed site appraisal information could be referred to the approved CAP, as shown in **Appendix A**, and the geology, hydrogeology information in the approved CAP were extracted and listed as below:

SITE GEOLOGY AND HYDROGEOLOGY

2.2 The study area is mainly underlain by Shing Mun Formation, which is the most complex and lithologically variable formation, both laterally and vertically; undivided sedimentary and volcanic rock consisting of tuffite of Upper Jurassic Period of Mesozoic Era.

2.3 As reported in Ground Investigation (GI) reports and EIA report Sections 5.12 to 5.15, '*the area close to Study Area is generally covered by a layer of fill materials/colluviums (~0.5m to 1.5m in thickness) composed of sandy SILT and clayey sandy SILT with occasional fine to medium gravel. It is then followed by a layer (~1.15 m to 10.1m in thickness) of saprolitic soil (in the majority of fine ash vitric TUFF and sandy SLIT) before reaching the lower variable decomposed rock (rock of grade IV with thickness of ~0.4m to 6m). In terms of the likelihood of migration of contaminants, fill materials (i.e. top soil layer) generally have higher permeability and therefore, ability if potential contaminant migration through this horizon is higher than downward migration.'*

HYDROGEOLOGY

2.4 '*According to the general topography of the Study Area and groundwater levels recorded in some of the reviewed GI reports, elevation of the groundwater level varies from +153mPD to +110mPD from hillside south to hillside north of the Existing Crematorium. The general groundwater pattern likely flows from south to north, i.e. from Tai Tam Road towards Fung Wah Estate.*'

3. SITE APPRAISAL IN YEAR 2012

3.1 Site inspections were conducted on 8 June 2012 and 19 October 2012, to identify the area with potential soil and/or groundwater contamination and review the site condition stated in the approved EIA report prepared in 2008.

3.2 Photographical records for Trial Pit 1 (TP1), Cremation Room 1 and 2 (CR1 and CR2) and those storage rooms under CR1 and CR2 were taken to depict the existing conditions of the site area. Photographic records are shown in the **Appendix B.**

3.3 The locations plan of TP1 and CR1 and CR2 are shown in **Figure 2, 4 and 5**.

Trial Pit 1 (TP1)

3.4 The current use of this area is in line with those stated in the approved CAP.

3.5 The pipes which deliver diesel fuel from the Underground Storage Tank (UST) to CR1 run under concrete paved access road next to a slope maintained by Civil Engineering and Development Department (CEDD).

3.6 Cracks in the pipes may lead to potential leakage of diesel oil those results in land contamination. Therefore, the area near the pipes is considered a potentially contaminated area. As such, TP1 was proposed at a point within the potentially contaminated area.

3.7 The detailed drawing showing the layout of the pipes was extracted from the approved CAR/RAP and shown in **Figure 2**.

Cremation Room 1 and 2 (CR1 and CR2)

3.8 Site inspections were conducted on 8 June 2012 and 19 October 2012 to inspect condition the current condition of Cremation Room 1 and 2 (CR1 and CR2); and to identify the potential leakage or spillage of diesel oil which will cause land contamination in CR1 and CR2.

3.9 Drawings showing the structures of CR1, CR2 and the lower level of CR1, CR2 are shown in **Figures 4 and 5**, and the site conditions and observations are described as below:

CR1 and CR2 - Ground floor

3.10 The floor of CR1 and CR2 is covered by intact ceramic tiles while the Crematorium was set up on concrete foundation. There are eleven cremators (No.1-11) in CR1 and one cremator (No. 12) in CR2. The layout plan of Cremator No.1-11 is shown in **Figure 6** while the location of Cremator No. 12 could be referred to the photographical record in **Appendix B**.

3.11 The diesel oil that fuels the cremators in CR1 and CR2 are delivered through pipelines from the Aboveground Storage Tank (AST) outside CR1. The main pipe in CR1, which is enclosed with a concrete channel, connected to each cremator by external vertical

pipelines. For the cremator in CR2, diesel fuel is fed by the external pipelines from CR1 along the ceiling.

3.12 Rather than Cremator No. 1 to 12, no chemicals and dangerous goods were observed in the ground floor of CR1 and CR2.

3.13 Visual inspection showed no apparent evidence of oil leakage from the pipe in CR1 and CR2 while oil stains were observed on the covers of concrete channel in CR1, which enclosing main pipe. The oil stain might due to oil spillage from the joint between the main pipe for diesel feeding and the cremators during the repairing and maintenance works.

Cremation Room 1 and 2 (CR1 and CR2) – Lower Level

3.14 At the lower level of CR1 and CR2, there are few storage rooms, under the part of the area of the concrete floor of CR1 and CR2, namely CR1_S1, to CR1_S3, CR2_S1 to CR2_S2. For the area namely CR1A and CR2A, it is under the cremator No. 1 to 12 and filled by backfilling material, such as soil and rocks. The area CR2_E1 is an extension and above-ground structure from CR2 with two supporting piles. The layout of these storage rooms and filled area are shown in **Figure 4**.

3.15 As shown in the photographic records in **Appendix B**, metal frames, cements and maintenance materials were found in storage rooms under CR1 while electrical machinery was operating in the storage rooms under CR2.

3.16 No fuel and chemical was found in storage rooms under CR1 and CR2 during the site inspection. As advised by the operator of Food and Environmental Hygiene Department (FEHD) via the Contractor in October 2012, the rooms under the whole area of the concrete floor of CR1 and CR2 were and will be continued to be storage rooms for material for maintenance works, refrigerator and resting rooms.

3.17 After the site inspection, no potential oil leakage/spillage in the storage room at the lower level of the CR1 and CR2 was expected.

3.18 **Table 3.1** provides a summary of observation during the site inspection in June and October 2012.

Table 3.1 Summary of Site Inspection

Location	Site Observation
TP 1	i) Located on the Ground Floor; ii) Oil pipes connecting Underground storage tank and CR1 are under TP1.
CR1 and CR2 at Ground Level	i) Oil stains appeared on the cover of the concrete channel packs the main pipe in CR1; ii) No chemical, dangerous goods were found in CR1 and CR2 during the site inspection.
Storage Room at Lower Level of CR1 and CR2	i) No chemical, dangerous goods were found in the site inspection; and FEHD operator confirmed that these storage rooms were and will be used for storage of the daily maintenance materials.

4. SAMPLING STRATEGY

TP1, CR1 and CR2

4.1 As mentioned in Section 3, potential land contamination of soil and/or groundwater would be contributed to oil spillage/ leakage from the pipes, on the ground level of CR1 and CR2; and the leakage from the underground pipeline via the proposed TP1, which connecting UST and AST.

4.2 With reference to the EPD's GN and PG, extra sampling points will be located at or near potential sources of contamination, such as near underground storage tanks or pipelines. Hence, soil and groundwater samples at different locations are proposed to be taken.

4.3 Should cracks of concrete channel of the CR1 and CR2 and oil stains were observed after the removed Cremator No, 1- 12, photographic records will be taken and additional sampling point(s) would be required.

S1 to S5 (Surface Soil Sampling Points)

4.4 According to Section 4.80 of approved EIA report, '*Among five 0.1m samples analyzed, no surface soil samples were found to have testing parameters exceeding the relevant Risk-Based Remediation Goals (RBRGs); In additional, further investigations and confirmatory test should be carried out to determine if additional remediation (in addition to the current RAP) is required.'*

4.5 There were five locations for surface soil sampling, namely S1 to S5 in Year 2008. Since the S2 and S3 (for the North of Chimneys) were covered by the Phase 1 Crematorium Building, 2 alternatives sampling points, namely S2_A and S3_A at the North of Chimneys are proposed for sampling confirmatory soil samples. The locations of S1 to S5 and the proposed S2_A and S3_A are shown in **Figure 7.**

4.6 With the existing sampling points S1, S4 and S5, there are five locations for surface soil sampling, in which soil samples of 0.1m and 0.5m of the exposed area will collected and tested, in the following sequences, to confirm no addition remediation will be required:

i) Soil samples at 0.1m and 0.5m will be collected and samples at 0.1m will be tested first for the Dioxins and Heavy metals;
ii) If contaminant(s) in 0.1m soil samples exceed the RBRGs, 0.5m soil samples of that locations will be tested as for confirmatory.

Underground Storage Tank (UST)

4.7 According to Section 5.50,'*During removal of the underground storage tank, appropriate precautions should be taken to avoid contamination. All fuel tank and associated pipelines should be emptied prior to any demolition work being undertaken. Any remaining sludge or sediment in the tanks or pipelines should be removed and disposed of as chemical waste in accordance with the appropriate regulation for disposal of such material. After removal of the underground storage tank, confirmatory soil sample(s) underneath the tank should be collected and tested for TPH, VOCs and Pb using the same approach as mentioned in Sections 5.43 and 5.44 above to ensure that no contamination due to fuel leakage.'*

4.8 Photographic records of the site investigation, soil/groundwater samples will be taken for the preparation of SCAR and SRAP.

4.9 The proposed sampling and testing plan is shown in **Table 4.1**.

Table 4.1 Proposed Sampling and Testing Plan

Proposed Sampling Location	Sampling Method	S / GW	Depth (m bcl)	Proposed Testing Parameters			
				Heavy Metals	VOCs	TPH	Dioxins
TP1, CR1 and CR2							
TP1a TP1b1-b4 TP1c1-c4 TP1d1-d4	Trial Pit to 3m bcl	S	Immediately below pipeline	Lead	Y	Y	-
		S	Every 1m below pipeline, to 3m	Lead	Y	Y	-
		S	Additional sampling if contamination is found	Lead	Y	Y	-
		GW	If present	-	Y	Y	-
CR1_1, CR1_2 and CR1_3: 3 sampling points, under the joint between fuel pipe and Cremator and at the location(s) of cracks in concrete channel with oil stains observed after the Cremator No. 1 to 11 removal	Borehole to 2m below GW or 6m bcl if no GW is encountered	S	0.5bcl	Lead	Y	Y	-
		S	1.5 bcl	Lead	Y	Y	-
		S	At 2m below GW level or at 6m bcl	Lead	Y	Y	-
		GW	If present	-	Y	Y	-
CR2_1: The area below the joint between the fuel pipe and Cremator No.12 and at the location(s) of oil stains observed after the Cremator No. 12 removal	Borehole to 2m below GW or 6m bcl if no GW is encountered	S	0.5bcl	Lead	Y	Y	-
		S	1.5 bcl	Lead	Y	Y	-
		S	At 2m below GW level or at 6m bcl	Lead	Y	Y	-
		GW	If present	-	Y	Y	-
Confirmatory Soil Sampling							
S1 (West of Chimneys)	Surface soil sample to 0.5m of exposed area	S	0.1	Y[2]	-	-	Y
			0.5[1]	Y[2]	-	-	Y
S2_A, S3_A (North of Chimneys)	Surface soil sample to 0.5m of exposed area	S	0.1	Y[2]	-	-	Y
			0.5[1]	Y[2]	-	-	Y
S4-5 (East of Chimneys)	Surface soil sample to 0.5m of exposed area	S	0.1	Y[2]	-	-	Y
			0.5[1]	Y[2]	-	-	Y
UST-1	Soil sampling to 3m below the underground storage tank by Borehole	S	Immediately below tank	Lead	Y	Y	-
		S	Every 1m below tank, to 3m	Lead	Y	Y	-
		S	Additional sampling if contamination is found	Lead	Y	Y	-
		GW	If present	-	Y	Y	-

Remarks:
1) 0.5m soil samples will be tested only if contaminant(s) in 0.1m soil samples exceed the relevant RBRGs.
2) Heavy Metals to be tested for surface soil samples include Antimony, Arsenic, Barium, Cadmium, Chromium III, Chromium VI, Cobalt, Copper, Lead, Manganese, Mercury, Molybdenum, Nickel, Tin and Zinc.

a) S – Soil, TP – Trial Pit, Bh – Borehole, bcl – Below concrete level , GW – Groundwater
b) Details of the testing parameters are shown in Table 5.1.
c) The detailed location plans of TP1 to TP1d4 are shown in **Figure 3**.
d) The detailed location plans of CR1_1, CR1_2, CR1_3 and CR2_1 are shown in **Figure 6**.
e) The detailed location plans for UST and surface soil sampling are shown in **Figure 7**.

SAMPLING METHODS

4.10 Underground utilities should be surveyed prior to the proposed trial pit and borehole locations. The actual locations of Site Investigation should be finely adjust and agreed by the Architect and the Environmental Team member with experience in contaminated land assessment.

Borehole Sampling:

4.11 Dry rotary drilling method will be employed for soil boring and sampling, in which no flushing medium will be used. Inspection pit will be excavated to 1.5m below concrete slab to inspection underground utilities. The disturbed soil at 0.5m and 1.5m below concrete slab will be collected as samples for laboratory analysis. Drilling rigs will be used for sampling at depth below 1.5m to the maximum boring depth. Soil samples will be collected 2m below groundwater level or 6m below the concrete level if no groundwater to be encountered. Should the dry rotary drilling equipment could not be accessed into the CR1 and CR2 building due to headroom constrain, trail pit method will be employed instead.

Trail Pit at TP-1

4.12 Trial pits will be excavated with used for depths of up to 3 meters below concrete level. Hand operation concrete breaker and other hand tools will be used for pit digging. If contamination is found at the sample at 3 meters below concrete level, addition sampling should be carried out.

4.13 At the horizontal level, soil sample will be collected at each side of distances up to 3m from the centre of the Trial Pit. Soils from each zone will be stockpiled separately Detailed illustration of the sampling points is shown in **Figure 3**.

4.14 Signs and labels (with a highlighted map) for each distance will be provided to indicate the locations from where the soil being excavated. Sand bags will be placed around the stockpile to avoid collapsing and spillage. Also the stockpile will be covered with tarpaulin sheets to minimize generation of fugitive dust and cross contamination between soils.

Surface Soil Sampling for Confirmatory Soil Sampling:

4.15 Hand tools will be used to collect the surface soil samples at 0.1m and 0.5m. If contaminant(s) in 0.1m soil samples exceed the RBRGs, soil sample at 0.5m of the same location, will be tested as for confirmatory.

4.16 The excavated soil will be refilled or treated base on the contaminants found, if any, in the laboratory test.

4.17 Excavated soil should be immediately collected once exposed by hand sampling.

4.18 All equipment in contact with the ground shall be thoroughly decontaminated prior to use at each trial pit or borehole by scrubbing with a lab-grade detergent.

4.19 Strata Log will be recorded for boreholes and trail pit. It records the stratigraphic structure, soil sampling depths, the thickness of each band of materials and the depth at which groundwater sampling encountered. Grain size, odour, presence of rock and other materials will be recorded. Photographic record will be taken during the site investigation and sampling process.

GROUNDWATER SAMPLES

4.20 Groundwater sample will be collected and tested in laboratory where groundwater is encountered. The design of groundwater sampling well to be installed at borehole is shown in **Figure 8**.

4.21 For boreholes sampling locations, groundwater sampling well will be installed to the boreholes in advance of conducting the sampling.

4.22 For trail pit location, the pit should be pumped to almost dry and allowed to stand for 24 hours. Groundwater samples will be collected using decontaminated bucket. The location of groundwater sampling is at TP1a, where is shown in **Figure 3**.

4.23 All samples shall be uniquely labeled. Between samples, all equipment used for sample handling and storage shall be thoroughly decontaminated with laboratory-grade detergent. Samples shall be stored in appropriate pre-washed containers (provided by laboratory) and put in an insulated box below ice immediately. It must be ensured that the sample containers and the box are tightly closed and that sufficient ice is provided to maintain refrigerated at 4^0C.

SAMPLE SIZE AND HANDLING PROCEDURES

4.24 1 groundwater samples and 52 soil samples will be taken at 4 distances and depths at TP1.

4.25 4 ground water samples and 12 soil samples will be taken at proposed 4 sampling points at CR1 and CR2.

4.26 Maximum 10 soil samples at S1, S2_A, S3_A, S4 and S5, i.e. (0.5m soil samples will be tested if 0.10 soils samples exceed the relevant RBRGs); 1 groundwater and 4 soil samples at UST-1 will be taken, for confirmatory soil sampling.

4.27 In total, there are 6 groundwater samples and 78 soil samples will be collected.

TRANSPORTATION OF SAMPLES

4.28 All the samples must be uniquely labelled and described on-site prior to sending to a HOKLAS accredited laboratory for analysis. Description shall include, but not be restricted to:

i) test site where sample collected;
ii) sample identification number;
iii) soil sampling depth (with respect to lowest level of concrete slab);
iv) estimated physical characteristics (clay, silt, sand, gravel, stone, cobble, colour, odour, moisture);
v) colour photograph; and
vi) any other relevant information.

4.29 The samples must be put in an insulated box below ice immediately after being placed in an appropriate pre-washed container (provided by the laboratory) without being agitated. Headspace should also be minimised. It must be ensured that samples containers and the box are tightly closed and that sufficient ice packs are provided to maintain refrigerated conditions at about 4°C.

4.30 Samples will be delivered to laboratory within 24 hours after collected and analysed within 7 days upon delivery.

DECONTAMINATION

4.31 All equipment used for sample handling and storage must be decontaminated before and after collection of each sample. The following is the standard procedure for cleaning drilling equipment and sampling equipment on site:

i) Clean with tap water and lab-grade detergent (using brush if necessary) to remove particulate matter and surface films.

ii) Rinse thoroughly with tap water (for drilling equipment) or distilled water (for sampling equipment).

iii) After field cleaning, the equipment shall be handled by personnel wearing clean gloves to avoid re-contamination. If the equipment is not to be used immediately it should be covered with clean plastic sheeting or wrapped in aluminium foil to avoid re-contamination.

iv) The drilling equipment and sampling equipment shall be cleaned according to the above procedures between sampling holes.

4.32 The samples should be scooped directly from the sampling tool into the sample containers. The scoop should be stainless steel. If a gloved hand comes into contact with the sample, then new gloves should be used for each sample.

QA/QC PROCEDURES

4.33 A chain of custody system shall be operated as part of the QA/QC procedure. QA/QC samples shall be collected in the following frequency:

i) 1 equipment blank per 20 samples for full suite analysis,
ii) 1 field blank per 20 samples for full suite analysis,
iii) 1 trip blank per 20 samples for full suite of analysis,
iv) 1 duplicate sample per 20 samples for full suite of analysis.

From the proposed sampling plan, there should be at least 4 sets of equipment blank, field blank, trip blank and duplicate sample for soil and 1 set of the mentioned QA/QC samples for groundwater to be collected and tested under this Study.

5. LABORATORY ANALYSIS

5.1 With reference to the EPD's GN and PG, potential contamination is from fuel oil leakage, and the potential contaminants associated are list as follows:-

Oil installations

- Total Petroleum Hydrocarbons (TPH).
- Simple Aromatics VOCs: Benzene, Toluene, Ethylbenzene, Xylenes (Total); and
- Heavy Metals (Lead);

5.2 The soil and groundwater samples shall be dispatched to the HOKLAS accredited laboratory for analysis. The schedule for laboratory analysis is listed in **Table 5-1.**

Table 5.1 Laboratory Analysis Schedule for Groundwater Samples

Parameter	Reference Method	Groundwater Reporting Limit (mg/L)
TPH		
C6-C8	USEPA Method 5030B & 8015C	0.006
C9 – C16	USEPA Method 8015C	0.125
C17 – C35		0.2
VOCs		
Benzene	USEPA 8260B	0.0002
Toluene		0.0002
Ethyl Benzene		0.0002
Xylenes (total)		0.0006

TABLE 5.2 LABORATORY ANALYSIS SCHEDULE FOR SOIL SAMPLES

Parameter	Reference Method	Soil Reporting Limit (mg/kg) dry weight
TPH		
C6-C8	SOP - 140 - In-house method based on: In-house method based on USEPA Method 5035 & 8015C	1.2
C9 – C16	In-house method based on USEPA Method 8015C	20
C17 – C35		47.5
VOCs		
Benzene	USEPA 3820, 5035 &8260B	0.04
Toluene		0.04
Ethyl Benzene		0.04
Xylenes (total)		0.12
Heavy Metals		
Antimony	SOP 093 and 094 – In-house method based on APHA 19ed 3030F 3b, USEPA Method 3005A and ASTM D3976-92; APHA 20ed 3125 A & B and USEPA Method 6020A	0.02
Mercury		0.01
Chromium III	In-house method by calculation	5
Chromium VI	In-house method based on USEPA Method 3060A and 7196A	4
Arsenic	For SOP053 - In-house method based on APHA 19ed 3030F 3b and 3120B, ASTM D3976-92	1
Barium		5
Cadmium		1
Cobalt		5
Copper		5
Lead		5
Manganese		5
Molybdenum		5
Nickel		5
Tin		5
Zinc		5
Dioxin		
I-TEQ	High Resolution Gas Chromatography/High Resolution Mass Spectrometry (USEPA 8290)	2.69 (pg/g)

5.3 All soil and groundwater samples will be tested within the holding times of 7 days.

5.4 In according to Section 3.7 of the 'Practice Guide for Investigation and Remediation of Contaminated Land', "*all laboratory test methods must be accredited by the Hong Kong Laboratory Accreditation Scheme (HOKLAS) or one of its Mutual Recognition Arrangement Partners.*"

5.5 The soil and groundwater samples shall be dispatched to the HOKLAS accredited laboratory for analysis of TPH, VOCs and Heavy Metals. The schedule for laboratory analysis, which are HOKLAS accredited Wellab Ltd., is listed in **Table 5.1** and **Table 5.2**.

5.6 For the dioxin analysis, surface soil samples will be dispatched to another HOKLAS accredited laboratory or its mutual recognition Arrangement partners, which will be mentioned in SCAR/SRAP.

6. INTERPRETATION OF RESULTS

6.1 As defined in the CAP in the EIA report, the future land use of Crematorium is regarded as Industrial; the results of the laboratory analyses shall be interpreted in accordance RBRGs Criteria for Industrial, with the guidance documents referred to "Guidance Note for Contaminated Land Assessment and Remediation".

6.2 The RBRGs Criteria for Industrial land use, Soil Saturation limits and Solubility limits, as extracted from GN-RBRGs, are in **Table 6.1**.

Table 6.1 RBRGs Criteria

Parameter	Soil samples		Groundwater samples	
	RBRGs of Soil of Industrial (mg/kg)	**Soil Saturation Limit (Csat)** (mg/kg)	**RBRGs of Groundwater of Industrial** (mg/L)	**Solubility Limit** (mg/L)
TPH				
C6-C8	10,000	1,000	1150	5.23
C9 – C16	10,000	3,000	9,980	2.80
C17 – C35	10,000	5,000	178	2.80
VOCs				
Benzene	9.21	336	54	1,750
Toluene	10,000	235	10,000	526
Ethyl Benzene	8,240	138	10,000	169
Xylenes (total)	1,230	150	1,570	175
Heavy Metals				
Antimony	261	N/A	N/A	N/A
Arsenic	196	N/A	N/A	N/A
Barium	10,000	N/A	N/A	N/A
Cadmium	653	N/A	N/A	N/A
Chromium III	10,000	N/A	N/A	N/A
Chromium VI	1,960	N/A	N/A	N/A
Cobalt	10,000	N/A	N/A	N/A
Copper	10,000	N/A	N/A	N/A
Lead	2,290	N/A	N/A	N/A
Manganese	10,000	N/A	N/A	N/A
Mercury	38.4	N/A	6.79	N/A
Molybdenum	3,260	N/A	N/A	N/A
Nickel	10,000	N/A	N/A	N/A
Tin	10,000	N/A	N/A	N/A
Zinc	10,000	N/A	N/A	N/A

IN-SITU SAMPLING

6.2 If any exceedance of RBRGs levels for soil is found at the distance 3m from the Trial Pit1/6m bcl from borehole after laboratory testing, additional soil sampling is required to determine the extent of the contamination at sites where contaminants have been detected. Soil samples at 3m extended from the tested location at which RBRGs levels have been exceeded will be taken and tested. If RBRGs levels are still exceeded, soil sampling will be extended outwards in 3m and tested until levels below RBRGs standards are reached.

6.3 Soil samples will be tested for limited parameters depended on previous exceedances of RBRGs at the original location.

GROUNDWATER RESULT

6.6 The analytical results of groundwater samples will be interpreted with the RBRGs, as listed in **Table 6.1**, and which should be used as the clean-up target of the groundwater,

EXISTENCE OF NON-AQUEOUS PHASE LIQUID (NAPL)

6.7 Field assessment, which includes visual and odour observation during the sampling will be recorded. They include, but not limit to, the appearance of unnaturally colored; liquid layer; petroleum or solvent smell; oily residual in the soil or groundwater samples.

6.8 When the conditions listed in Section 6.7 to be observed, no matter the chemical concentrations in soil/groundwater samples exceed or that the RBRG, removal of NAPL and clear-up to lower of RBRG or C_{sat}/Solubility limit would be required.

6.9 If the chemical concentrations in soil/groundwater samples exceed that the RBRG but field assessment indicates no NAPL, the clean-up target of soil/groundwater would be RBRG.

6.10 No remediation would be required if the chemical concentrations in soil/groundwater samples lower than the RBRG and field assessment indicates no NAPL

REPORTING OF RESULTS

6.11 No later than one month after the completion of the land contamination investigation work, a Supplementary Contamination Assessment Report (SCAR) which certified by the ET Leader and verified by IEC should be submitted to EPD for approval. If the results of the site investigation reveal contamination at the subject site, a Supplementary Remediation Action Plan (SRAP) which certified by the ET Leader and verified by IEC, should be submitted to EPD for approval.

7. CONTAMINATED SOIL TREATMENT AND DISPOSAL ARRANGEMENT

7.1 A Supplementary Contamination Assessment Report (SCAR) and Supplementary Remediation Action Plan (SRAP) (if the tested parameters exceed relevant criteria) will be prepared. Detail of the treatment method will be given in the SCAR and SRAP.

7.2 Remediation Report (RR) should be prepared and submitted to EPD no later than two weeks before demolition of the existing crematorium. Before submission, the RR should be certified by the ET Leader and verified by IEC.

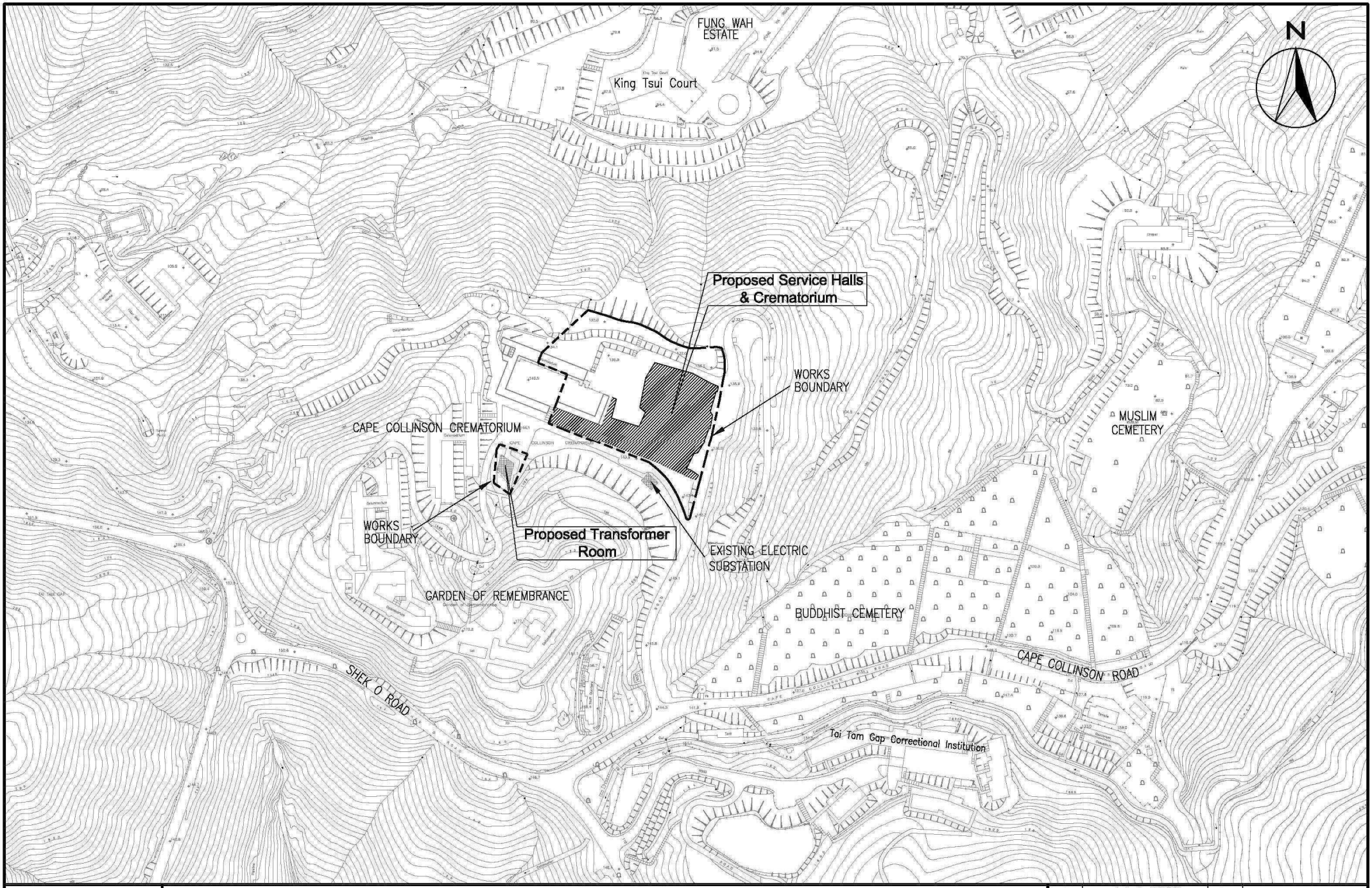
8. HEALTH AND SAFETY

8.1 The following measures should be implemented to minimise risks to workers during remediation works such as excavation of soil. These measures will also mitigate against transferring contamination to groundwater, to surface water courses or to the air.

- Site workers should wear gloves, masks, and other protective clothing where exposure to vapours or contaminated soil may be encountered.

- Contaminated materials should be moved with bulk earthmovers to prevent human contact.
- Adequate washing facilities should be provided and smoking/eating should be prohibited in the area.
- Contaminated soils, which have been stockpiled or are being transported, should be covered with tarpaulin.
- Leakage of pollutants or leaching from excavated soil should be prevented by storing on an impermeable surface.

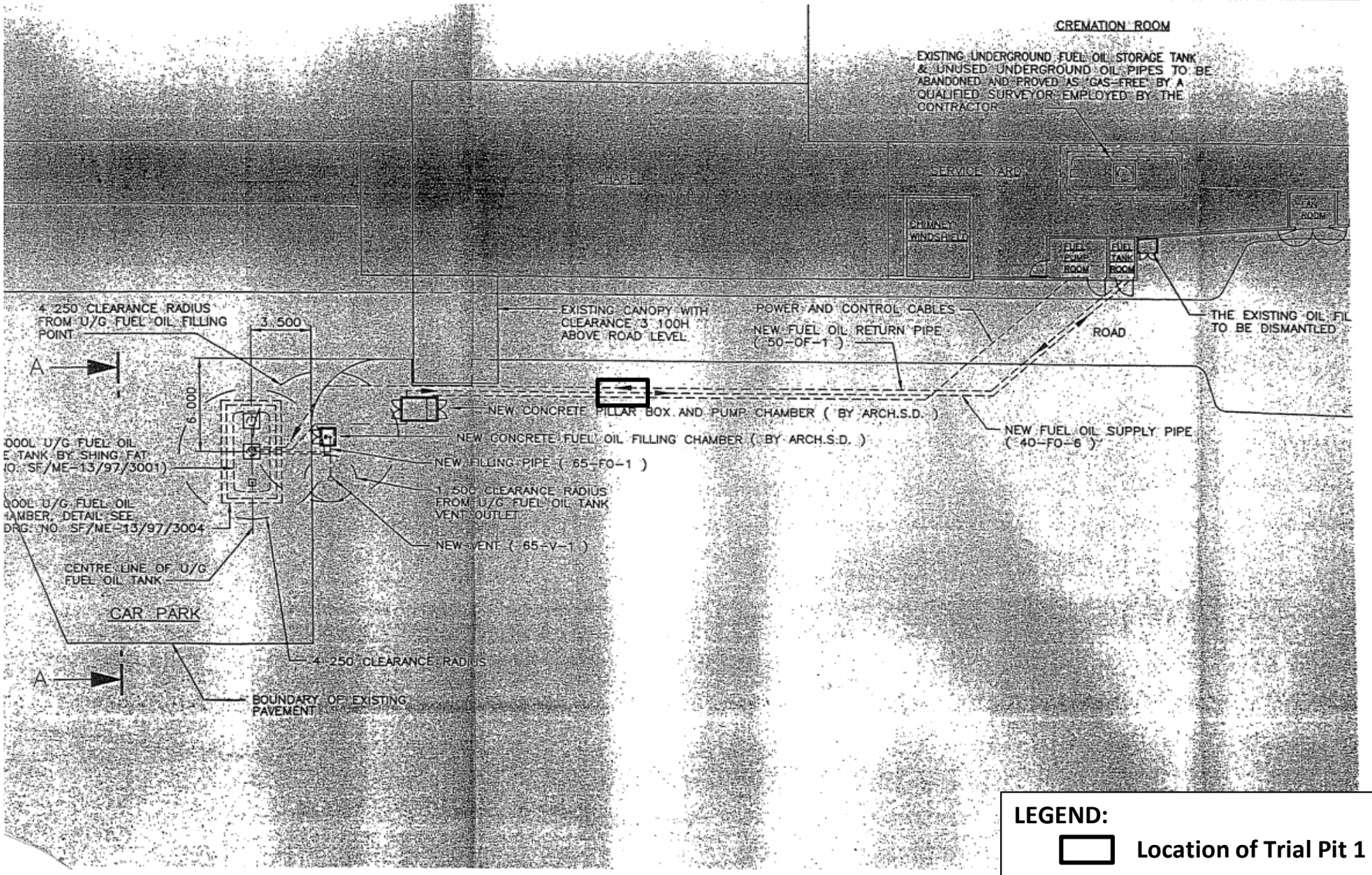
FIGURES



CINOTECH

Contract No. SSW 327
Repeovisioning of Cape Collinson Crematorium
Layout Plan of the Project

Scale	A3 1: 2000	Date	June - 2010
Check	GL	Drawn	GL
Project No.	MA 0031	Figure No.	Figure 1
		REV	–



LEGEND:

Location of Trial Pit 1

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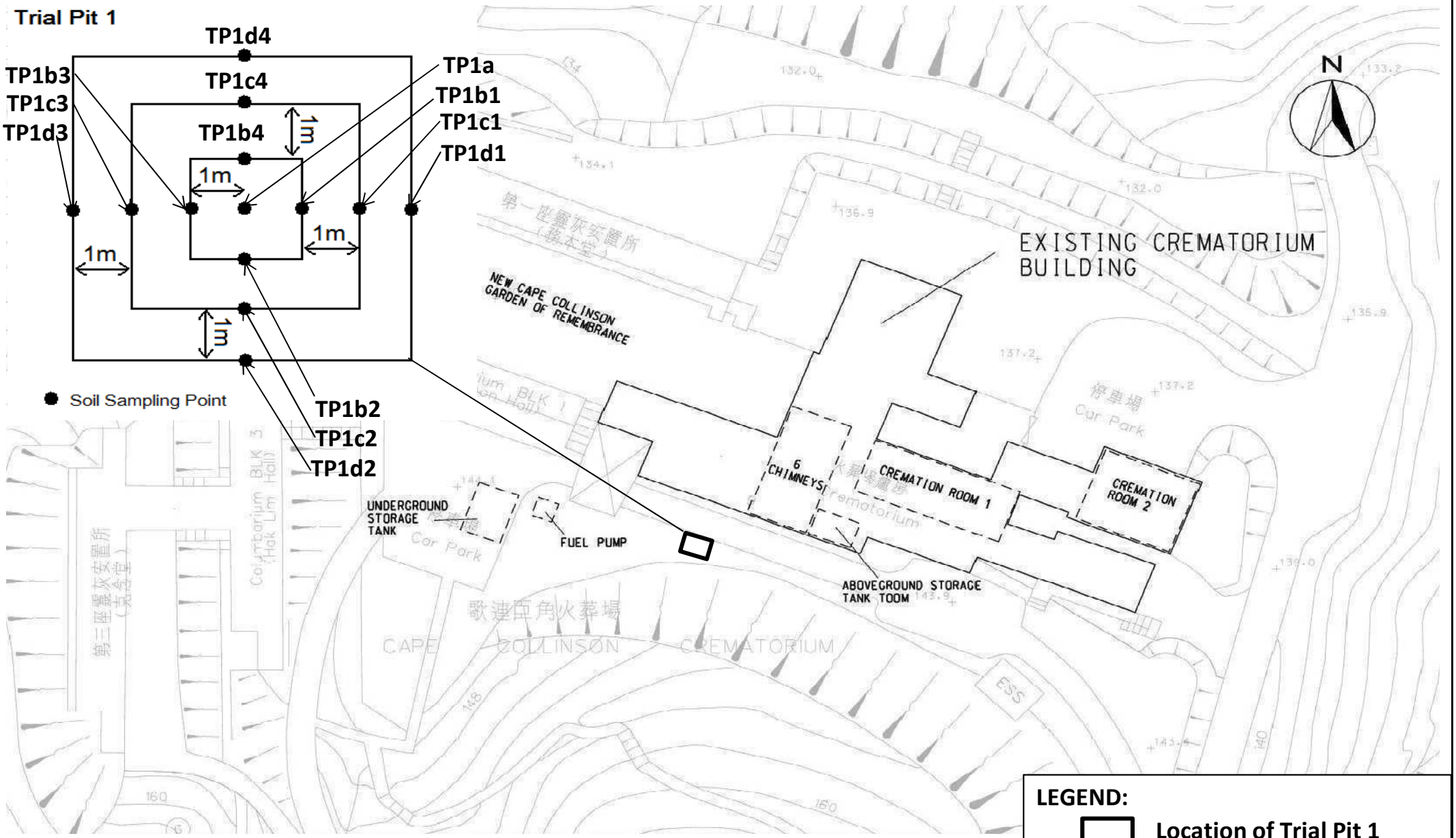
Reprovisioning of Cape Collinson Crematorium

Layout of Fuel Pipes under Trial Pit 1

SCALE	N.T.S.	DATE	Jul-12
CHECK	GL	DRAWN	N/A
JOB NO.	MA 0031	Figure No. 2	Rev 0



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Contract No. SSW 327
Reprovisioning of Cape Collinson Crematorium

Proposed Sampling Locations at Trial Pit 1

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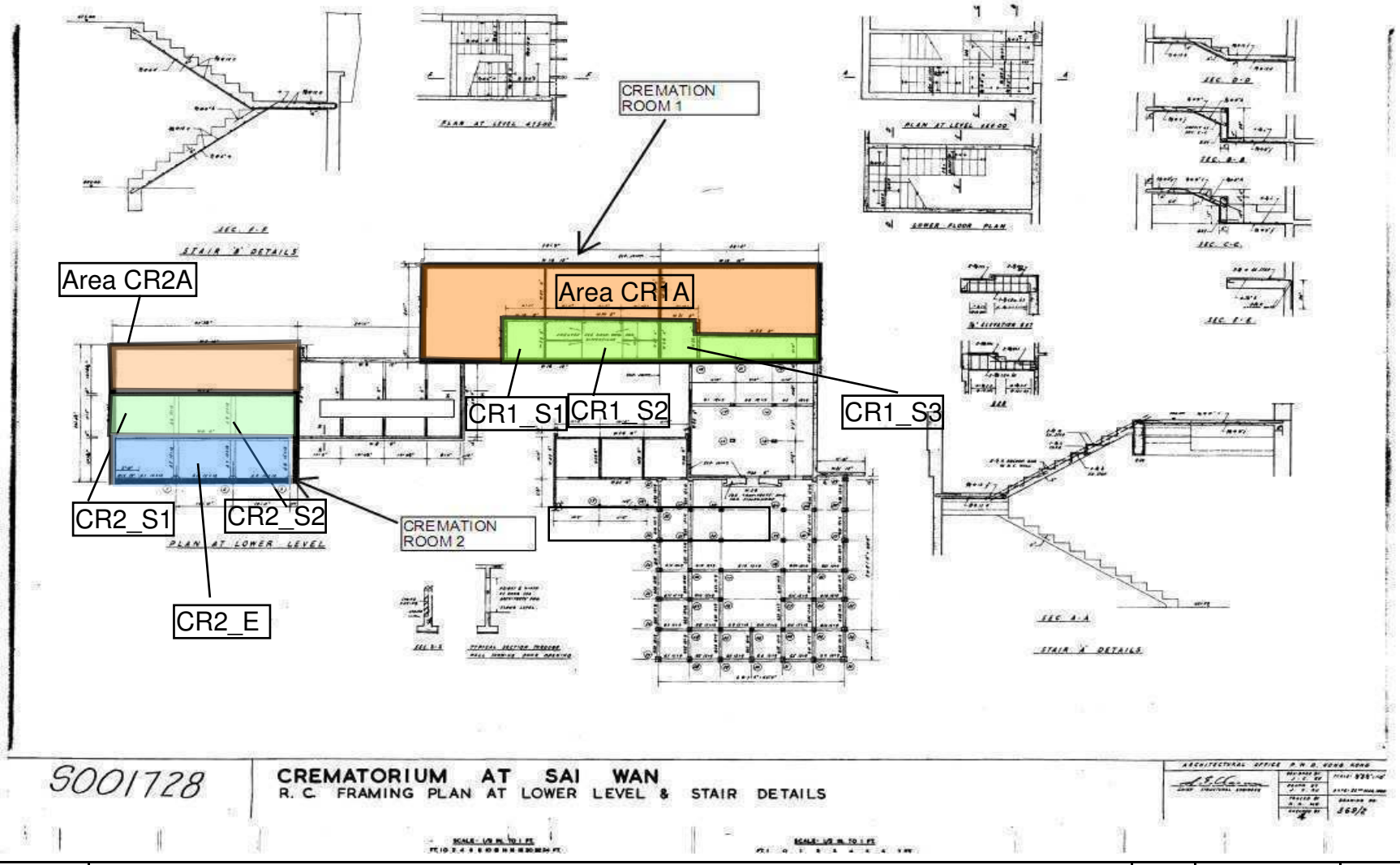
CHECK	GL	DRAWN	N/A
JOB NO.	MA 0031	Figure No. 3	Rev 1



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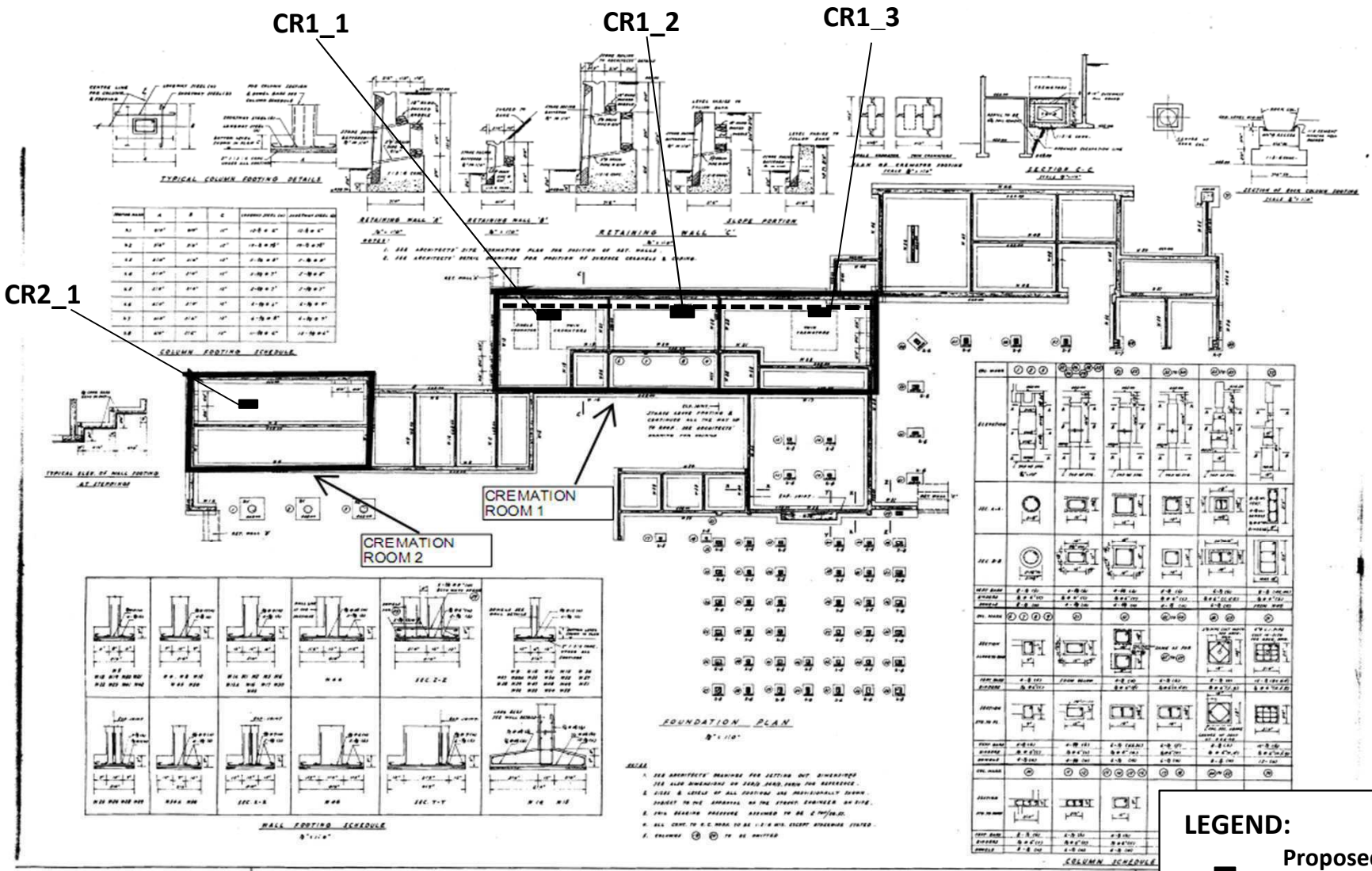
Contract No. SSW 327
Reprovisioning of Cape Collinson Crematorium

Structural Layout of Cremation Room 1 and 2 (Lower Level)

SCALE	N.T.S.	DATE	Oct-12
CHECK	GL	DRAWN	N/A
JOB NO.	MA 0031	Figure No. 4	Rev 1



LEGEND:

- ■ **Proposed Locations for Borehole Sampling**
- **Concrete Channel Enclosing the Fuel Piep**

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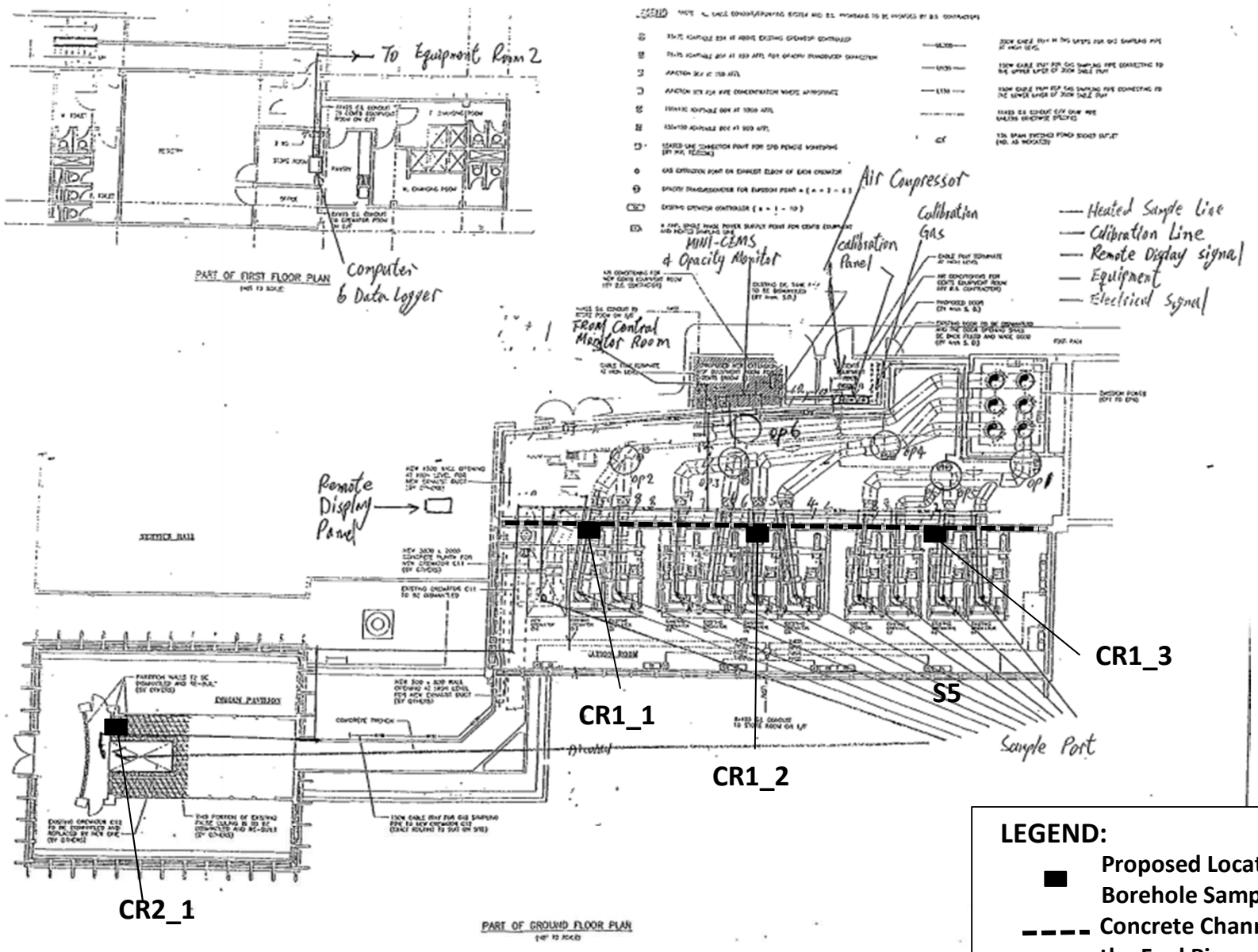
Contract No. SSW 327
Reprovisioning of Cape Collinson Crematorium

Structural Layout of Cremation Room 1 and 2 (Ground level)

SCALE	N.T.S.	DATE	Nov-12
CHECK	GL	DRAWN	N/A
JOB NO.	MA 0031	Figure No. 5	Rev 2



LEGEND:

- ■ **Proposed Locations for Borehole Sampling**
- **Concrete Channel Enclosing the Fuel Piep**

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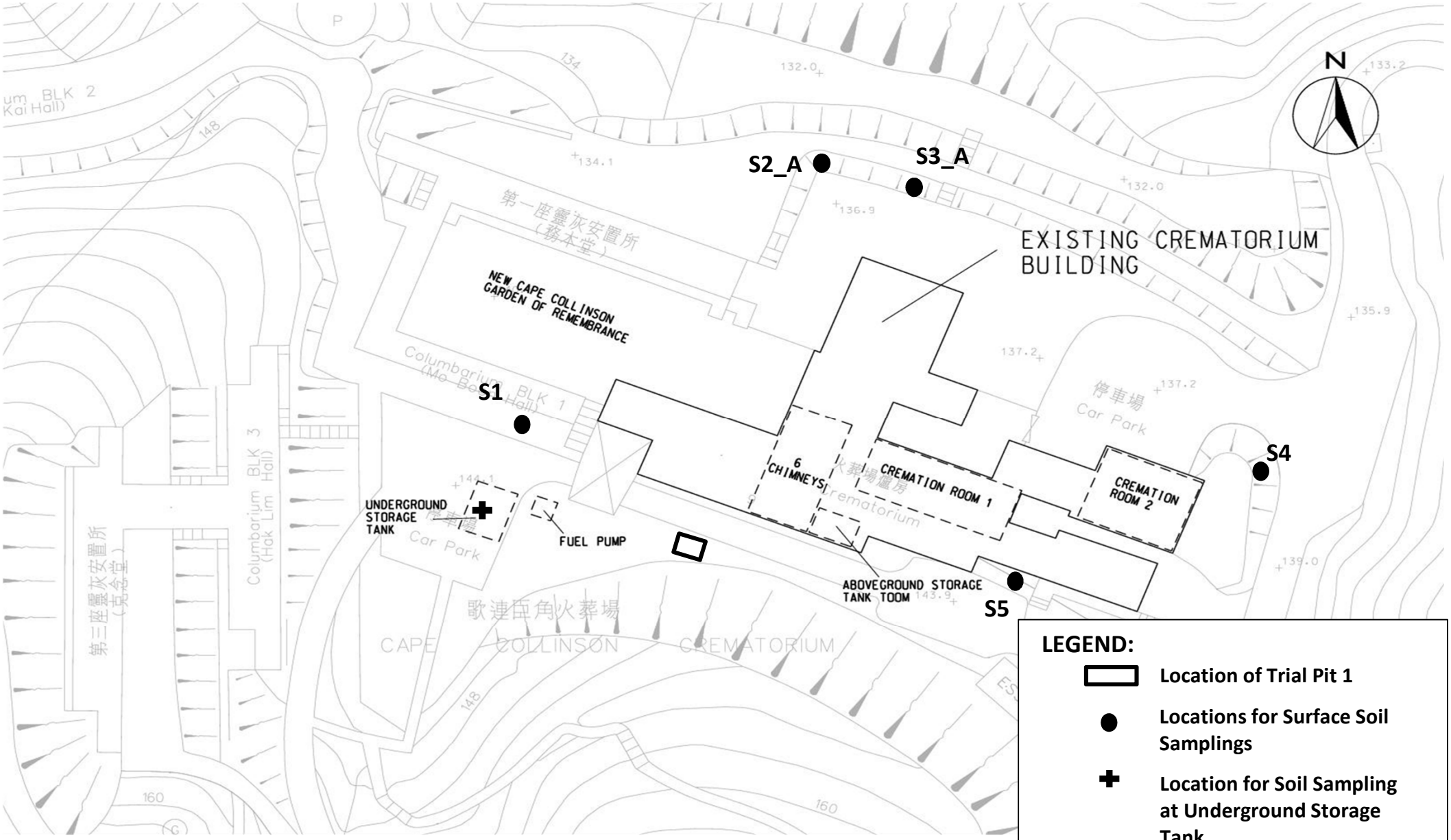
Contract No. SSW 327
Reprovisioning of Cape Collinson Crematorium

Proposed Borehole Sampling Locations in Cremation Room1 and 2

SCALE	N.T.S.	DATE	Nov-12
CHECK	GL	DRAWN	N/A
JOB NO.	MA 0031	Figure No. 6	Rev 2



CINOTECH
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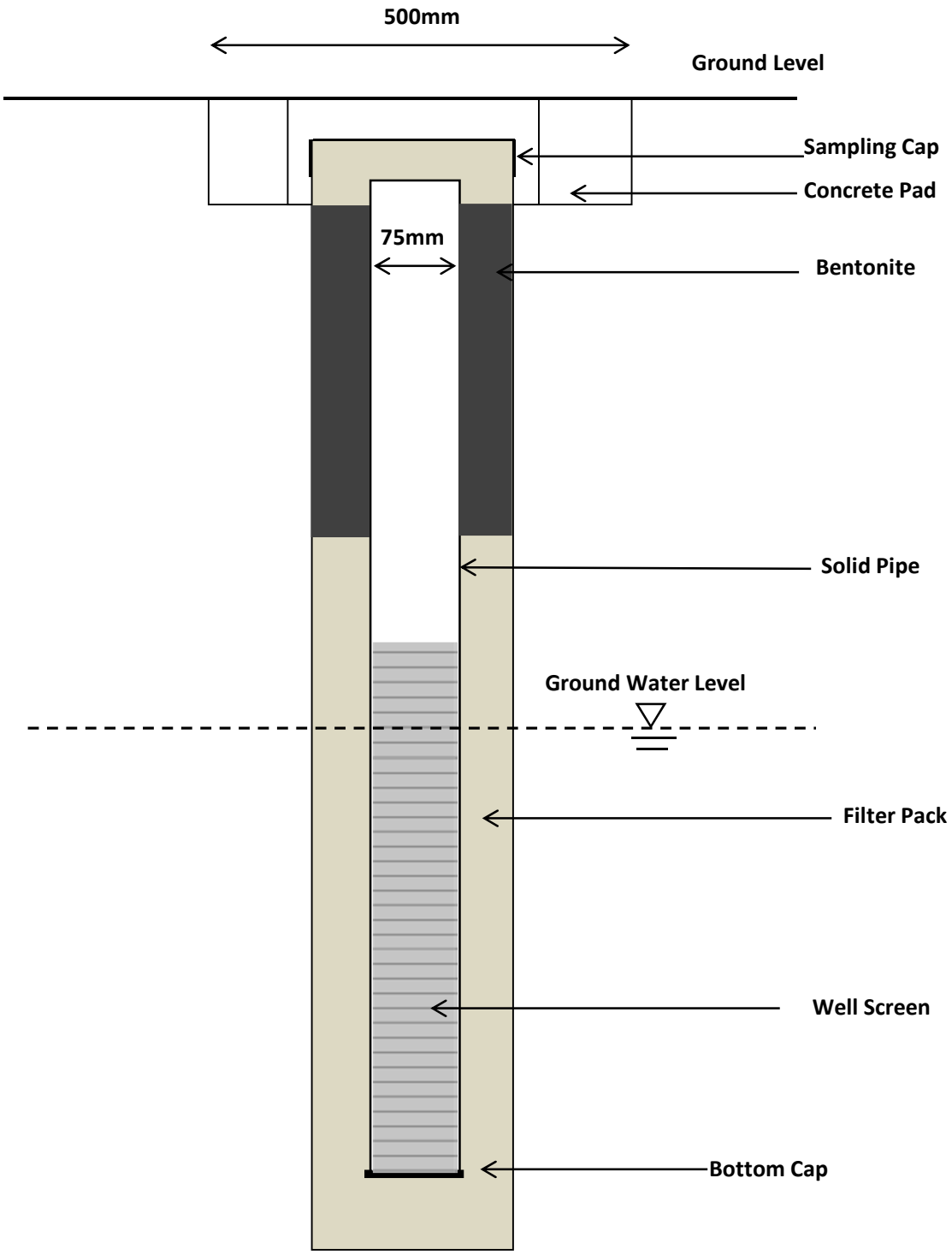
Contract No. SSW 327
Reprovisioning of Cape Collinson Crematorium

Locations Plan for Confirmatory Soil Sampling for Surface Soil and Underground Storage Tank

SCALE	N.T.S.	DATE	Nov-12
CHECK	GL	DRAWN	GL
JOB NO.	MA 0031	Figure No. 7	Rev 2



CINOTECH Cinotech Consultants Limited	Contract No. SSW 327 Reprovisioning of Cape Collinson Crematorium Design of Groundwater Sampling Well	SCALE	N.T.S.	DATE	Dec-12
		CHECK	HL	DRAWN	GL
		JOB NO.	MA0031	DRAWING No. 8	Rev 1

APPENDIX A

CAP IN APPROVED EIA REPORT

Architectural Services Department

PWP No. 016NB

Phased Reprovisioning of Cape Collinson Crematorium Environmental Impact Assessment Study

Contamination Assessment Plan

March 2008

	Name	Signature
Prepared & Checked:	Derek Lam	
Reviewed & Approved:	Freeman Cheung	

Version: 2	Date: 11 March 2008

The information contained in this report is, to the best of our knowledge, correct at the time of printing. The interpretation and recommendations in the report are based on our experience, using reasonable professional skill and judgment, and based upon the information that was available to us. These interpretations and recommendations are not necessarily relevant to any aspect outside the restricted requirements of our brief. This report has been prepared for the sole and specific use of our client and ENSR Asia (HK) Ltd. accepts no responsibility for its use by others.

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1 INTRODUCTION

Background

1.1 The existing Cape Collinson Crematorium (The Existing Crematorium) consists of four service halls with twelve cremators. The Existing Crematorium was first in use in 1962 and had several cremators upgraded in 1995 and 2001. To cope with the growing service demand while meeting the emission standards, the Food and Environmental Hygiene Department (FEHD) as the Project Proponent will replace all the existing cremators by new ones with higher capacity and more efficiency. The construction of the replacement crematorium was proposed in two phases. Phase 1 works involve the site formation work for the new crematorium, the construction of four new cremators and the provision of ancillary facilities. After commissioning of the four new cremators and their ancillary facilities, Phase 2 works will proceed to demolish the existing twelve cremators and construct six new cremators with ancillary facilities.

1.2 This "*Phased Reprovisioning of Cape Collinson Crematorium*" (The Project) is a designated project under Part I, Schedule 2, Item N4 of the *Environmental Impact Assessment Ordinance* (EIAO). In October 2007, Architectural Services Department (ArchSD), being the works agent commissioned ENSR Asia (HK) Limited (ENSR) to conduct Environmental Impact Assessment for the Project of which the area (Project Area) is shown in **Drawing No. 1.**

1.3 Potential land contamination resulting from the operation of the Existing Crematorium has been identified in the Project Profile (No. PP 338/2007). The Environmental Protection Department (EPD) issued the EIA Study Brief (No. ESB-177/2008) in January 2008 which demands a detailed assessment of land contamination impacts for the Project Area. This Contamination Assessment Plan (CAP) is to formulate the necessary investigation to address the potential land contamination concern associated with historic/current land uses in the Project Area. This CAP and the subsequent Contamination Assessment Report (CAR) and Remediation Action Plan (RAP) (if required) will form part of the EIA Study and be included in the EIA Report.

Objectives

1.4 The objectives of this CAP are to:

(i) present the findings of the desktop study and site appraisals;
(ii) identify potential hotspots of land contamination for intrusive site investigation; and
(iii) propose a sampling and testing strategy for the site investigation.

2 ENVIRONMENTAL LEGISLATION, POLICIES, PLANS, STANDARDS AND CRITERIA

2.1 Three publications issued by EPD, "*Guidance Note for Contaminated Land Assessment and Remediation*" (referred to as Guidance Note 1), "*Guidance Notes for Investigation and Remediation of Contaminated Sites of: Petrol Filling Stations, Boatyards, and Car Repair /Dismantling Workshops*" (referred to as Guidance Note 2) and *Guidance Manual for Use of Risk-based Remediation Goals for Contaminated Land Management*" (referred to as Guidance Manual) provide guidance on land contamination assessment.

2.2 According to Guidance Note 2, Risk-based Remediation Goal (RBRG) shall be used as the criteria for assessing land contamination and as the remediation goals if remediation is required.

3 LAND CONTAMINATION SITE APPRAISAL

General Site Context

3.1 The Project Area is located at Cape Collinson Road, Eastern District near Buddhist Cemetery, with site area of about 2000m^2. The Existing Crematorium consists of four service halls for carrying out ceremonies, two cremation rooms consisting of twelve cremators and several offices.

3.2 The Existing Crematorium is bounded to west and south by six columbarium blocks and Hong Kong Electric substation. Cemeteries and Fung Wah Estate are at the west and north of the Existing Crematorium respectively.

Geology and Hydrogeology

3.3 According to the Hong Kong Geological Survey Map (Series: HGM20) – Sheet No. 11 (1:20,000 scale) on the solid and superficial geology of the Project Area, the Project Area is mainly underlain by Shing Mun Formation, undivided sedimentary and volcanic rock consisting of tuffite of Upper Jurassic Period of Mesozoic Era.

3.4 A review of previous ground investigation (GI) reports undertaken at or in vicinity of the Project Area was conducted at the Civil Engineering and Development Department's (CEDD) Geotechnical Information Library to obtain information about the geological and hydrogeological conditions of the Project Area. Details of the reviewed GI reports are listed below:

- *Agreement No. CE 9/95 Feature No. 11SE-D/F19 Chai Wan Ground Investigation Factual Fieldwork Report* by Bachy Soletanche Group in 1995. (CEDD's Geotechnical Information Unit Report No. 21583)
- *Slope No. 11SE-D/R2 Regional Council Crematorium, Tai Tam Road, H.K. Ground Investigation Factual Fieldwork Report* by Bachy Soletanche Group in 1999. (CEDD's Geotechnical Information Unit Report No. 30513)
- *Agreement No. CE 10/2004 (GE) 10-Year Extended LPM Project, Phase 5, Package D – Hong Kong Island Landslip Preventive Works on Government Slopes and Related Studies – Investigation, Design and Construction Feature No. 11SE-D/C71 Location: Cape Collinson Crematorium Final Factual Fieldwork Report* by Fugro Geotechnical Services Ltd. in 2006. (CEDD's Geotechnical Information Unit Report No. 42859)

3.5 With reference to the above GI reports, the area close to the Project Area is generally covered by a layer of fill materials/colluvium (~0.5m to 1.5m in thickness) composed of sandy SILT and clayey sandy SILT with occasional fine to medium gravel. It is then followed by a layer (~1.15m to 10.1m in thickness) of saprolitic soil (in the majority of fine ash vitric TUFF and sandy SILT) before reaching the lower variable decomposed rock (rock of grade IV with thickness of ~0.4m to 6m). In terms of the likelihood of migration of contaminants, fill materials (i.e. top soil layer) generally have higher permeability and therefore, ability of potential contaminant migration through this horizon is higher than downward migration.

3.6 According to the general topography of the Project Area and groundwater levels recorded in some of the reviewed GI reports, elevation of the groundwater level varies from +153mPD to +110mPD from hillside south to hillside north of the Existing Crematorium. The general groundwater pattern likely flows from south to north, i.e. from Tai Tam Road towards Fung Wah Estate.

Review of Historical Aerial Photographs

3.7 A review of historical aerial photographs (as shown in **Table 3.1**) available in the Survey and Mapping Office of Lands Department was undertaken. The aim of this review is to identify the landuses associated with potential contamination implication within or near the Project Area.

Table 3.1 Reviewed Historical Aerial Photographs

Year	Height (Ft.)	Photograph Reference No.
1945	20000	4062
1949	8600	6063
1961	30000	120
1963	2700	6979
1967	6250	5631
1972	13000	2289
1974	12500	9697
1976	4000	12673
1978	4000	23782
1980	4000	29864
1982	4000	40872
1984	4000	53720
1986	4000	A06043
1987	4000	A10339
1989	4000	A17812
1992	4000	A32626
1994	4000	CN6926
1996	4000	CN14150
1998	4000	CN21101
2000	4000	CN28278
2002	3500	CW39611
2004	4000	CW55553
2006	4000	CW72455
2007	3000	CW77143

3.8 As concluded from the review of aerial photographs, the location of the Existing Crematorium was open area until 1962 and residential houses were found in the location of current Fung Wah Estate. Six columbarium blocks were built successively from 1970s to 1990s. Tai Tam Gap Correctional Institution at the southeast of the Existing Crematorium was also built in 1972. Residential houses were demolished and Fung Wah Estate was built in 1980s. No major land uses changes of the Project Area were observed since then.

4 SITE INSPECTION AND OBSERVATIONS

4.1 A site visit to Cape Collinson Crematorium was conducted on 1 February 2008 to inspect and identify any potential contamination hotspots within the Project Area. There were four service halls for carrying out ceremonies, two cremation rooms with twelve cremators and a number of smaller structures such as offices. New Cape Collinson Garden of Remembrance, which was open in December 2007, was situated at the west of the Existing Crematorium.

4.2 A capacity of 15,000L underground storage tank (UST), located at the south of the Existing Crematorium, has been used for diesel storage. The diesel fuel stored in the UST was pumped via the underground pipeline to the aboveground storage tank (AST) which situated at ground floor of the Existing Crematorium serving the cremators thereby by gravity. The exact alignment of the underground pipeline was concealed and could not be identified visually or from the available as-built plans. As a follow-up, an enquiry on the alignment was made to ArchSD. During a site interview with the site person in charge (PIC) from Electrical and Mechanical Services Department (EMSD), there noted no reportable events of leakage concerning the fuel tanks and pipeline.

4.3 Twelve cremators were located in two cremation rooms at the ground floor of the Existing Crematorium. Floors of both cremation rooms were covered by intact ceramic tiles while the cremators were set up on concrete foundation. Diesel fuel was fed to the cremators from the AST via vertical pipelines that ran outside along the wall. The oil pipes ended behind the cremators where their connections were clad in metal plates. Given the limited space and burn hazard from the operating cremator for close inspection, it was not able to access to the pipe joint or coupling where their conditions or any signs of leakage were uncertain. The site PIC from EMSD expressed that small-scale leakage of fuel from the pipes happened occasionally inside the cremation room. There was no storage of chemicals or dangerous goods as told by the manager of the Crematorium and observation during site visit.

4.4 Six chimneys connected to the twelve cremators were located at the top roof of the Existing Crematorium. Some areas around the Existing Crematorium were landscaped with trees and shrubs while other areas were paved with intact concrete. No stain or odour was observed during site inspection.

4.5 **Table 4.1** summarizes the findings of site inspection and photographs taken during site inspection were shown in **Appendix A. Drawing No. 2** illustrates the layout of the Existing Crematorium.

Table 4.1 Findings of Site Inspection

Location	Site Observation	SI Proposed?
Underground Storage Tank	• Located at the south of Existing Crematorium with capacity of ~15,000L for fuel storage; • No leakage incident happened as told by site PIC from EMSD; • Fuel is pumped from the underground fuel tank to the aboveground storage tank via underground pipeline. Exact location of the pipeline was not clear. • As the UST has been used for more than 40 years, there was potential leakage from the tank via cracks to the ground, further site investigation is required.	Yes

Location	Site Observation	SI Proposed?
Aboveground Storage Tank	• Located inside the tank room at the ground floor of Existing Crematorium for fuel storage ; • Tank room covered by intact concrete floor with no stain observed during site visit; • Fuel was pumped from the underground tank via underground pipeline; • As the underground pipe had been used for more than 40 years, there was potential leakage of fuel from the pipe via cracks to the ground, further site investigation is required.	Yes
Cremation Room 1	• Located at the ground floor of Existing Crematorium ; • The floors were well covered by intact tiles with no stain observed; • The oil pipes ended behind the cremators where their connections were clad in metal plates. Given the limited space and burn hazard from the operating cremator for close inspection,. Therefore, any signs of leakage were uncertain. • It was told by PIC from EMSD that occasional leakage of fuel was suspected. Further site investigation is required.	Yes
Cremation Room 2	• Located at the ground floor of Existing Crematorium with one cremator; • The floors were covered by intact tiles with no stain observed; • It was told by PIC from EMSD that occasional leakage of fuel was suspected. Further site investigation is required.	Yes
East of Chimneys	• Some part of the ground was covered by intact concrete while some part of the area was landscaped with trees and shrubs; • Construction works may be conducted within these areas. As contaminants of stack emissions might deposit on the soil where the ground was unpaved, further site investigation is required.	Yes
South of Chimneys	• As no works would be carried out at the south of Existing Crematorium, disturbance of soil is not anticipated, site investigation is not proposed for area at the south of chimneys.	No
West of Chimneys	• Construction works may be conducted within these areas. As contaminants of stack emissions might deposit on the soil where the ground was unpaved, further site investigation is required.	Yes
North of Chimneys	• Some part of the ground was covered by intact concrete while some part of the area was landscaped with trees and shrubs; • As contaminants of stack emissions might deposit on the soil where the ground was unpaved, further site investigation is required	Yes

4.6 Other areas inside the Existing Crematorium, which were covered by intact tiles, were used as service halls and offices. Chemicals were seldom used inside these areas and thus potential land contamination is not likely. Site investigation is not recommended for these areas.

4.7 An interview with the manager of the Crematorium has conducted. A summary of past, current and anticipated future land uses for the Project Area is presented in **Table 4.2** below.

Table 4.2 Summary of On-site Land Use

Current Use

Study Area	Type of facility/ business	On-site property land use	Date began	Description of business process/ primary products	Owner or Occupier	Approximate size of on-site property (m^2)	Off-site property affected?
Existing Crematorium Building	Crematorium	Crematorium	1962	To cremate the remains	Food and Environmental Hygiene Department (FEHD)	~1500	Yes
Car Park	Car Park	Car Park		Vehicles parked on site		~400	No

Past Use

Are past uses different from current uses? √ Yes ____ No

Study Area	Type of facility/ business	On-site property land use	Date began	Date ended	Description of business process/ primary products	Owner or Occupier	Approximate size of on-site property (if different from current size) (m^2)	Off-site property affected?
Existing Crematorium Building	Open Area	Vacant	Unknown	1962	Vacant	Unknown	~1500	No
Car Park							~400	

Future Use

Are future uses different from current uses? √ Yes ____ No

Study Area	Type of facility/ business	On-site property land use	Description of business process/ primary products	Owner or Occupier	Approximate size of on-site property (m^2)
Existing Crematorium Building	New Crematorium Building	Crematorium	To cremate the remains	FEHD	~2200
Car Park					

5 SAMPLING PLAN FOR SITE INVESTIGATION

Sampling Locations

5.1 Ten sampling locations are proposed for the potential contamination hotspots mentioned in **Table 4.1,** except for the cremation rooms 1 and 2. . Locations of proposed sampling points are illustrated in **Drawing No. 3**. The strategy of selection of sampling locations are based on the site observation of stain/floor discolourisation, machine/chemical storage locations, areas with contaminative activities undertaken or information provided by site personnel during the interviews.

5.2 Four boreholes and one trial pit along the fuel tank system are proposed to investigate whether there is contamination around the fuel tank system due to seepage or leakage. Five sampling locations are proposed for surface soil sampling to investigate whether there is surface soil contamination associated with aerial depositions from stack emissions.

5.3 As the cremators are still in operation, it is not possible to carry out site investigation behind the cremators at this stage. To maintain uninterrupted cremation services, further site investigation in cremation rooms is proposed at the later stage in Phase 2 during/ after the demolition of the Existing Crematorium. A supplementary CAP, which details further site investigation and testing plan for the cremation rooms, shall be prepared for EPD endorsement. Findings of supplementary site investigation and appropriate remediation methods (if contamination found) shall be presented in the supplementary CAR/RAP for EPD approval before the commencement of any earthworks.

Requirements of Site Investigation

5.4 Underground utilities survey shall be conducted to locate/ identify any underground utilities at/ in vicinity of the proposed borehole locations prior to commencement of drilling works. The exact sampling locations of the SI shall be determined on site and subject to fine adjustment due to site specific conditions (e.g. locations, presence of foundations, underground utilities, delivery pipes and services). The locations shall be agreed with both the premise owner, the Architect and the land contamination specialist prior to drilling and sampling.

5.5 It should be noted that if serious contamination is revealed during SI, more sampling locations or more number of samples at the specific sampling points would be recommended to determine the exact extent of contamination. For the proposed trial pit, additional soil sample would be collected if contamination is found at the sample collected at 3m.

5.6 The selection of potential contaminants recommended for laboratory analysis at each proposed SI location is referenced to the EPD's "*Guidance Notes for Investigation and Remediation of Contaminated Sites of Petrol Filling Stations, Boatyards, and Car Repair/Dismantling Workshops*" and "*Guidance Note for Contaminated Land Assessment and Remediation*". **Table 5.1** presents the sampling and testing plan for the 10 locations proposed for SI at the Project Area.

Table 5.1 Sampling and Testing Plan

Locations	Proposed Sampling ID	Sampling Method	Sample Matrix		Testing Parameters				When to conduct?
					TPH	VOCs	Heavy Metals	Dioxins	
Fuel Tank System	BH1 – BH 4	Borehole to 2m below GW level or 6m bcl if no GW is encountered	Soil	0.5m bcl	Y	Y	Lead	-	In this Study
			Soil	1.5m bcl	Y	Y	Lead	-	
			Soil	At GW level or at 6m bcl	Y	Y	Lead	-	
			GW	If present	Y	Y	Lead	-	
	TP1	Trial pit to 3m bcl	Soil	Immediately below pipeline	Y	Y	Lead	-	In this Study
			Soil	Every 1m below pipeline	Y	Y	Lead	-	
			GW	If present	Y	Y	Lead	-	
West of Chimneys	S1	Surface soil sample to 0.5m of exposed areas	Soil	0.1m			Y	Y	In this Study
			Soil	0.5m (Subject to the test results of 0.1m sample)	-	-	Y	Y	
North of Chimneys	S2 – S3	Surface soil sample to 0.5m of exposed areas	Soil	0.1m	-	-	Y	Y	In this Study
			Soil	0.5m (Subject to the test results of 0.1m sample)	-	-	Y	Y	
East of Chimneys	S4 – S5	Surface soil sample to 0.5m of exposed areas	Soil	0.1m	-	-	Y	Y	In this Study
			Soil	0.5m (Subject to the test results of 0.1m sample)	-	-	Y	Y	

Notes:
bcl = below concrete layer; GW = groundwater; BH = borehole; TP=trial pit; S=surface sample; Y = testing proposed; TPH=Total Petroleum Hydrocarbons; VOCs=Volatile Organic Chemicals; SVOCs=Semi-volatile Organic Chemicals.
Details of the chemical parameters should be referred to Table 6.1.
This table should be read in conjunction with Drawing No. 3.

Sampling Method and Depth of Sampling

5.7 All soil boring and sampling should be supervised by a qualified land contamination specialist. Boreholes should be undertaken by means of dry rotary drilling method i.e. without the use of flushing medium. For safety reasons, an inspection pit should be excavated down to 1.5m below ground to inspect for underground utilities at the proposed borehole location. Disturbed soil samples should be collected at the depth of 0.5m and 1.5m below concrete slab. Soil boring using drill rigs should then be performed for depth from 1.5m to the maximum boring depth. Undisturbed U100/U76 (stainless steel) soil samples should be collected at the groundwater level, or 6m below concrete layer if no groundwater is encountered.

5.8 Trial pit should be excavated by means of hand tools to expose the soil under the fuel pipeline for sampling. Disturbed soil samples should be collected immediately below the pipeline and every 1m below the pipeline from trial pit by hand sampling.

5.9 Surface soil samples should be taken at 0.1m and 0.5m by hand tools. The second soil sample at 0.5m shall be analyzed if contamination is found at the 0.1m sample.

Strata Logging

5.10 Strata logging for boreholes or trial pit should be undertaken during the course of drilling/digging and sampling by a qualified geologist. The logs should include the general stratigraphic descriptions, depth of soil sampling, sample notation and level of groundwater (if encountered). The presence of rocks/boulders/cobbles discoloration, odour and foreign materials such as metals, wood and plastics should also be recorded. If trial pit is used, photographic records should be taken.

Free Product and Groundwater Level Measurement

5.11 The thickness of any free product and groundwater level if present at sampling locations should be measured with an interface probe. The free product if encountered in sufficient amount should be collected for laboratory analysis to determine the composition.

Groundwater Sampling

5.12 Groundwater samples shall be collected if groundwater is encountered at the sampling locations.

5.13 For each proposed borehole location, a groundwater sampling well should be installed into the boreholes prior to ground the commencement of sampling if groundwater is encountered or agreed by the land contamination specialist. After installation of the monitoring wells, the depth to water table and the thickness of free product (if exists) at all monitoring wells should be measured using an interface probe. Well developments (approximately five well volumes) should be carried out to remove silt and drilling fluid residue from the wells. The wells should then be allowed to stand for a day to permit groundwater conditions to equilibrate. Groundwater level and thickness of free product layer, if present, should be measured at each well before groundwater samples are taken.

5.14 Prior to groundwater sampling, the monitoring wells should be purged (at least three well volumes) to remove fine-grained materials and to collect freshly refilled representative groundwater samples. Time for each groundwater purging/recharge should be recorded as well as the estimated groundwater flow.

5.15 After purging, one groundwater sample should then be collected at each well using Teflon bailer and decanted into appropriate sample vials or bottles in a manner that minimises agitation and volatilisation of VOCs from the samples. All samples should be uniquely labeled.

5.16 Apart from boreholes, groundwater sample should be also collected at the trial pit if encountering groundwater during excavation. The trial pit should be pumped to near dry and

allowed to stand for 24 hours. Groundwater sample should be collected using decontaminated bucket.

5.17 Immediately after collection, groundwater samples should be transferred to new, clean, laboratory-supplied glass jars for sample storage/transport. The sampling jars should be of opaque type that minimizes any sunlight effect on the sample. Groundwater samples should be placed in the glass jars with zero headspace and promptly sealed with a septum-lined cap. All sample jars should be transported in ice chests where they are cooled and maintained at a temperature of around 0-4°C until delivered to the analytical laboratory.

Sampling Size and Decontamination Procedures

5.18 All equipment in contact with the ground should be thoroughly decontaminated between each excavation, drilling and sampling event to minimise the potential cross contamination. The equipment (including drilling pit, digging tools and soil/groundwater samplers) should be decontaminated by steam cleaning/ high-pressure hot water jet, and then washed by phosphate-free detergent and finally rinsed by distilled/deionized water.

5.19 Prior to sampling, the laboratory responsible for analysis should be consulted on the particular sample size and preservation procedures that are necessary for each chemical analysis. Extra soil samples shall be reserved for Toxicity Characteristics Leaching Procedure (TCLP) analysis, if it is required.

5.20 The sample containers should be laboratory cleaned, sealable, water-tight, made of glass or other suitable materials with aluminium or Teflon-lined lids, so that the container surface will not react with the sample or adsorb contaminants. No headspace should be allowed in the containers which contain samples to be analysed for VOCs, TPH or other volatile chemicals.

5.21 The containers should be marked with the sampling location codes and the depths at which the samples were taken. If the contents are hazardous, this should be clearly marked on the container and precautions taken during transport. Samples should be stored at between 0-4°C but never frozen. Samples should be delivered to laboratory within 24 hours of the samples being collected and analysed within 7 days upon delivery.

QA/QC Procedures

5.22 QA/QC samples shall be collected in the following frequency during the SI. Chain of Custody protocol shall be adopted.

- 1 equipment blank per 20 samples for full suite analysis.
- 1 field blank per 20 samples for full suite analysis.
- 1 trip blank per 20 samples for full suite of analysis.

5.23 From the proposed sampling plan, there should be at least 2 equipment blanks, 2 field blanks and 2 trip blanks to be collected under this Study.

Health and Safety Measures

5.24 The specific safety measures to be taken depend on the nature and content of contamination, the site conditions and the regulations related to site safety requirements. Workmen Compensation Insurance and third party insurance must be provided for the SI.

5.25 Extreme care should be exercised when toxic gases or other hazardous materials are encountered. Any abnormal conditions found shall be reported immediately to the safety officer and the land contamination specialist.

5.26 The SI contractor shall establish and maintain a Health and Safety Plan, before commencement of the SI, that will include the following:

(i) Instruction of works on work procedures, safe practices, emergency duties, and applicable regulations;

(ii) Regularly scheduled and impromptu meetings of the workers in which the possible hazards, problems of the job, and related safe practices are emphasized and discussed;
(iii) Good housekeeping practices; and
(iv) Availability of and instruction in the location, use and maintenance of personal protective equipment.

5.27 The SI Contractor shall maintain equipment and supplies reasonably required in an emergency, including lifesaving, evacuation, rescue and medical equipment in good working order and condition at all times. The SI Contractor shall use all reasonable means to control and prevent fires and explosions, injury to personnel and damage to equipment of property. Without limiting the foregoing, the SI Contractor shall:
(i) Maintain proper safety devices, barriers to minimise hazards during performance of the work;
(ii) Prohibit smoking and open flames and the carrying of matches and lighters;
(iii) Develop and maintain a written emergency plan applicable to the Work and Site;
(iv) Maintain equipment in good operating condition and have emergency and first aid equipment ready for immediate use, where applicable;
(v) Conduct equipment tests to ensure that equipment is properly placed and in good operating condition, and that workers are able to respond to emergency situations;
(vi) Require all workers employed or retained by the Contractor, or a subcontractor, to at all time wear clothing suitable for existing work, weather and environmental conditions; and
(vii) The personnel are required to wear respirator and gloves for vapour exposure protection, if necessary. Safety helmet and protective boots should be worn.

6 LABORATORY ANALYSIS

6.1 Laboratory analysis is proposed in order to assess the presence of potential contaminants that are of concern at the Site. **Table 6.1** summarises the parameters, detection limits and reference methods for the laboratory analyses of soil and groundwater samples for this Study.

Table 6.1 Preliminary Testing Parameters Proposed for Laboratory Analysis

Item	Parameter	Soil		Groundwater	
		Detection Limit (mg/kg) or otherwise stated	Reference Method	Detection Limit (mg/L) or otherwise stated	Reference Method
1	**Total Petroleum Hydrocarbons (TPH)**	C6 – C8: 5 C9 – C16: 200 C17 – C35: 500	USEPA 8015	C6 – C8: 0.02 C9 – C16: 0.5 C17 – C35: 0.5	USEPA 8015
2	**VOCs**				
	Benzene	0.2	USEPA 8260	0.001	USEPA 8260
	Toluene	0.2	USEPA 8260	0.002	USEPA 8260
	Ethylbenzene	0.2	USEPA 8260	0.002	USEPA 8260
	Meta & para Xylene	0.4	USEPA 8260	0.004	USEPA 8260
	Ortho xylene	0.2	USEPA 8260	0.002	USEPA 8260
3	**Heavy Metals**				
	Antimony	1	USEPA 6020	NA	NA
	Arsenic	1	USEPA 6020	NA	NA
	Barium	0.5	USEPA 6020	NA	NA
	Cadmium	0.2	USEPA 6020	NA	NA
	Chromium III	1	USEPA 6020	NA	NA
	Chromium VI	1	USEPA 6020	NA	NA
	Cobalt	0.5	USEPA 6020	NA	NA
	Copper	1	USEPA 6020	NA	NA
	Lead	1	USEPA 6020	NA	NA
	Manganese	1	USEPA 6020	NA	NA
	Mercury	0.05	USEPA 6020	0.05	USEPA 6020
	Molybdenum	1	USEPA 6020	NA	NA
	Nickel	1	USEPA 6020	NA	NA
	Tin	0.5	USEPA 6020	NA	NA
	Zinc	1	USEPA 6020	NA	NA
4	**Dioxins (I-TEQ)**	0.5 ug/kg	USEPA 8280A	NA	NA

Note:
NA: No test is required.

6.2 For sampling and laboratory analyses, chain of custody procedure shall be included as QC/QA procedure.

6.3 All laboratory analyses for soil and groundwater samples shall be conducted by laboratory accredited by the Hong Kong Laboratory Accreditation Scheme (HOKLAS).

6.4 Extra soil samples shall be stored at 0-4°C and tested for Toxicity Characteristics Leaching Procedure (TCLP) before submission of Remediation Action Plan (RAP) if excavation and landfill disposal is identified as the last resort.

7 INTERPRETATION OF RESULTS FOR SITE INVESTIGATION

7.1 The results of the laboratory analyses shall be interpreted in accordance with and *Guidance Note for Contaminated Land Assessment and Remediation* (Guidance Note 1) and *Guidance Notes for Investigation and Remediation of Contaminated Sites of Petrol Filling Stations, Boatyards, and Car Repairing/Dismantling Workshops* (Guidance Note 2), published by EPD.

7.2 Risk-Based Remediation Goals (RBRGs) would be used as criteria for the soil and groundwater contamination assessment. The Guidance Manual launched by EPD on 15 August 2007 provides RBRGs for 4 types of land-uses including Urban Residential, Rural Residential, Industrial and Public Park. For each type of land-uses, a list of limits is provided for assessing land contamination purposes.

7.3 According to the Guidance Manual, land contamination data should be compared with the relevant RBRGs in accordance with the future land-use of the site. It is understood that the future site development will be crematorium. As workers are likely the group exposed to potential contaminated soil during excavation stage and maintenance works, RBRGs for Industrial is proposed to adopt as the land contamination assessment criteria. Relevant soil and groundwater Industrial RBRGs levels for this Study are presented in **Table 7.1**.

Table 7.1 RBRGs (Industrial) Values for Soil and Groundwater

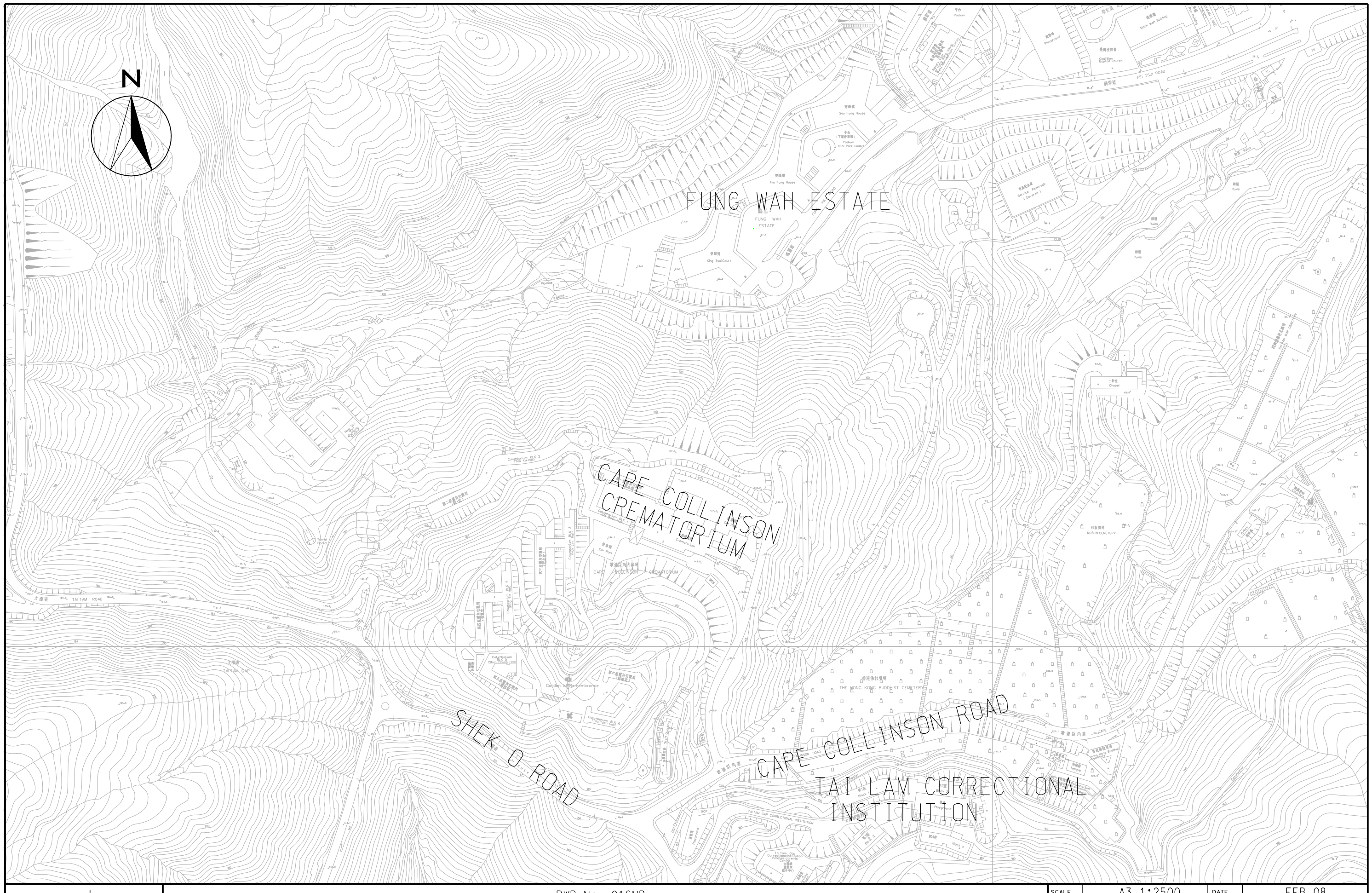
Parameter	Soil (mg/kg)		Groundwater(mg/L)	
	Industrial	Soil Saturation Limit	Industrial	Solubility Limit
VOCs				
Benzene	9.21	336	54	1,750
Toluene	10,000	235	10,000	526
Ethylbenzene	8,240	138	10,000	169
Xylenes (total)	1,230	150	1,570	175
Total Petroleum Hydrocarbons (TPH)				
C6-C8	10,000	1,000	1,150	5.23
C9-C16	10,000	3,000	9,980	2.8
C17-C35	10,000	5,000	178	2.8
Heavy Metals				
Antimony	261	NA	NA	NA
Arsenic	196	NA	NA	NA
Barium	10,000	NA	NA	NA
Cadmium	653	NA	NA	NA
Chromium III	10,000	NA	NA	NA
Chromium VI	1,960	NA	NA	NA
Cobalt	10,000	NA	NA	NA
Copper	10,000	NA	NA	NA
Lead	2,290	NA	NA	NA
Manganese	10,000	NA	NA	NA
Mercury	38.4	NA	6.79	NA
Molybdenum	3,260	NA	NA	NA
Nickel	10,000	NA	NA	NA
Tin	10,000	NA	NA	NA
Zinc	10,000	NA	NA	NA
Dioxins				
Dioxins (I-TEQ)	0.005	NA	NA	NA

7.4 A Contamination Assessment Report (CAR) shall be compiled following the SI. The CAR shall present the methodology used during the soil boring and sampling work, details of field observations, and interpretation of laboratory testing results for soil and groundwater contamination.

7.5 If land contamination is confirmed, a Remediation Action Plan (RAP) shall be drawn up to formulate necessary remedial measures. The subsequent CAR and RAP, as part of the EIA Study, shall be endorsed by EPD before implementation of any remediation work.

7.6 Since the cremators are still in operation, it is not possible to carry out site investigation inside the cremation rooms at this stage. Referring to Section 4.5, potential land contamination at cremation rooms would mainly due to fuel spillage and leakage from the cremators. Since there is no record of large scale spillage, only small scale spillage or leakage from the cremator are anticipated. Further site inspection is recommended during Phase 2 works of demolishing the existing cremators. Further the site inspection, a supplementary CAP shall be prepared for EPD endorsement to present detailed sampling and testing plan. Findings of site investigation and appropriate remediation methods shall be presented in supplementary CAR/ RAP for EPD endorsement prior to the commencement of any earthworks.

Drawings



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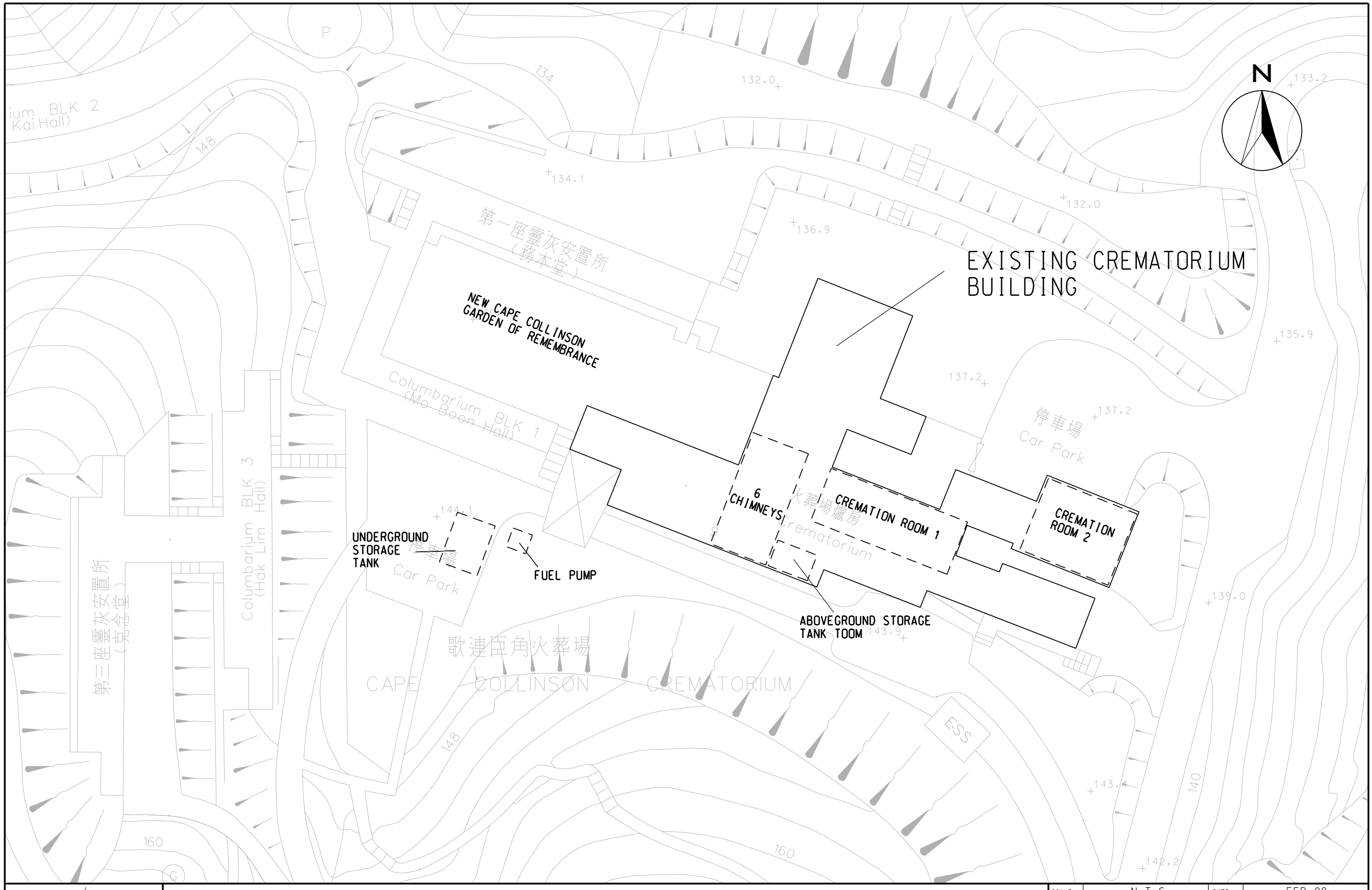
PWP No. 016NB

PHASED REPROVISIONING OF CAPE COLLINSON CREMATORIUM ENVIRONMETNAL IMPACT ASSESSEMENT STUDY

LOCATION PLAN

SCALE	A3 1:2500	DATE	FEB 08
CHECK	IWSL	DRAWN	CHKM
JOB No.	60028568	DRAWING No. 1	REV –

P:/60028568/1.01/CAD/Drawing/Report/CAP/DRAWING NO. 1.DGN



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PWP No. 016NB

PHASED REPROVISIONING OF CAPE CLLINSON CREMATORIUM ENVIRONMENTAL IMPACT ASSESSMENT STUDY

STRUCTURAL LAYOUT OF THE EXISTING CREMATORIUM

SCALE	N.T.S.	DATE	FEB 08
CHECK	IWSL	DRAWN	CHKM
JOB No.	60028568	DRAWING No.	2
		REV	–

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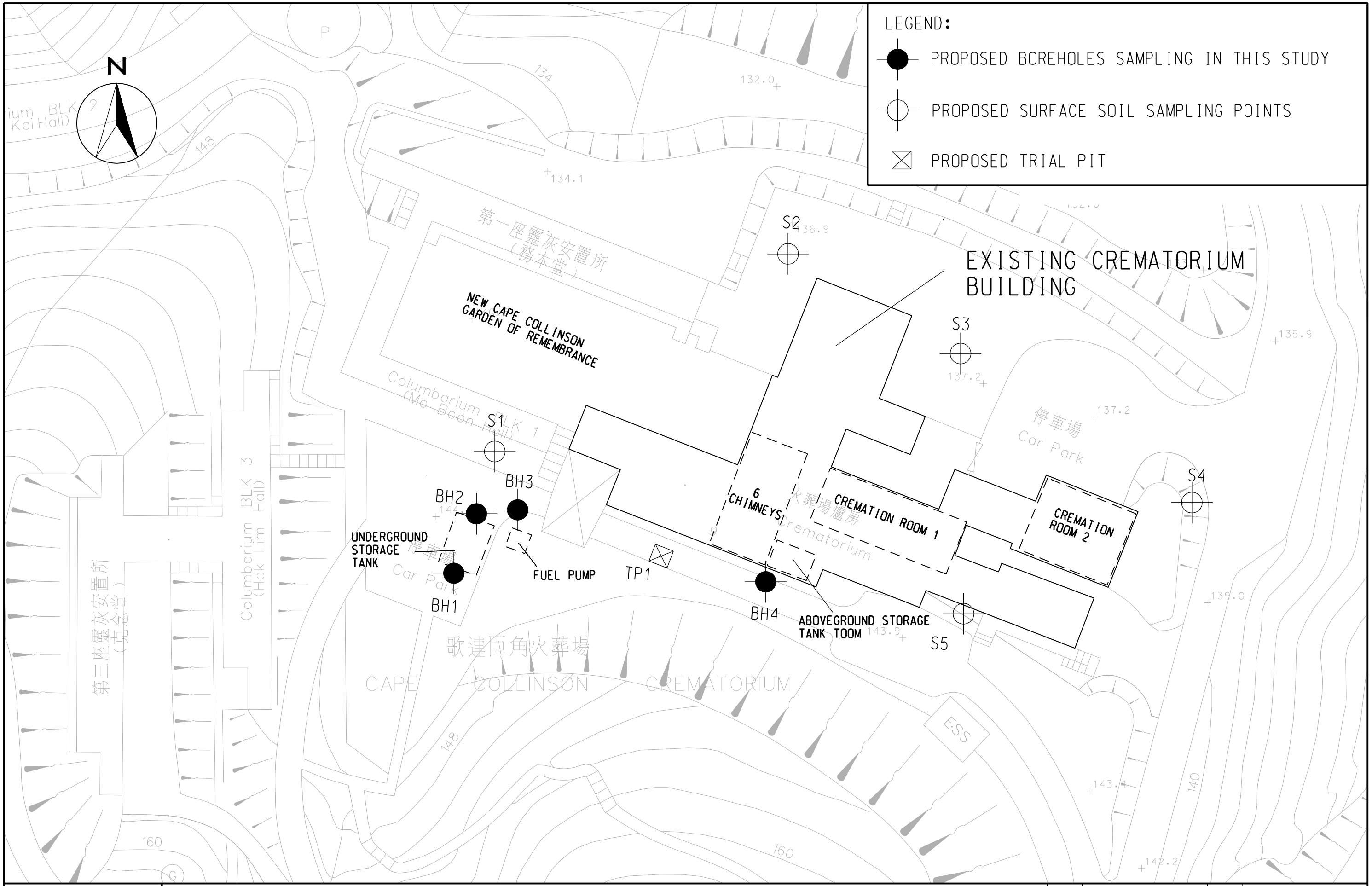

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PWP No. 016NB
PHASED REPROVISIONING OF CAPE CLLINSON CREMATORIUM ENVIRONMENTAL IMPACT ASSESSMENT STUDY

PROPOSED SAMPLING LOCATIONS

SCALE	N.T.S.	DATE	FEB 08
CHECK	IWSL	DRAWN	CHKM
JOB No.	60028568	DRAWING No. 3	REV –

P:/60028568/1.01/CAD/Drawing/Report/CAP/DRAWING NO 3.DGN

Appendix A

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Architectural Services Department	Cape Collinson Crematorium	60028568

Photo No.	Date:
1	Feb. 08

Direction Photo Taken:

South of Existing Crematorium

Description:

Underground Storage Tank System

With capacity of ~15,000L. It is used for diesel fuel storage. Stain was observed on intact concrete paved ground.

Photo No.	Date:
2	Feb. 08

Direction Photo Taken:

South Portion of Existing Crematorium

Description:

Aboveground Storage Tank

Located at the ground floor of Crematorium. For diesel fuel storage. No stain was observed on intact concrete paved ground.

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
Architectural Services Department	Cape Collinson Crematorium	60028568

Photo No.	Date:
3	Feb. 2008

Direction Photo Taken:

West of Chimneys

Description:

A total of 6 chimneys connected to 12 cremators were located at the roof of existing crematorium.

Photo No.	Date:
4	Feb. 2008

Direction Photo Taken:

East of Chimneys

Description:

Some area was landscaped with shrubs and trees. Stack emissions may deposit on exposed soil.

PHOTOGRAPHIC LOG

Client Name:	**Site Location:**	**Project No.**
Architectural Services Department	Cape Collinson Crematorium	60028568

Photo No.	**Date:**
5	Feb. 2008

Direction Photo Taken:

North of Chimneys

Description:

Some area was landscaped with shrubs and trees. Stack emissions may deposit on exposed soil.

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AERIAL PHOTOGRAPHIC LOG

Client Name:	**Site Location:**	**Project No.**
Architectural Services Department	Cape Collinson Crematorium	60028568

Photo No.	**Date:**
A	Feb. 2008

Description:

(Extracted from aerial photo Ref. No. 6063 dated 1949)

Crematorium has not yet been built. The area was left open.

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AERIAL PHOTOGRAPHIC LOG

Client Name:	**Site Location:**	**Project No.**
Architectural Services Department	Cape Collinson Crematorium	60028568

Photo No.	**Date:**
B	Feb. 2008

Description:

(Extracted from aerial photo Ref. No. 6979 dated 1963)

Crematorium has been built.

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AERIAL PHOTOGRAPHIC LOG

Client Name:	**Site Location:**	**Project No.**
Architectural Services Department	Cape Collinson Crematorium	60028568

Photo No.	**Date:**
C	Feb. 2008

Description:

(Extracted from aerial photo Ref. No. 9697 dated 1974)

Columbarium Blocks 1 and 2 have been built.

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AERIAL PHOTOGRAPHIC LOG

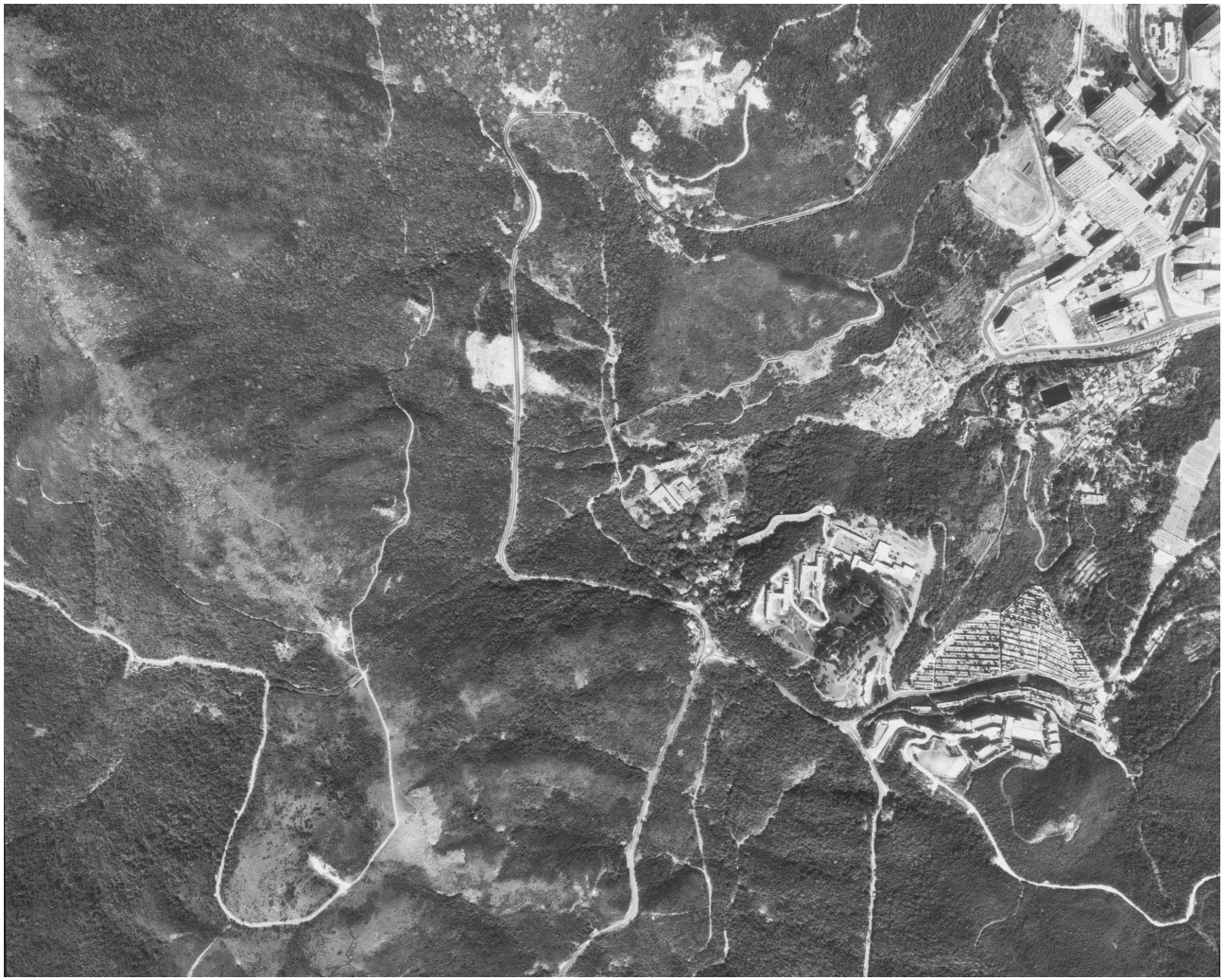
Client Name:	**Site Location:**	**Project No.**
Architectural Services Department	Cape Collinson Crematorium	60028568

Photo No.	**Date:**
D	Feb. 2008

Description:

(Extracted from aerial photo Ref. No. 53720 dated 1984)

Columbarium Blocks 3 and 4 have been built.



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AERIAL PHOTOGRAPHIC LOG

Client Name:	**Site Location:**	**Project No.**
Architectural Services Department	Cape Collinson Crematorium	60028568

Photo No.	**Date:**
E	Feb. 2008

Description:

(Extracted from aerial photo Ref. No. CN14150 dated 1996)

Residential houses in the north of crematorium were demolished and Fung Wah Estate has been built on it. Columbarium Block 5 and 6 have also been built.

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AERIAL PHOTOGRAPHIC LOG

Client Name:	**Site Location:**	**Project No.**
Architectural Services Department	Cape Collinson Crematorium	60028568

Photo No.	**Date:**
F	Feb. 2008

Description:

(Extracted from aerial photo Ref. No. CW77143 dated 2007)

No major land use changes were observed.

APPENDIX B

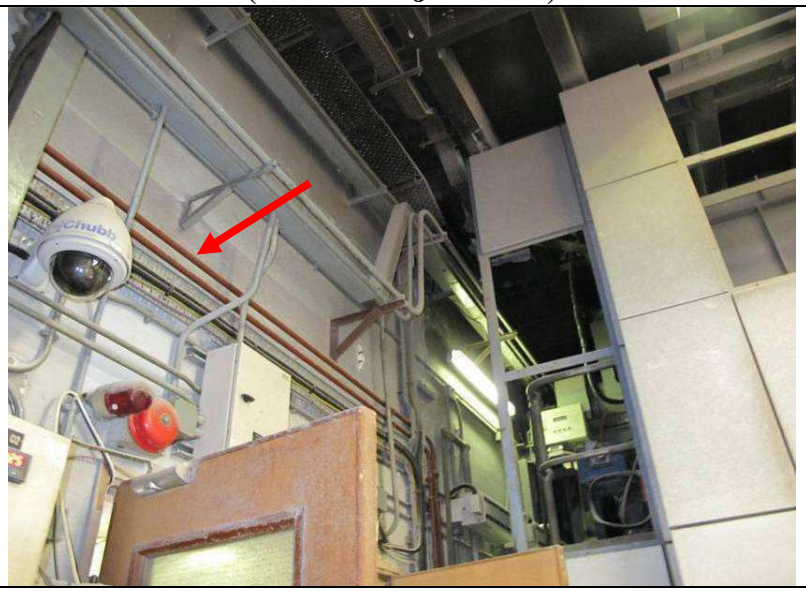
PHOTOPGRAPHIC RECORD OF SITE INSPECTION ON 6 JUNE 2012 AND 19 OCTOBER 2012

Appendix B – Photographic record of Site inspection on 6 June 2012 and 19 October 2012

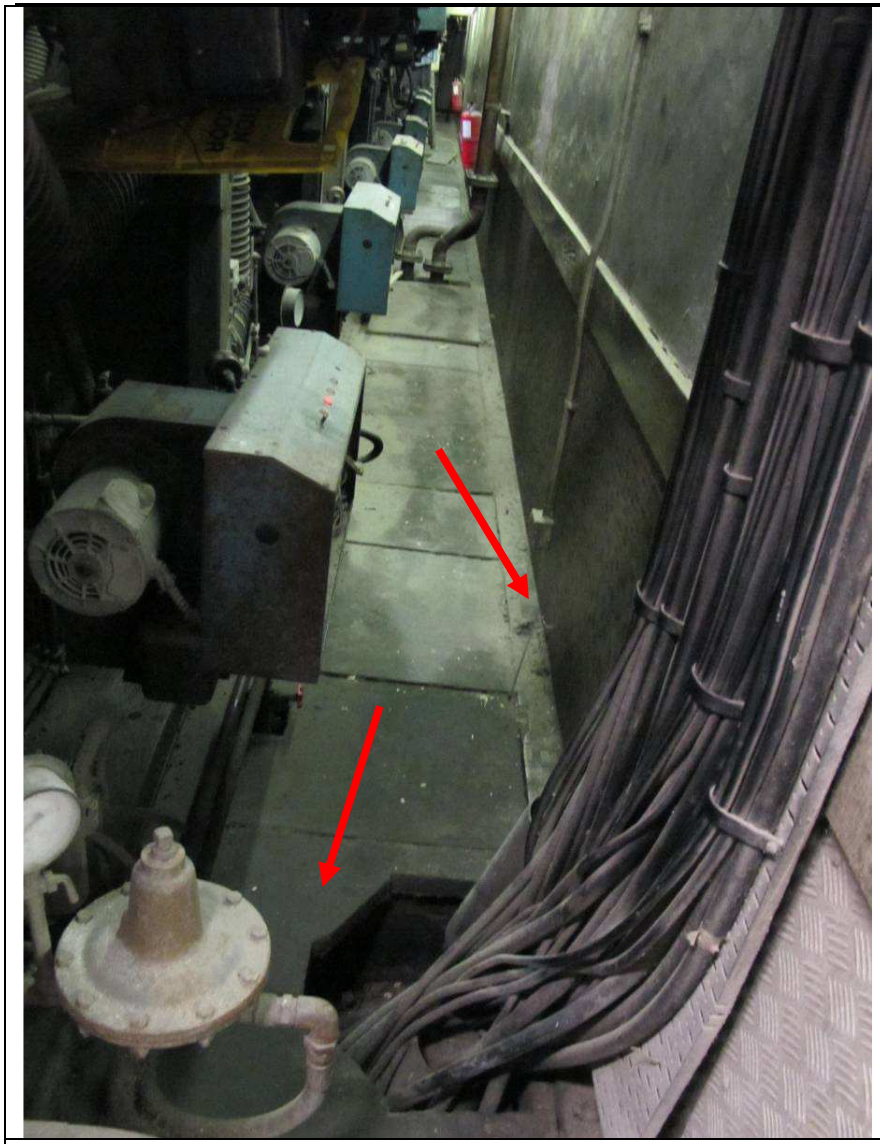
Description: Location of Underground Storage Tank (UST)
(Taken on 6 June 2012)

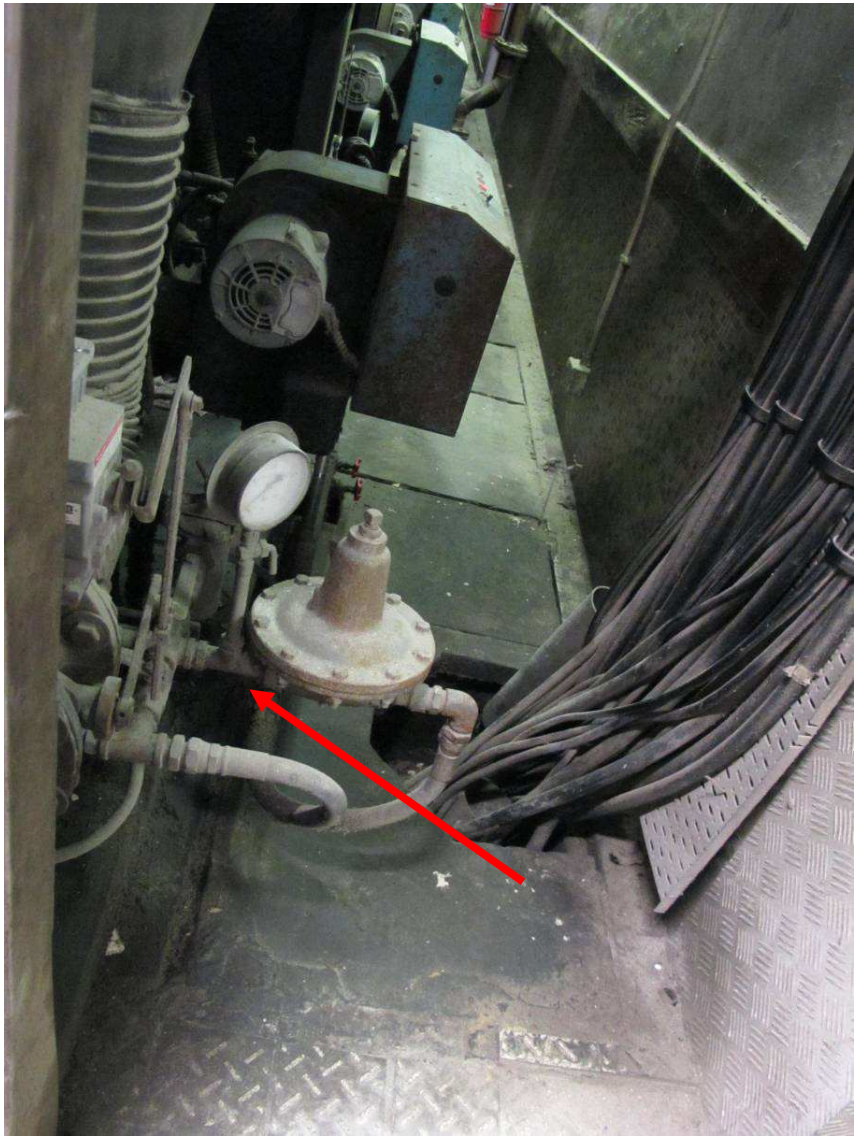
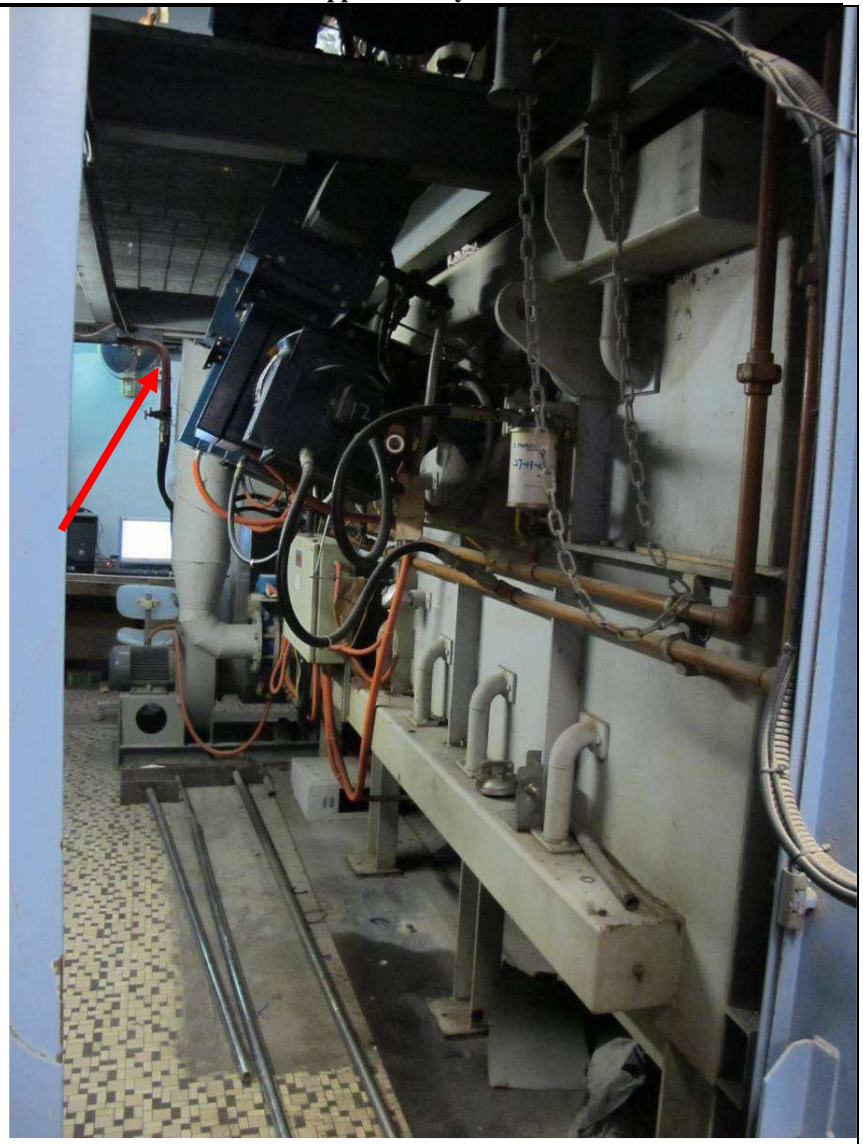
Description: Location: Trial Pit 1(TP1)
(Taken on 6 June 2012)

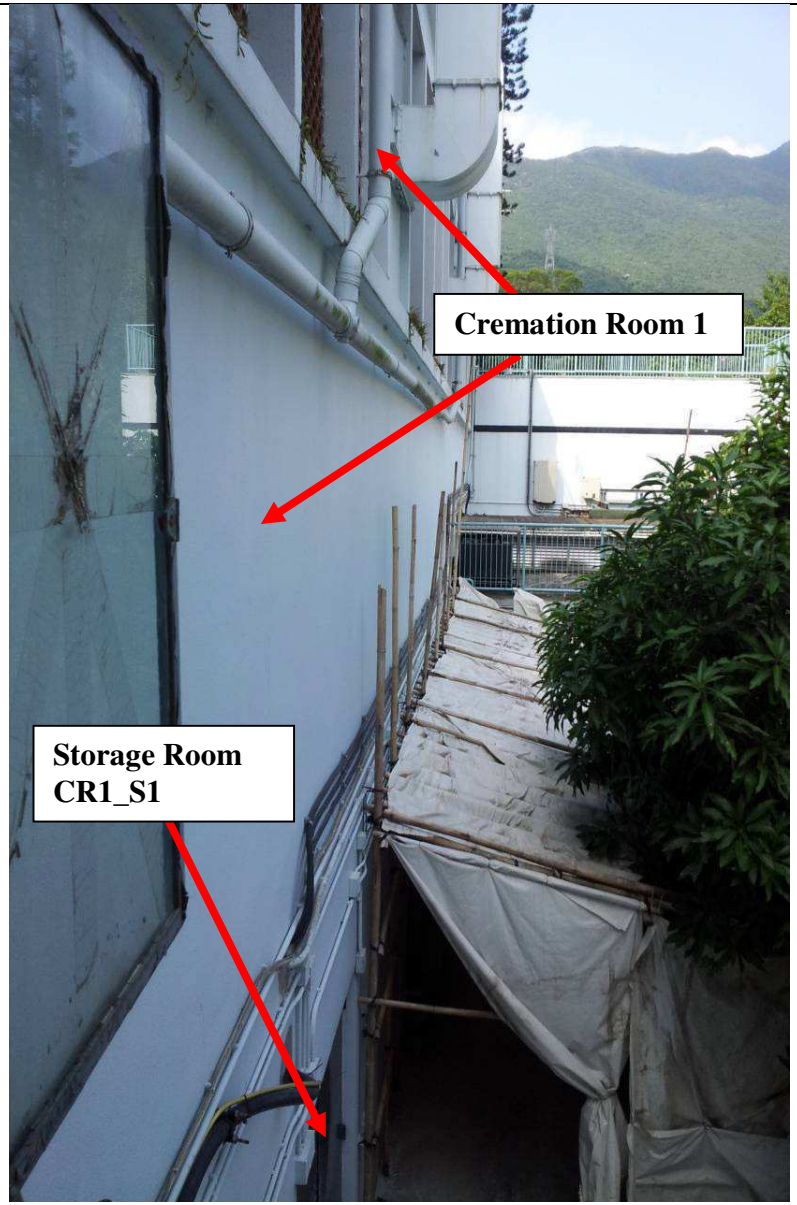
Description: Cremator in Cremation Room 1 (CR1)
(Taken on 6 June 2012)



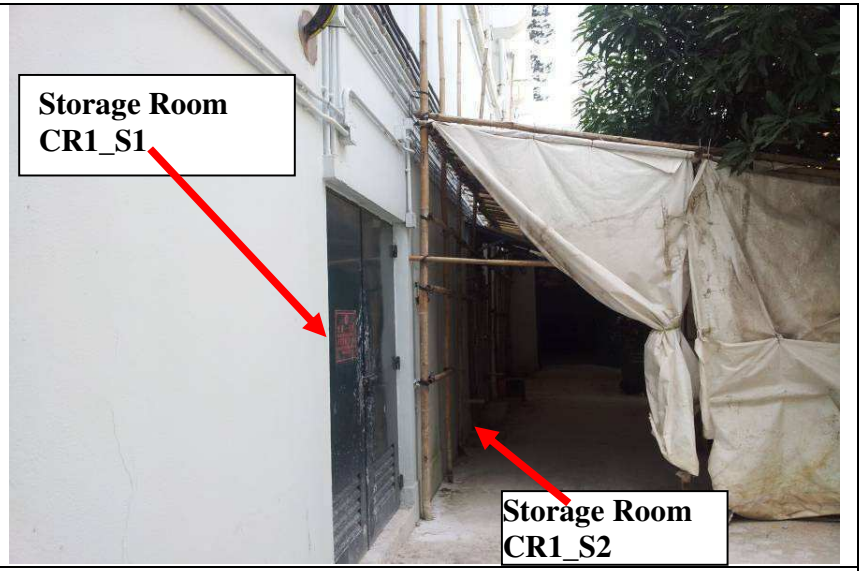
Description: External Fuel Pipelines to Cremator (CR1)
(Taken on 6 June 2012)

	
Description: Concrete Channel for Main Fuel Pipe (CR1) (Taken on 6 June 2012)	**Description: External Main Fuel Pipe to Cremator (CR1) (Taken on 6 June 2012)**

	
Description: The joint between fuel pipe to Cremator (CR1) (Taken on 6 June 2012)	**Description: External Fuel Pipelines form Cremation Room 1 (CR1) to Cremator 2 (CR2) (Taken on 6 June 2012)**



Description: Cremation Room (CR1) and the Storage Rooms CR1_S1 under CR1 (Taken on 19 October 2012)



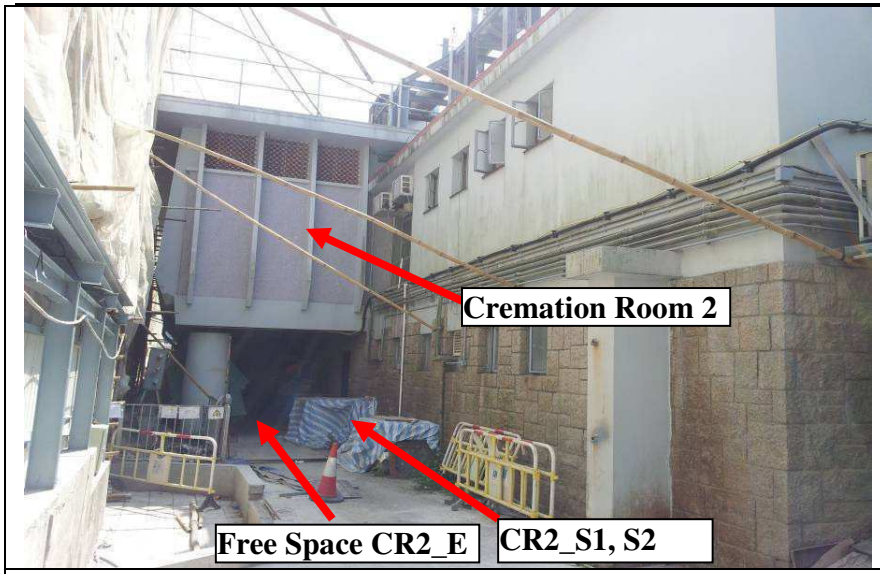
Description: Cremation Room (CR1) and the CR1_S1 and S2 under CR1 (Taken on 19 October 2012)

Description: Storage Room CR1_2 and 3 under CR1 (Taken on 19 October 2012)
***CR1_S2 is the refrigerator for dead bodies and no photo was taken in CR1_S2.**

Description: CR1_S1 under CR1
(Taken on 19 October 2012)

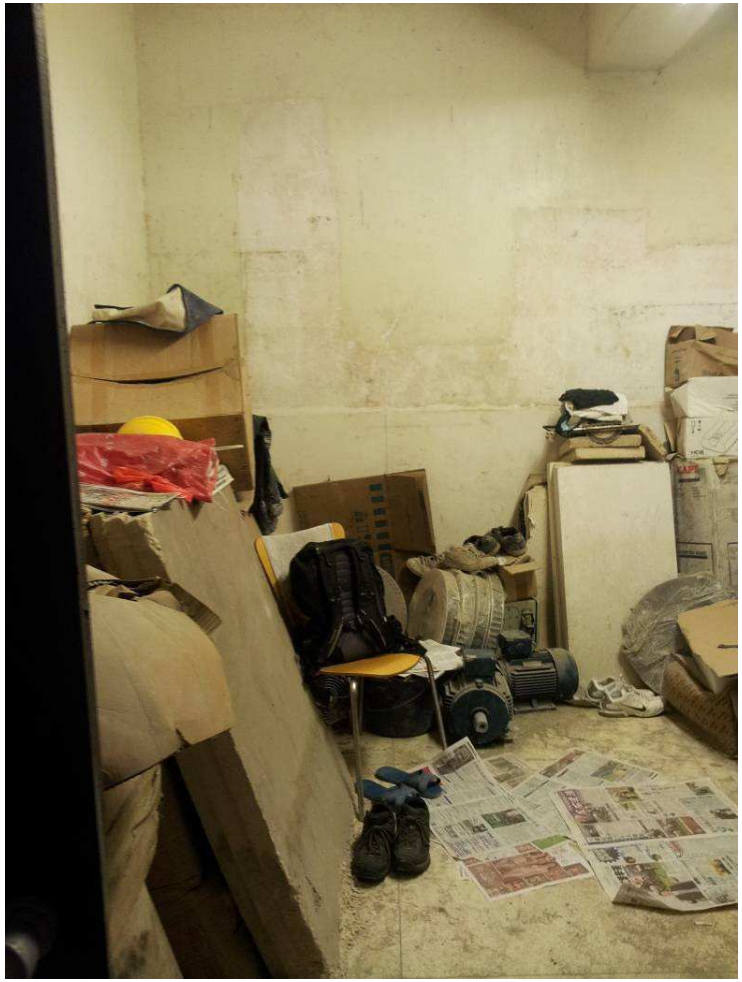
Description: Location: CR1_S3 under CR1
(Taken on 19 October 2012)

Description: Location: CR1_S3 under CR1
(Taken on 19 October 2012)



**Free Space CR2_E and
the Storage Rooms CR2_S2 under CR2
(Taken on 19 October 2012)**

**Description: Storage Room CR2_S2 under CR2
(Taken on 19 October 2012)**



**Description: CR2_S1 under CR2
(Taken on 19 October 2012)**