Architectural Services Department

Provision of Cremators at Wo Hop Shek Crematorium

Interim Contamination Assessment Report & Remediation Action Plan

Hyder Consulting

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1 Introduction

1.1 Background

Hyder Consulting Limited (Hyder) were commissioned by Architectural Services Department (ArchSD) to undertake an assessment of potential land contamination as part of the EIA study for the provision of cremators at Wo Hop Shek Crematorium – hereafter referred to as the "Project".

A Contamination Assessment Plan (CAP) was prepared for setting out the plan for the SI works for the Project and was submitted to EPD. The CAP was endorsed by EPD in May 2006.

This report, named the Interim Contamination Assessment Report and Remediation Action Plan (CAR & RAP), is to present the results and findings of the site investigation (SI) works and suggest remedial works that may be necessary for the Project. The identification of suitable remedial works is dependent on further investigation.

This report is considered an Interim document due to the recommendation that further investigation work must be undertaken when the redevelopment work commences. The results of the further investigation must be reported by the persons undertaking or supervising the investigation in a revised CAR & RAP, which would then supplement this interim report.

The SI works was carried out during the period between 8 June 2006 and 22 June 2006 in accordance with the endorsed CAP. This CAR & CAP is prepared in accordance with following documents:

- Annex 19 of the Technical Memorandum on Environmental Impact Assessment Process;
- Practice Note for Professional Persons (ProPECC) PN 3/94 "Contaminated Land Assessment and Remediation";
- EPD's Guidance Notes for Investigation and Remediation of Contaminated Sites of Petrol Filling Stations, Boatyards and Car Repair/Dismantling Workshops (GN); and
- Study Brief of the EIA study of the Project.

1.2 Objectives

The objectives of this report are described as follows:

- to present the works done and the analytical results of the samples collected from the from the SI works;
- to locate and identify contaminated materials on-site;
- to assess and evaluate the level and extent of contamination on-site;

- to evaluate site remediation options and recommend appropriate measures that provide for the protection of the environment consistent with the principles of waste minimisation and reduction;
- to formulate optimal mitigation and/or remedial measures for inclusion in civil works contract documents; and
- to recommend best practicable methods for the handling of any contaminated materials during all stages of the site development work.

1.3 Limitations

The findings of this study are based on the methodology described in the CAP and on representative samples positioned at/or nearby the specific locations. The results therefore are considered representative of the ground conditions in these specific locations and only provide an indication of the general conditions across the whole site area. Further contamination may be detected during redevelopment works.

In addition, as the existing coffin crematorium and skeletal cremator are still in operation. The results and findings in this report can only conclude the contamination status of the site for the current situation and where investigation has occurred.

The contamination status may be changed in future subject to current operation practice and any future accidental incident (e.g. oil spillage/leakage).

In addition, the contamination status of the site as discussed in this interim report could change depending on the results of further investigation in the currently inaccessible areas of the site, this is discussed in Section 4.4.

2 Site Investigation

2.1 Sampling Locations

According to the endorsed CAP, sampling would be carried out at the locations as shown in Table 2-1 by means of borehole.

For BH1 and BH2, the boreholes were drilled to a depth of 3.6 metres (BH1) below ground level (m.b.g.l.) and 3.0m.b.g.l. (BH2) respectively. At these depths a concrete mass was encountered at the afore-said levels. Trial pits (0.5m x 0.5m) at both boreholes were constructed to extend the visual inspection area in order to ascertain the underground condition. A concrete structure was encountered and no other information was available to enable the extent of the concrete structure and its purposes.

It was anticipated that if drilling continued, pipe-works or other structure in vicinity of the concrete structure might be impaired and ultimately the operation of the crematorium affected. Options for open excavation of the areas was explored but found impossible because such excavation would require that the access road of the crematorium was blocked.

Since the continued operation of the cremators was vital and operations could not be disturbed, no further drilling works has been carried at this stage.

No soil sample was collected from both boreholes (i.e. BH1 and BH2). However, water was encountered and samples were collected for analysis. The water encountered was perched on top of the concrete structure.

For BH3, three soil samples were collected but groundwater was not encountered.

Therefore, a total of five soil samples and two groundwater samples were collected. The sampling locations are shown in Table 2-1.

Item	Location (Depth below ground)	Sampling Depth below Ground Level	Parameters to be Analysed
Underground Fuel Tank at the existing Crematorium	BH1[1] (7m) BH2[1] (7m)	No soil sample could taken due to unknown concrete structures underground. Groundwater were encountered and collected for analysis.	TPH PAHs
Underground Fuel Tank at Skeletal Cremator Building	BH3[1] (3m below the base of the fuel tank)	2m, 3.5m and 5m (base of the fuel tank at ~1.5m)	TPH PAHs BTEX
Area impacted by Aerial Deposition from Stack Emissions	SS1 (0.1m) SS2 (0.1m)	0.1m 0.1m	Metals (Cr, Co, Ni, Cu, Zn, As, Mo, Cd, Sn, Ba, Hg, Pb) Dioxin PAHs

Table 2-1 Details of Sampling Regime

Note 1: Borehole logs of the site investigation are given in Appendix 1.

2.2 Summary of Ground Conditions

At BH1 and BH2, ground consists of sandy fill material with rock fragment to the depths of 3.6m.b.g.l. and 3.0m.b.g.l. respectively. Unknown concrete structures were encountered at these depths. Water was encountered on top of the concrete, it is not considered this water is representative of the quality of underlying groundwater.

At BH3, ground consists of silty fill material to the depth of 2m.b.g.l. and then decomposed fine grained granodiorite were found to the depth of 5.5m.b.g.l.

2.3 Further Site Investigations

As stated in the CAP, further site investigation in the areas, which are currently being used and cannot be accessed, are required. These areas include the transformer room, dangerous goods stores, day tank room, fuel pump room, sunken fuel pipe and cremator. The transformer room, which could not be accessed during previous site appraisal was accessed on 21 August 2006. Further site investigations will be carried out after the

decommissioning of the existing crematorium and skeletal cremator building. Sampling and analysis plans for these investigations should be prepared and submitted to EPD for approval prior to any of these investigation works.

Until these areas are investigated this report should be considered an interim report and a supplementary CAR and RAP should be prepared to detail the results and findings of these site investigations and recommend, as appropriate, any necessary remedial works.

It is anticipated that further site investigations will be carried out by the demolition contractor. As mentioned in Section 2.1, no soil samples were collected from BH1 and BH2 and the water encountered indicated the presence of mineral oils. Thus, sampling at these locations should also be included in the future investigation after decommissioning.

3 Contamination Assessment

3.1 Assessment Criteria

In accordance with the CAP and *ProPECC Note PN3/94*, the Dutch A, B, C Classification system is used as the assessment criteria for the interpretation of analytical results of soil and groundwater samples.

For metals, TPH and PAH, Dutch B Levels is used as the assessment criteria for soil samples. The Dutch B values are used to determine if pollution is present and further investigation is required.

It is noted that the Dutch Classification system is designed to protect a heavily utilised and shallow groundwater resource. It is considered that these values are very stringent, especially because groundwater is not used as potable water in Hong Kong.

A it is considered that alternatives such as the requirements of the Water Pollution Control Ordinance and Technical Memorandum on Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters (TM) are more suitable to ensure protection of the environment.

For dioxins in soil, 1ng/g Toxicity Equivalent (TEQ) is used as the assessment criteria[1].

3.2 Analytical Results

Soil samples were sent to Lam Laboratories for analyzes. The analytical results are given in Appendix 2.

3.2.1 Soils

Form the soil results available, see Appendix 2, no significant exceedance of the assessment criteria B was found in the soil samples collected.

The results of interest are shown in the Table 3-2 below.

[1] Preliminary Remediation Goal for residential soils, United States Environmental Protection Agency OSWER Directive 9200.4-26 “Approach for Addressing Dioxin in Soil at CERCLA and RCRA Sites”, 13 April 1998.

Parameters	BH3			SS1	SS2	Dutch B	Dutch C
	2.0m	3.5m	5.0m	0.1m	0.1m		
Cd	N/A	N/A	N/A	ND	ND	5	20
Cr	N/A	N/A	N/A	5.0	8.2	250	800
Cu	N/A	N/A	N/A	6.6	5.2	100	500
Ni	N/A	N/A	N/A	ND	0.65	100	500
Pb	N/A	N/A	N/A	72	52	150	600
Hg	N/A	N/A	N/A	0.03	0.09	2	10
As	N/A	N/A	N/A	30	22	30	50
Co	N/A	N/A	N/A	2.9	4.8	50	300
Zn	N/A	N/A	N/A	33	45	500	3000
Mo	N/A	N/A	N/A	0.96	0.88	40	200
Sn	N/A	N/A	N/A	22	4.4	50	300
Ba	N/A	N/A	N/A	18	20	400	2000
TPH	106	ND	ND	N/A	N/A	1000	5000
BTEX	ND	ND	ND	N/A	N/A	0.5 to 5	5 to 50
PAH	ND	ND	ND	ND	ND	5 to 10	50 to 100
Dioxins	N/A	N/A	N/A	0.0019	0.0030	1[4]	

Notes:

1. All units are in mg/kg except dioxins of which the unit is in ng-TEQ/g.
2. ND denotes not detected.
3. N/A denotes not applicable as no analyses of such parameter was carried out.
4. Preliminary Remediation Goal for residential soils, United States Environmental Protection Agency OSWER Directive 9200.4-26 “Approach for Addressing Dioxin in Soil at CERCLA and RCRA Sites”, 13 April 1998.

Table 3-2 Summary of Analytical Results for Soil Samples

3.2.2 Waters

Water was detected at boreholes 1 and 2. The borehole logs and site reports show that the water was detected above the concrete slabs. It is considered that the water is likely to be perched on the concrete and based on current information is not in continuity with the underlying geology. This is dependent on the thickness and extent of the slab and any migration of the water. This information is unknown.

Parameters	SS1	SS2	Dutch B	Dutch C
TPH	183	661	200	600
PAH	ND	ND	1 to 20	5 to 60

Notes:

1. All units are in µg/L.
2. ND denotes not detected.

Table 3-3 Summary of Analytical Results for Groundwater Samples

The TPH concentrations in groundwater samples of BH2 (661 µg/L) exceed the Dutch C level for mineral oils. The presence of the longer hydrogen chains indicates fuel oils rather that gasoline, hence the Dutch value chosen for assessment.

PAH was not detected in the groundwater samples.

The water detected on top of the concrete slab indicates some leakage or spillage of fuel has occurred at the site. The water is not considered to be indicative of the quality of any underlying groundwater because the samples were not taken from the natural strata. There is no evidence to indicate whether or not the water has migrated along the top of the slab and migrated into the underlying geology.

Until further information on the extent of any contaminated water a suitable remedial option would be hard to specify.

3.3 Nature and extent of Contamination

No soil samples were collected from BH1 and BH2 or the surrounding area, however the presence of contaminated water would indicate that there is potential for the soils to be contaminated with hydrocarbons.

As mentioned in Section 2.3, further soil sampling works is required in the area to evaluate the level and extent of contamination around this area. Excavation of the soils around BH1 and BH2 to determine the length and extent of the concrete slab and the contaminated water is required.

Boreholes need to be drilled to determine whether the water found has impacted the natural geology and any underlying groundwater.

No significant contamination is found in the surface soil samples (SS1 and SS2). This reveals that no contamination was caused by the aerial deposition from the stack emission of the existing crematorium.

No contamination was found around the underground fuel tank next to the skeletal cremator building. However, contamination could exist under the building if leakage has occurred in this direction.

For other areas where soil sampling could not be undertaken at this stage, nature of contamination should be evaluated through the further site investigation works.

4 Remediation Action Plan

4.1 Approach

Although soil contamination is not confirmed at this stage, contaminated groundwater found indicates that soil in the vicinity of the underground fuel tanks at the existing crematorium is potentially contaminated by TPH. Moreover, further soil sampling at BH1 and BH2, transformer room, dangerous goods stores, day tank room, fuel pump room and sunken fuel pipe after decommissioning of the crematorium will be carried out to identify any contamination at these areas. If contamination is found, suitable site remediation measures should be implemented to ensure the following:

- safe redevelopment of the site;
- safe occupation of the site and;
- the redeveloped site does not present significant impact on the environment.

Determination of the remediation level required and the optimal site remedial option involves consideration of technical and economic aspects. General considerations which should be taken into account include:

- the end use of the site;
- the construction activities to be undertaken;
- engineering feasibility;
- economics;
- health and safety;
- environmental impact and;
- current and future standard codes of practice.

The remediation works to be adopted should be cost-effective, practical and should provide a safe environment for the site users.

4.2 Remediation Options

Soil samples could not be collected in some of the identified areas of where sources of contamination are present. However, it could be anticipated that the soils within the project site would only be contaminated by organics (TPH, PAHs and PCBs) at various areas. The following remediation options may be considered as appropriate:

- Bioremediation
- Cement Stabilization

- Excavation and disposal to landfill
- In-situ containment

A comparison of the above remediation options is summarized in Table 4.1 and they are briefly discussed below.

Bioremediation

Bioremediation is a treatment technology based on the degradation of organic substances in the contaminated soil by micro-organisms. Bioremediation can degrade a wide range of organics, however, it takes a relatively longer time for this process than for some of the alternatives.

Cement Stabilization

For cement based stabilisation waste materials are mixed with cement followed by hydration to form a crystalline structure consisting of calcium alumino-silicate. This results in a rock like, monolithic, hardened mass. Cement based stabilisation is considered best suited to inorganic contaminants (e.g. metals). As a result of the high pH of the cement, the metals are retained in the form of insoluble hydroxide or carbonate salts within the hardened structure.

There are a number of advantages of cement based stabilisation. The technology of cement is well known including handling, mixing, setting and hardening. Cement is widely employed in the construction industry and hence the material costs are relatively low.

In-situ Containment

In-situ containment is a technology to isolate the contaminated soil from the surrounding environment and applicable for most contaminants. However, it cannot destroy the contaminants in the soil.

Excavation and Landfilling

For excavation and landfilling, all contaminated soil can be removed immediately. This option requires a relatively shorter time in comparison with the other options. However, this method transfers much of the burden to landfills which are scarce as area valuable resource. Hence, this option would only normally be considered if the quantity of contaminated material requiring landfilling is small.

Remediation Option	Potential Application	Basic Technology	Remediation Time Required	Limitation / Comments	Remediation Cost
Excavation / Landfill Disposal	Removal of small volume of contaminated soil, Suitable for implementation during reconstruction, One-time removal, Addresses all contaminants	Process involves physical removal of contaminated soil	Days to weeks	Large volume of soil will burden landfill and may not be acceptable to Contend Authority	Low for small volume
Bioremediation	Cost effective for large volumes of contaminated materials, Degrade a wide range of organics, Suitable for widespread contamination	Natural or enhanced biodegradation by added bacteria to break down the contaminant in the soil or to convert them into harmless substances	Several months to years	Labour intensive, Requires considerable maintenance	Low, however the land development is delayed
Cement stabilization	Mainly applies to the remediation of land contaminated with heavy metals	Solidification / stabilization treatment process, to decrease the mobility of the waste constituents	Weeks to months	Bench-scale treatability studies should be performed prior to a field/full-scale treatment	Low to moderate
In-situ Containment	Used to prevent contaminant migration, Applicable to most chemicals	Isolating contaminated soils from the surrounding environment by use of slurry walls, grout curtains, sheet piles, surface cap	1-6 months	Does not destroy contaminants, only prevents migration	Low

Table 4-4 Remediation Options

4.3 Remediation Plan

According to the findings of site appraisal, there is no historical evidence showing that there were any landuses prior to the operation of the existing crematorium that could have caused contamination. In addition, based on the information available it is considered that soil contamination is unlikely at most of the areas, except those near the underground fuel tanks, vegetated areas and transformer room, within the site.

Although further site investigation is required to confirm the status of contamination on-site, it is not anticipated, based on current information, that widespread of soil contamination across the site would be present. Thus, a large amount of contaminated soil is not anticipated and the disposal of contaminated soil to landfills is considered as an economic and

acceptable remedial option. If a large amount of contaminated soil (say 3,000m^3) is found from the further site investigation after the decommissioning of the crematorium, remediation options such as bioremediation for organics should be considered as appropriate.

If disposal of to landfills is chosen as the remediation, the criteria set primarily of Toxicity Characteristic Leaching Procedure (TCLP) limits as stated in Annex E in the GN should be met. At least three soil samples should be taken from the most contaminated area(s) and tested for TCLP for a full suite of parameters (16 metals) as stated in Table E1 in Annex E in the GN. If the testing result shows that any of the aforesaid TCLP limits cannot be met, the soil should be treated by cement stabilization and further tested for TCLP for landfill disposal or treated as chemical waste and disposed of at the Chemical Waste Treatment Center (CWTC).

Groundwater collected from BH1 and BH2 has been shown to be principally contaminated with petroleum hydrocarbons. It is recommended that excavation works in this area be undertaken in order to determine the extent of the contaminated water. Appropriate health and safety measures for workers must be employed. Should volumes of contaminated water encountered be considerable then the use of on-site oil interceptors for removal of any free phase hydrocarbons is recommended for all groundwater arising from the foundation works. The recovered oil should be treated as a chemical waste and disposed of to CWTC.

It should be noted that all the soil treated as a chemical waste should be collected by a registered chemical waste contractor and the Waste Disposal (Chemical Waste) Regulations under the Waste Disposal Ordinance (Cap.354) should be observed. Reference should be made to A Guide to the Registration of Chemical Waste Producers and Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes issued by the EPD.

The treated groundwater could be discharged into the drainage systems nearby the site. The discharged groundwater should comply with the effluent standards as stipulated in the TM. In order to ensure the discharged groundwater comply with the effluent standards of the TM, effluent discharge monitoring should be carried out. The monitoring parameters and frequency should be subject to the discharge license of the site issued by the EPD. In the event of any non-compliance, treatment for a specific pollutant(s) causing the non-compliance will be required to achieve full compliance.

The Contractor will be responsible for implementing the oil interceptor as a minimum treatment during the excavation of contaminated soils. Furthermore, the Contractor is required to undertake monitoring for compliance with the TM governing wastewater discharge. Results from the discharged groundwater monitoring programme should be submitted to EPD for record.

Residual materials inside the cremators, flues and chimneys should be properly handled and disposed of. Details will be discussed in the waste management section in the EIA report.

4.3.1 Confirmatory Soil Sampling

In order to confirm the extent of the soil contamination and all the contaminated soil is removed or treated, confirmatory soil sampling should be carried out during the remediation works. It will consist of five to six samples in each of the location of where soil contamination is identified from site investigation works. The locations will be located to the north, south, east and west of the location where contaminated soil is found. Two locations should also be located above and below the location where contaminated soil is found. If analytical results are above the Dutch B Levels, the contamination area should be extended and further confirmatory sampling should be carried out until no further contamination is encountered.

4.4 Future Site Investigation

As mentioned in Section 2.3, CAP recommended further site investigations in areas where are currently in use and currently cannot be accessed is required. These areas include the transformer room, dangerous goods stores, day tank room, fuel pump room, sunken fuel pipe and cremator.

As no sample was collected from BH1 and BH2, sampling at these locations should also be included in the future investigation works. Boreholes may be required if excavation works indicate the contaminated water encountered has entered the natural strata. Groundwater samples from BH1 and BH2 should be collected and analyzed during further site investigation to confirm any contamination of groundwater in the natural strata and to develop suitable remedial option and necessary groundwater treatment.

Inspection of the transformer room was carried out on 21 August 2006. It was observed that there is one transformer inside the room and one electrical panel as shown in Appendix 3. A gap was found between the transformer and the concrete floor slab. As advised by China Light & Power (CLP), the transformer is an oil type transformer. However, no oil stain on the floor was observed. Moreover, there is no observable crack on the concrete floor slab. Thus, it is considered that the potential of soil contamination due to the operation of the transformer is unlikely. Nevertheless, further site investigation at the transformer room should be carried out as recommended in CAP.

Potential contaminants in the soils have been identified in CAP. Thus the parameters to be analyzed for the soils at different locations are summarised in Table 4-3.

Location	Parameters
Existing Crematorium	
Underground fuel tank (BH1 and BH2)	• Petroleum hydrocarbons • PAHs
Dangerous goods store	• Petroleum hydrocarbons • PAHs
Daily tank room, fuel pump room and sunken fuel pipe	• Petroleum hydrocarbons • PAHs
Cremators (residual inside the cremator, flue and chimneys)	• PAHs • Dioxins • Metals (Cr, Co, Ni, Cu, Zn, As, Mo, Cd, Sn, Ba, Hg, Pb)
Transformer room	• PCBs
Skeletal Cremator Building	
Dangerous goods store	• Petroleum hydrocarbons • PAHs
Cremator (residual inside the cremator, flue and chimneys)	• PAHs • Dioxins • Metals (Cr, Co, Ni, Cu, Zn, As, Mo, Cd, Sn, Ba, Hg, Pb)

Table 4-5 Testing Parameters for Further Site Investigation

The further site investigations will be carried out after the decommissioning of the existing crematorium and skeletal cremator building. Sampling and analysis plans for these investigations should be prepared and submitted to EPD for approval prior to any of these investigation works.

In order to update this interim report, supplementary CAR and RAP should be prepared to detail the results and findings of these site investigations and, if any, necessary remedial works. It is currently envisaged that further site investigations will be the responsibility of the demolition contractor.

The underground fuel tanks will be removed during the demolition phase of the Project. After removal of the underground fuel tank, soil underneath the tank should be inspected by experienced specialist in order to determine whether there is any visual or olfactory evidence of contamination due to fuel leakage. If contamination is likely, further sample(s) should be collected from the soil underneath the tank and the sample(s) should be tested for TPH.

4.5 General Site Remediation and Control Measures

Apart from the above-mentioned remediation proposal, site remediation and control measures should include the following:

1 On-site stockpiling of the contaminated materials should be avoided. However, if stockpiling is required, contaminated/potentially contaminated materials should be stockpiled in designated concrete paved area(s) with fencing and warning sign(s). The designated area is the place where unauthorised site workers and the public cannot gain access. The stockpiles should be covered with tarpaulins or similar weatherproof fabric to prevent surface erosion.

2 Any contaminated water encountered must be disposed of in and correct and safe manner. Large volumes may require the use of on site interceptors.

3 Regular watering or application of binding agent is necessary to suppress the generation of dust during the redevelopment works (e.g. once every 2 hours in normal conditions and hourly in dry/windy conditions).

4 Mitigation measures should be in place during site works to contain run-off and ensure that water discharges via appropriate drainage routes.

5 All surface run-off should be diverted to pass through silt/sand traps.

6 Wheel washing facilities should be provided at the site exit to avoid material deposited on public roads.

7 Vehicles used for transporting materials/spoils should be covered with tarpaulin or similar material. The cover shall extend over the edges of the sides and tail boards.

4.6 Site Health and Safety

General health and safety precautions for all personnel entering or working on the site are listed below. This can be applied during the removal of the fuel tanks and throughout the construction phase of the development.

- No food or drink shall be consumed whilst on site;
- Direct skin contact with the excavated material should be avoided;
- Basic hygiene shall be observed and hand wash basins should be provided accessible to all workers.

Dust control measures shall be employed during earth moving to avoid dust inhalation. Water sprays and suitable face masks for workers should be provided.

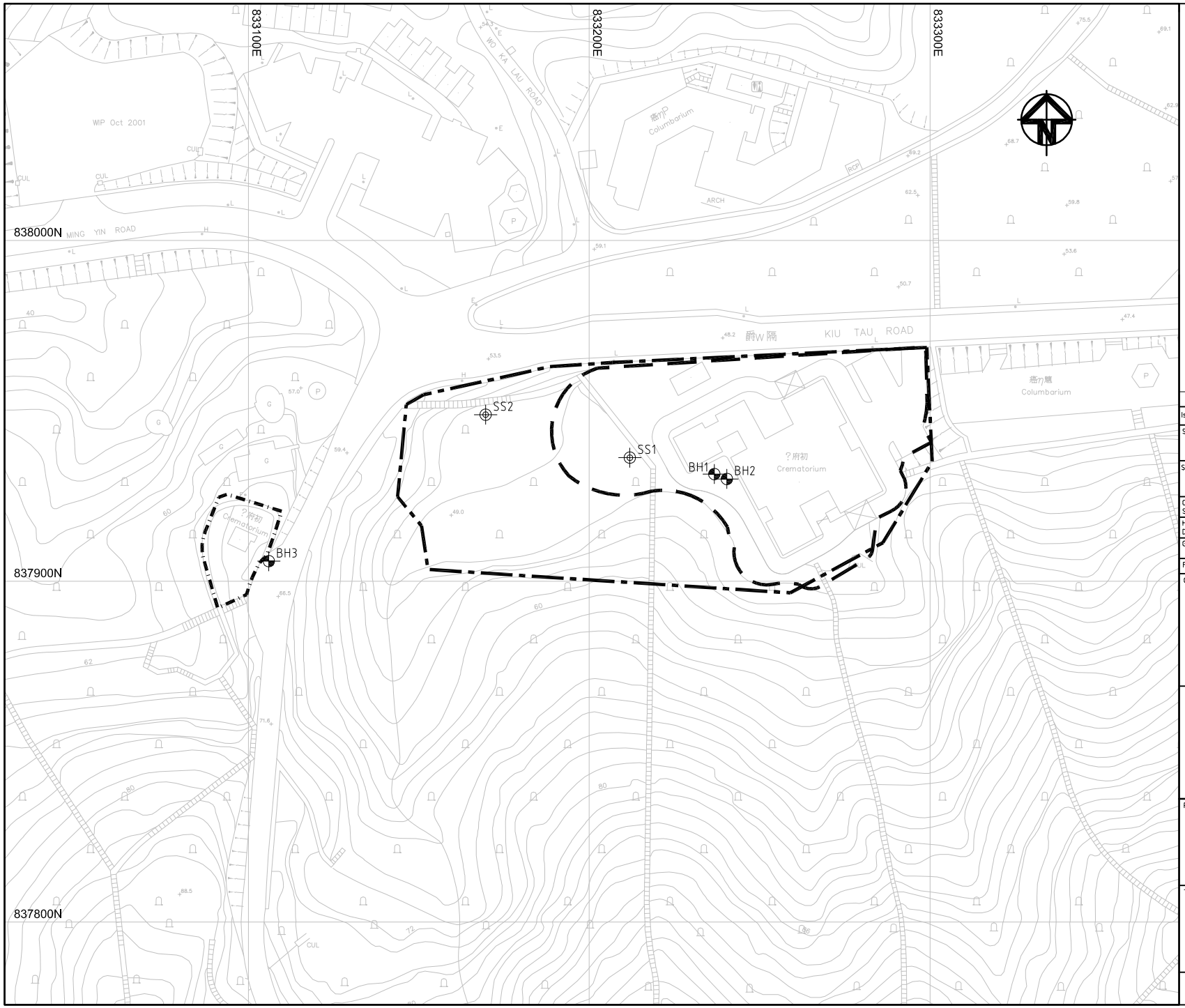
Potential contaminants including Petroleum Hydrocarbons and PAHs may arise during the site works. Implementation of “standard” civil engineering precautionary techniques will ensure that direct contact by the site workers

should be avoided. The provision of the personnel protective equipment as listed below should be made available in the event that contamination is found:

- Protective footwear;
- Gloves;
- Dust masks; and
- Overalls.

4.7 Remediation Report

The remediation strategy may be changed and updated subject to information obtained from the further site investigation. A Remediation Report should be submitted to EPD within one month after the completion remediation works. The Remediation Report should include details of the remediation works including excavation or treatment, confirmatory sampling and landfill/chemical waste disposal records to demonstrate the remediation works has been carried out in accordance with this RAP and supplementary RAP.



LEGEND :

- SITE BOUNDARY OF NEW CREMATORIUM
- EXISTING SITE BOUNDARY OF COFFIN CREMATORIUM
- SITE BOUNDARY OF SKELETAL CREMATOR BUILDING
- BH1 DRILLHOLE
- SS1 SURFACE SAMPLE

Issue	Description	Date
01	FIRST ISSUE	18AUG06

Status: PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

Scales	1 : 1500	Current Issue Signatures
		Author G. Ho
Original Size	A4	Checker C. NG
Height Datum	DATUM	Approver C. NG
Grid	GRID	© Copyright reserved

Filename: FIG_2-1 BIND.DWG

Client: ARCHITECTURAL SERVICES DEPARTMENT

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Project: PROVISION OF CREMATORS AT WO HOP SHEK CREMATORIUM

Title: SAMPLING LOCATION

Drawing No.	Issue
2.1	–

50mm on Original

11/Sep/2007 9:57 AM K:\EA01256 Wo Hop Shek\E-OurDrawings\Issue\2006-08-18 Sampling Location\FIG_2-1 Bind.dwg V1

Appendix 1

Borehole Logs

DRILLHOLE RECORD

DRILLHOLE No. **BH1**

SHEET 1 of 1

JOB TITLE **Provision of Cremators at Wo Hop Shek Crematorium**

METHOD **IP+W+RC**	CO-ORDINATES E **833236.71** N **837931.44**	PROJECT No. **LG26012**
MACHINE & No. **Toho, D61**		DATE from **21/06/2006** to **21/06/2006**
FLUSHING MEDIUM **Water**	ORIENTATION **Vertical**	GROUND LEVEL **+ 48.76** mPD

Drilling Progress	Casing Depth/Size	Water Depth (m)	Water Recovery %	Total Core Recovery %	Solid Core Recovery %	R.Q.D.	Fracture Index	Tests	Samples No.	Type	Depth	Reduced Level	Depth (m)	Legend	Grade	Description
21/06/2006	Hw								1	INSPECTION PIT	0.50	48.76	0.00			Yellowish brown, clayey silty fine to coarse SAND with some angular fine to coarse gravel sized moderately strong rock fragments (FILL)
									2		1.00					
									3		1.50	47.26	1.50			
			0													Wash drilling
									4	▲	3.00					
21/06/2006	Hw 3.60	1.50m at 18:00		100						Hw	3.48 3.60	45.28 45.16	3.48 3.60			Grey, CONCRETE
																End of investigation hole at 3.60m
													10.00			

- Small Disturbed Sample
- ▲ Water Sample
- SPT Liner Sample
- U76 Undisturbed Sample
- U100 Undisturbed Sample
- Mazier Sample
- Piston Sample
- Packer Test
- Piezometer / Standpipe Tip
- Standard Penetration Test
- Pressuremeter Test
- Permeability Test
- Impression Packer / Televiewer Test
- In-situ Vane Shear Test

LOGGED H.K.Fung

DATE 24/06/2006

CHECKED I.S.McGlen

DATE 28/06/2006

REMARKS

1. Inspection pit excavated to 1.50m depth.
2. No environmental soil samples.
3. Environmental groundwater sample taken at 3.00m depth.

DRILLHOLE RECORD

DRILLHOLE No. **BH2**

SHEET **1** of **1**

JOB TITLE **Provision of Cremators at Wo Hop Shek Crematorium**

METHOD **IP+W+RC**	CO-ORDINATES E **833240.39** N **837930.00**	PROJECT No. **LG26012**
MACHINE & No. **Toho, D61**		DATE from **10/06/2006** to **10/06/2006**
FLUSHING MEDIUM **Water**	ORIENTATION **Vertical**	GROUND LEVEL **+ 48.76** mPD

Drilling Progress	Casing Depth/Size	Water Depth (m)	Water Recovery %	Total Core Recovery %	Solid Core Recovery %	R.Q.D.	Fracture Index	Tests	Samples No.	Type	Depth	Reduced Level	Depth (m)	Legend	Grade	Description
10/06/2006	Pw								1		0.50	48.76	0.00			Light greyish brown, clayey silty fine to coarse SAND with some angular fine to coarse gravel sized moderately strong rock fragments (FILL)
									2	INSPECTION PIT	1.00					
			0						3		1.50	47.26	1.50			
	Pw 2.00 Hw															Wash drilling
									4	▲	2.50					
10/06/2006	Hw 3.00	Dry at 18:00		100							2.96 3.00	45.80 45.76	2.96 3.00			Grey, CONCRETE End of investigation hole at 3.00m
													10.00			

- Small Disturbed Sample
- Water Sample
- SPT Liner Sample
- U76 Undisturbed Sample
- U100 Undisturbed Sample
- Mazier Sample
- Piston Sample
- Packer Test
- Piezometer / Standpipe Tip
- Standard Penetration Test
- Pressuremeter Test
- Permeability Test
- Impression Packer / Televiewer Test
- In-situ Vane Shear Test

LOGGED **H.K.Fung**

DATE **24/06/2006**

CHECKED **I.S.McGlen**

DATE **28/06/2006**

REMARKS

1. Inspection pit excavated to 1.50m depth.
2. No environmental soil samples.
3. Environmental groundwater sample taken at 2.50m depth (taken from trial pit TP-BH2).

DRILLHOLE RECORD

DRILLHOLE No. **BH3**

SHEET 1 of 1

JOB TITLE **Provision of Cremators at Wo Hop Shek Crematorium**

METHOD **IP+W+RC**	CO-ORDINATES E **833105.98** N **837905.86**	PROJECT No. **LG26012**
MACHINE & No. **Toho, D61**		DATE from **08/06/2006** to **09/06/2006**
FLUSHING MEDIUM **Water**	ORIENTATION **Vertical**	GROUND LEVEL **+ 65.32** mPD

Drilling Progress	Casing Depth/Size	Water Depth (m)	Water Recovery %	Total Core Recovery %	Solid Core Recovery %	R.Q.D.	Fracture Index	Tests	Samples No.	Type	Depth	Reduced Level	Depth (m)	Legend	Grade	Description
08/06/2006	Hw											65.32	0.00			Firm, brownish yellow, slightly sandy clayey SILT (FILL)
		Dry at 18:00							1		0.50					
									2		1.00					
									3		1.50					
08/06/2006									4		2.00	63.32	2.00			
09/06/2006		Dry at 08:00		89				33 bls	5						V	Extremely weak, purplish red spotted white, completely decomposed fine grained GRANODIORITE (Stiff, slightly clayey SILT)
			0						6		2.40					
				89				59 bls	7		3.50					
									8		3.90 3.95					
												60.32	5.00			
				89				66 bls	9		5.00				V	Extremely weak, yellow, completely decomposed fine grained GRANODIORITE (Stiff, slightly clayey SILT)
09/06/2006	Hw 5.45	Dry at 18:00							10		5.40 5.45	59.87	5.45			End of investigation hole at 5.45m
													10.00			

INSPECTION PIT

- Small Disturbed Sample
- Water Sample
- SPT Liner Sample
- U76 Undisturbed Sample
- U100 Undisturbed Sample
- Mazier Sample
- Piston Sample
- Packer Test
- Piezometer / Standpipe Tip
- Standard Penetration Test
- Pressuremeter Test
- Permeability Test
- Impression Packer / Televiewer Test
- In-situ Vane Shear Test

LOGGED H.K.Fung

DATE 24/06/2006

CHECKED I.S.McGlen

DATE 28/06/2006

REMARKS

1. Inspection pit excavated to 2.00m depth.
2. Environmental soil samples taken at 2.00m, 3.50m and 5.00m depths.
3. No environmental groundwater sample.

Appendix 2

Analytical Results

Provision of Cremators at Wo Hop Shek Crematorium

Summary Analytical Results of Site Investigation

Soil

Location	Sampling Depths (m)	Metals											
		Cadmium (Cd)	Chromium (Cr)	Copper (Cu)	Nickel (Ni)	Lead (Pb)	Mercury (Hg)	Arsenic (As)	Cobalt (Co)	Zinc (Zn)	Molybdenum (Mo)	Tin (Sn)	Barium (Ba)
		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Reporting Limit		0.2	0.5	0.5	0.5	0.5	0.02	0.5	0.5	0.5	0.5	0.5	0.5
SS1	0.1	<0.20	5.0	6.6	<0.50	72	0.03	30	2.9	33	0.96	22	18
SS2	0.1	<0.20	8.2	5.2	0.65	52	0.09	22	4.8	45	0.88	4.4	20

Location	Sampling Depths (m)	Total Petroleum Hydrocarbon			
		C6-C9	C10-C14	C15-C28	C29-C36
		mg/kg	mg/kg	mg/kg	mg/kg
Reporting Limit		2	50	100	100
	2.0	<2	<50	106	<100
	3.5	<2	<50	<100	<100
BH3	5.0	<2	<50	<100	<100

Location	Sampling Depths (m)	BTEX				
		Benzene	Toluene	Ethyl benzene	m-, p-Xylenes	o-Xylene
		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Reporting Limit		0.2	0.2	0.2	0.4	0.2
	2.0	<0.2	<0.2	<0.2	<0.4	<0.2
	3.5	<0.2	<0.2	<0.2	<0.4	<0.2
BH3	5.0	<0.2	<0.2	<0.2	<0.4	<0.2

Location	Sampling Depths (m)	Polyaromatic Hydrocarbons													
		Naphthalene	Acenaphthylene	Acenaphtene	Fluorene	Phenanthrene	Anthraoene	Pyrene	Benzo(a)anthracene	Chrysene	Benzo(a)pyrene	Indeno(1,2,3-cd)pyrene	Dibenz(ah)anthracene	Benzo(ghi)perylene	Benzo(b&k)fluoranthene
		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Reporting Limit		0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1.0
	2.0	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1.0
	3.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1.0
BH3	5.0	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1.0
SS1	0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1.0
SS2	0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1.0

Location	Sampling Depths (m)	Dioxins																	
		2,3,7,8-Tetrachlorodibenzo-p-Dioxin	1,2,3,7,8-Pentachlorodibenzo-p-Dioxin	1,2,3,4,7,8-Hexachlorodibenzo-p-Dioxin	1,2,3,6,7,8-Hexachlorodibenzo-p-Dioxin	1,2,3,7,8,9-Hexachlorodibenzo-p-Dioxin	1,2,3,4,6,7,8-Heptachlorodibenzo-p-Dioxin	1,2,3,4,5,6,7,8-Octachlorodibenzo-p-Dioxin	2,3,7,8-Tetrachlorodibenzo furan	1,2,3,7,8-Pentachlorodibenzofuran	2,3,4,7,8-Pentachlorodibenzofuran	1,2,3,4,7,8-Hexachlorodibenzofuran	1,2,3,6,7,8-Hexachlorodibenzofuran	1,2,3,7,8,9-Hexachlorodibenzofuran	2,3,4,6,7,8-Hexachlorodibenzofuran	1,2,3,4,6,7,8-Heptachlorodibenzofuran	1,2,3,4,7,8,9-Heptachlorodibenzofuran	1,2,3,4,5,6,7,8-Octachlorodibenzofuran	
		ng/kg	ng/kg	ng/kg	ng/kg	ng/kg	ng/kg	ng/kg	ng/kg	ng/kg	ng/kg	ng/kg	ng/kg	ng/kg	ng/kg	ng/kg	ng/kg	ng/kg	
Reporting Limit		0.2	0.3	0.5	0.5	0.5	0.7	1	0.2	0.3	0.3	0.5	0.5	0.5	0.5	0.7	0.7	1	
SS1	0.1	ND	ND	ND	ND	ND	7.2	1800	ND	ND	ND	ND	ND	ND	ND	1.1	ND	ND	
SS2	0.1	ND	0.40	0.70	1.0	1.0	19	780	ND	2.1	1.2	3.7	2.2	ND	1.7	10	1.4	6.4	
TEFs		1	0.5	0.1	0.1	0.1	0.01	0.001	0.1	0.05	0.5	0.1	0.1	0.1	0.1	0.01	0.01	0.001	Total
SS1	Individual TEQs	0	0	0	0	0	0.000072	0.0018	0	0	0	0	0	0	0	0.000011	0	0	**0.0019** ng-TEQ/g
SS2		0	0.0002	0.00007	0.0001	0.0001	0.00019	0.00078	0	0.000105	0.0006	0.00037	0.00022	0	0.00017	0.0001	0.000014	0.0000064	**0.0030** ng-TEQ/g

Groundwater

Location	Sampling Depths (m)	Total Petroleum Hydrocarbon			
		C6-C9	C10-C14	C15-C28	C29-C36
		ug/L	ug/L	ug/L	ug/L
Reporting Limit		20	25	25	25
BH1	0.1	<20	55	128	<50
TP-BH2	0.1	**<20**	**215**	**446**	**<50**

Location	Sampling Depths (m)	Polyaromatic Hydrocarbons													
		Naphthalene	Acenaphthylene	Acenaphtene	Fluorene	Phenanthrene	Anthraoene	Pyrene	Benzo(a)anthracene	Chrysene	Benzo(a)pyrene	Indeno(1,2,3-cd)pyrene	Dibenz(ah)anthracene	Benzo(ghi)perylene	Benzo(b&k)fluoranthene
		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Reporting Limit		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2
BH1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2
TP-BH2	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2

Notes:
Shaded cell indicates Dutch B Level was exceeded.
Shaded cell and bold value indicate Dutch C Level was exceeded.

Appendix 3

Photos of Transformer Room

Photo 1 Transformer inside Transfomer Room

Photo 2 Electrical Panel inside Transformer Room