Planning Department and Civil Engineering and Development Department

Agreement No. CE 35/2012 (CE) Planning and Engineering Study for Housing Sites in Yuen Long South - Investigation

Contamination Assessment Plan

228228

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1 Introduction

1.1 Background

1.1.1.1 With the growing concern on the delivery of housing, the 2011-12 Policy Address announced the review of agricultural land in North District and Yuen Long, currently used mainly for industrial purposes, temporary storage or deserted, for housing development is one of the measures for long-term land supply. The 2013 Policy Address states that the review of such land in the North District and Yuen Long is one of the measures for increasing long-term land supply for housing development.

1.1.1.2 Being located in proximity to Yuen Long, Tuen Mun and Tin Shui Wai new towns, and the proposed new development area (NDA) in Hung Shui Kiu (HSK), the Yuen Long South (YLS) area is connected with the urban areas by strategic road links, including Route 3 and Yuen Long Highway.

1.1.1.3 The area south of Yuen Long New Town to be reviewed is bounded by Yuen Long Highway, Kung Um Road and Tai Lam Country Park. The tentative Potential Development Areas (PDAs) of YLS include the Tong Yan San Tsuen (TYST) area and a piece of land zoned "Undetermined" ("U") located to the west of Kung Um Road/Kiu Hing Road as well as two pieces of land zoned "Other Specified Uses" annotated "Rural Use" ("OU(RU)") in Tai Tong area located to the east of Kung Um Road/Kiu Hing Road (i.e. the YLS area).

1.1.1.4 The extent of the PDAs has subsequently been subject to a comprehensive review. To support the development proposals, the Study has proposed infrastructure works to be carried out outside the PDAs, including improvements to TYST Interchange and Tin Shui Wai (TSW) West Interchange, slip roads along Yuen Long Highway, extension of the existing water service reservoir or provision of an additional treat sewage effluent reservoir, as well partial decking of the Yuen Long Nullah.

1.1.1.5 The YLS area is generally rural in character with a mixture of land uses including open storage yards, warehouses, workshops, industrial operations, villages and residential settlements, agricultural land and unused land. Proliferation of open storage yards, warehouses and industrial workshops has resulted in degradation of the rural environment. There is a need to better utilise the degraded brownfield land occupied by open storage yards, warehouses, workshops, industrial operations for beneficial uses and optimise the development potential to meet the territory's needs, and to improve the local living environment with infrastructure.

1.2 The Study

1.2.1.1 Planning Department (PlanD) and Civil Engineering and Development Department (CEDD) of the HKSAR commissioned Ove Arup & Partners Hong Kong Ltd. (Arup) in November 2012 to undertake the Planning and Engineering Study for Housing Sites in YLS – Investigation (the Study). The 30-month Study will examine the future land use, optimise the development potential, and ascertain the feasibility for public and private housing developments in the YLS area. Specifically, the Study will:

- examine and identify sites within the YLS PDAs for public and private housing developments, supporting Government, Institution or Community (G/IC) facilities, open space and/or amenities and other uses, and review the boundaries of the PDAs;
- recommend appropriate development parameters for the development sites;
- ascertain the feasibility and acceptability of the Study proposals in terms of traffic and other infrastructure capacities, urban design, environment, air ventilation, etc.;
- identify and propose the engineering infrastructure works that are needed to support the Study proposals; and
- undertake a three-stage Community Engagement (CE) Programme to solicit public views on the Study proposals within the PDAs as input to this Study.

1.2.1.2 The findings and recommendations of the Study will serve as a reference for the revision of the TYST Outline Zoning Plan (OZP) and Tai Tong OZP and the prevailing OZPs that will be affected by the development proposals to guide the Developments and engineering infrastructure upgrading works identified.

1.3 Purpose of this Report

1.3.1.1 According to the EIA Study Brief (EIA SB No.: ESB-246/2012) Section 3.4.9.2, a detailed Land Contamination Study for the project shall be conducted. A Contamination Assessment Plan (CAP) shall be prepared and submitted to the Environmental Protection Department (EPD) for endorsement prior to conducting contamination assessments of the Site for the proposed developments.

1.3.1.2 The purpose of this CAP is to provide information and guidance to characterise land contamination and identify where any contamination is or may be present during the construction and operation of the Assessment Area. The objectives of this CAP are:

- To provide an account of the land use and relevant past land use history in relation to possible land contamination;

- To identify areas of potential contamination and the associated impacts, risks or hazards; and
- To identify the contaminant of concern and scoping of requirements for sampling and laboratory testing of soil and groundwater sampling.

1.4 The Contamination Assessment Area

1.4.1.1 Land Contamination Assessment Area (hereafter called Assessment Area) consists of three main parts within the PDAs and seven parts for the proposed supporting infrastructure (refer to **Section 1.1.1.4**) as described below and indicated in **Figure 1.1**.

1.4.1.2 The Assessment Area (Within PDAs) consists of three parts which are referred to as "Area 1", "Area 2" and "Area 3" in this report, as described below:

- Area 1: the area to the western side that includes Tong Yan San Tsuen;
- Area 2: the area either side of the northern section of Kung Um Road; and
- Area 3: the area either side of the southern section of Kung Um Road.

1.4.1.3 The extent of the Assessment Area (Within the PDAs) is shown in **Figures 1.2**, **1.2a**, **1.2b** and **1.2c**.

1.4.1.4 The Assessment Area (Supporting Infrastructure) consists of seven parts referred to as "Supporting Infrastructure 1", "Supporting Infrastructure 2", "Supporting Infrastructure 3", "Supporting Infrastructure 4", "Supporting Infrastructure 5", "Supporting Infrastructure 6" and "Supporting Infrastructure 7" as described below:

- Supporting Infrastructure 1: the area along Yuen Long Highway from Pok Oi Interchange to the section of Kung Um Road near the north east boundary of Area 2;
- Supporting Infrastructure 2: the area includes Tong Yan San Tsuen Interchange;
- Supporting Infrastructure 3: the area includes Tin Shui Wai West Interchange;
- Supporting Infrastructure 4: the area includes Tan Kwai Tsuen area and in the vicinity of the Fresh Water Service Reservoirs;
- Supporting Infrastructure 5: the area along the nullah of the southern part Kui Hing Road, west of Tai Tong;
- Supporting Infrastructure 6: the 2 areas immediately adjacent to the west of Area 2 and the area immediately adjacent to the east of Area 3; and

- Supporting Infrastructure 7: Section of new sewer along Hung Tin Road, Ping Ha Road, Tin Ha Road and Ha Tsuen Road to the north of Castle Peak Road.

1.4.1.5 As part of the Study, a new sewer from YLS STW to the existing inlet chamber of the NWNT effluent tunnel at San Wai for discharging to Urmston Road submarine outfall will be installed, which will run along the planned roads within the YLS PDA and existing roads outside the PDA including Hung Tin Road, Ping Ha Road, Tin Ha Road and Ha Tsuen Road.

1.4.1.6 The section of sewer along Hung Tin Road, Ping Ha Road, Tin Ha Road and Ha Tsuen Road to the north of Castle Peak Road (Supporting Infrastructure 7) has been covered in the assessment area of the approved EIA of Hung Shui Kiu New Development Area (AEIAR-203/2016) (see **Figure 1.1** for details). According to Section 1.2 and Figure 1.3 of the CAP in Appendix 8.1 of the HSK EIA, the land contamination assessment area comprises the respective Project Area in Hung Shui Kiu and Ha Tsuen, which included the proposed sewer section to the north of Castle Peak Road under the current YLS EIA. According to the land contamination assessment results of HSK CAP, no land contamination potential was identified along this section of new sewer. Land contamination impact is thus not anticipated and hence it is not further discussed in this CAP. While for the potential of land contamination along the remaining section of sewer within the assessment area of YLS PDA and supporting infrastructure (i.e. Supporting Infrastructure 3 bounded by Castle Peak Road), it will be assessed in the latter sections of this CAP.

1.4.1.7 In addition, the assessment area of supporting infrastructure (i.e. Supporting Infrastructure 6) comprises of the 2 areas immediately adjacent to the west of Area 2 and the area immediately adjacent to the east of Area 3. Although these discrete areas are located outside the PDA boundary, they are connected to Area 2 and Area 3, and wherever the potentially contaminated sites, if identified, lying on the PDA boundary will be described in the context of the respective PDAs. As such desktop review as well as the identification of potentially contaminated land uses conducted for Supporting Infrastructure 6 in the subsequent sections should be referred to that for Area 2 and Area 3 accordingly.

1.4.1.8 The extent of the Assessment Area (Supporting Infrastructure) is shown in **Figures 1.3**, **1.3a**, **1.3b, 1.3c, 1.3d and 1.3e**.

1.4.1.9 In terms of size of the PDAs, Area 1 covers about 98 hectares while Area 2 and Area 3 cover about 60 hectares and 58 hectares, respectively. The total area covered by the Assessment Area (Supporting Infrastructure) are about 76 hectares.

1.4.1.10 A memo was issued by CEDD on 28 March 2017 (Ref: CEDD NTW/2/8/56(E)) confirming that the areas out with the Land Contamination Assessment Area, but within the Study Area, would not

be subject to any development / redevelopment and thus not included in the contamination assessment. The reply for EPD is as follows:

1.4.1.11 *"Based on the information provided in your memo, we agree that the scope of the land contamination assessment of the subject EIA Study should cover the PDAs and the areas of the associated supporting infrastructures. Other areas outside the PDAs and the associated supporting infrastructures will not be included in the land contamination Assessment"*

1.4.1.12 The agreement between EPD and CEDD was given in **Appendix A**. As such, this contamination assessment has been undertaken with the Land Contamination Assessment Area outlined above, which falls within the Project Area of Study Brief (EIA Study Brief (EIA SB No.: ESB-246/2012).

1.5 Statutory Legislation and Evaluation Criteria

1.5.1.1 This CAP is prepared in accordance with the following Technical Memorandum and Guidance Notes:

- Annex 19 of the Technical Memorandum on Environmental Impact Assessment Process (TM-EIAO), Guidelines for Assessment of Impact On Sites of Cultural Heritage and Other Impacts (Section 3: Potential Contaminated Land Issues), EPD, 1997;
- Guidance Manual for Use of Risk-Based Remediation Goals (RBRGs) for Contaminated Land Management, EPD, 2007;
- Guidance Note for Contaminated Land Assessment and Remediation, EPD, 2007; and
- Practice Guide for Investigation and Remediation of Contaminated Land, EPD, 2011.

1.5.1.2 In accordance with EPD's *Guidance Note for Contamination Land Assessment and Remediation*, a contamination assessment evaluation should:

- provide a clear and detailed account of the present use of the land and the relevant past land history, in relation to possible land contamination;
- identify areas of potential contamination and associated impacts, risks or hazards; and
- submit a plan to evaluate the actual contamination conditions for soil and/or groundwater, if required.

1.5.1.3 The EPD's Guidance Note includes a summary of the general steps of a detail contamination assessment study.

1.5.1.4 Under the Annex 19 of the TM-EIAO, consideration shall be given to a number of potentially contaminating historical land uses, including

oil installations, gas works, metal workshops, car repair and dismantling workshops, as having the potential to cause or have caused land contamination.

1.5.1.5 This CAP has been prepared to set out the requirements for a baseline contamination evaluation of Assessment Area at Yuen Long South. After land resumption a supplementary CAP to summarise the relevant findings of the further site appraisal should be prepared. After approval of the supplementary CAP and upon completion of the SI works, if any. A Contamination Assessment Report (CAR) will be prepared following site investigation activities. If contamination is identified in the CAR, a Remediation Action Plan (RAP) should be developed to formulate appropriate remedial measures. The RAP should follow the requirements specified in EPD's *Practice Guide for Investigation and Remediation of Contaminated Land*. A Remediation Report (RR) should be prepared to demonstrate adequate clean-up and submitted to EPD for agreement prior to the commencement of any development works at the contaminated areas.

2 Desktop Review

2.1 Review of Historical Land Use

2.1.1.1 In order to identify any past land uses which may have the potential for causing land contamination, the development history of the Assessment Area has been reviewed with the aid of selected historical aerial photos between 1963 and 2012. The aerial photographs for the Assessment Area (within PDAs) and the Assessment Area (Supporting Infrastructure) are shown in **Appendices B-1** and **B-2** respectively and the findings are summarised in **Tables 2.1** and **2.2**.

Table 2.1 Summary of historical aerial photos review for the Assessment Area (Within PDAs)

Year of Aerial Photos	Assessment Area (Within PDAs)		
	Area 1	**Area 2 [1]**	**Area 3 [2]**
1963	The Assessment Area comprised of mainly rural residential area and agricultural land (Refer to **Appendix B-1**, Year 1963a).	The Assessment Area comprised of mainly natural terrain and agricultural land (Refer to **Appendix B-1**, Year 1963b).	The Assessment Area comprised of mainly natural terrain and agricultural land (Refer to **Appendix B-1**, Year 1963b).
1973	No significant change in land use was observed as compared with Year 1963 (Refer to **Appendix B-1**, Year 1973a).	No significant change in land use was observed as compared with Year 1963 (Refer to **Appendix B-1**, Year 1973b).	No significant change in land use was observed as compared with Year 1963 (Refer to **Appendix B-1**, Year 1973b).
1982	No significant change in land use was observed as compared with Year 1973 (Refer to **Appendix B-1**, Year 1982a).	No significant change in land use was observed as compared with Year 1973 (Refer to **Appendix B-1**, Year 1982b).	Part of natural terrain area in the upper, middle and lower portion was replaced by suspected industrial activities. Residential premises including "Pak Sha Tsuen" and "Wong Nai Tun Tsuen" outside the Assessment Area were under construction (Refer to **Appendix B-1**, Year 1982b).
1993	The rural residential area in the upper portion was partially replaced by suspected industrial activities. Residential premises "The Eldorado" were constructed. The agricultural land in the lower portion was partially replaced by suspected industrial activities. The Tin Shui Wai Interchange outside the Assessment Area was under construction (Refer to **Appendix B-1**, Year 1993a).	Part of the agricultural land was replaced by scattered industrial activities. The Yuen Long Highway outside the Assessment Area was under construction (Refer to **Appendix B-1**, Year 1993b).	Various industrial activities were scattered across the Assessment Area. "Pak Sha Tsuen" and "Wong Nai Tun Tsuen" were constructed (Refer to **Appendix B-1**, Year 1993b).

Year of Aerial Photos	Assessment Area (Within PDAs)		
	Area 1	**Area 2 [1]**	**Area 3 [2]**
2001	Residential premises located in the upper portion including "Windsor Garden" and "Recours La Serre" were constructed while the "Kisland Villa" and "Marbella Garden" were under construction. The "Taoist Temple" in the lower portion was constructed. Various industrial activities were scattered across the Assessment Area. The Tin Shui Wai Interchange was in operation (Refer to **Appendix B-1**, Year 2001a).	The agricultural land was gradually replaced by industrial activities. The Yuen Long Highway outside the Assessment Area was in operation (Refer to **Appendix B-1**, Year 2001b).	Most of the Assessment Area was replaced by scattered industrial activities (Refer to **Appendix B-1**, Year 2001b).
2007	Residential premises located in the upper portion including "Kisland Villa" and "Marbella Garden" were constructed (Refer to **Appendix B-1**, Year 2007a).	Most of the Assessment Area was replaced by industrial activities. Lam Tai East Road and Lam Tai West Road were under construction (Refer to **Appendix B-1**, Year 2007b).	The whole Assessment Area was replaced by industrial activities. The New residential premises "One Hyde" outside the Assessment Area were under construction (Refer to **Appendix B-1**, Year 2007b).
2012	No significant change in land use in the lower portion was observed as compared with Year 2007 except a new residential premise "Park Villa" was under construction. Various industrial activities were scattered across the Assessment Area (Refer to **Appendix B-1**, Year 2012a).	Lam Tai East Road and Lam Tai West Road were constructed. No significant change in land use was observed as compared with Year 2007 (Refer to **Appendix B-1**, Year 2012b).	The New residential premises "Regent's Park" and "One Hyde" outside the Assessment Area were under construction. No significant change in land use was observed as compared with Year 2007 (Refer to **Appendix B-1**, Year 2012b).

Note:
[1] The 2 areas of Supporting Infrastructure 6 located immediately to the west of Area 2 are included and assessed collectively with Area 2 in this CAP due to the proximity of their locations.
[2] The area of Supporting Infrastructure 6 located immediately to the east of Area 3 is included and assessed collectively with Area 3 in this CAP due to the proximity of its location.

Table 2.2 Summary of historical aerial photos for the Assessment Area (Supporting Infrastructure)

Year of Aerial Photos	Assessment Area (Supporting Infrastructure)				
	Supporting Infrastructure 1	**Supporting Infrastructure 2**	**Supporting Infrastructure 3**	**Supporting Infrastructure 4**	**Supporting Infrastructure 5**
1963	The Assessment Area comprised of mainly rural residential area and agricultural land. Yuen Long Town in addition to several residential areas such as Sheung Yau Tin Tsuen were observed to the north of the Assessment Area. (Refer to **Appendix B-2**, Year 1963c and 1963d).	The Assessment Area comprised of mainly rural residential and agricultural land (Refer to **Appendix B-2**, Year 1963e).	The Assessment Area comprised of mainly rural residential and agricultural land (Refer to **Appendix B-2**, Year 1963f).	The Assessment Area comprised entirely of natural terrain. (Refer to **Appendix B-2**, Year 1963f).	The Assessment Area comprised of mainly rural residential area and agricultural land.
1973	Tai Tong Road and Tai Shu Ha Road were constructed. No other significant change in land use was observed as compared with Year 1963 (**Appendix B-2**, Year 1973c and 1973d).	Kung Um Road was constructed. No other significant change in land use was observed as compared with Year 1963 (Refer to **Appendix B-2**, Year 1973e).	No significant change in land use was observed as compared with Year 1963 (Refer to **Appendix B-2**, Year 1973f).	No significant change in land use was observed as compared with Year 1963 (Refer to **Appendix B-2**, Year 1973f).	Kung Hing Road was constructed. No other significant change in land use was observed as compared with Year 1963.
1982	No significant change in land use was observed as compared with Year 1973	No significant change in land use was observed as compared with Year 1973	No significant change in land use was observed as compared with Year 1973	The Assessment Area was partially occupied by natural terrain whilst a service road was under	No significant change in land use was observed as compared with Year 1973.

Year of Aerial Photos	Assessment Area (Supporting Infrastructure)				
	Supporting Infrastructure 1	**Supporting Infrastructure 2**	**Supporting Infrastructure 3**	**Supporting Infrastructure 4**	**Supporting Infrastructure 5**
	(**Appendix B-2**, Year 1982c and 1982d).	(Refer to **Appendix B-2**, Year 1982e).	(Refer to **Appendix B-2**, Year 1982f).	construction. (Refer to **Appendix B-2**, Year 1982f).	
1993	Yuen Long Highway, Pok Oi Interchange, and Shap Pat Heung Interchange were under construction within the majority of the Assessment Area. (**Appendix B-2**, Year 1993c and 1993d).	Yuen Long Highway was under construction at the north of the Assessment Area. No other significant change in land use was observed as compared with Year 1982 (Refer to **Appendix B-2**, Year 1993e).	Tin Shui Wai West Interchange and Yuen Long Highway were under construction. (Refer to **Appendix B-2**, Year 1993f).	The service road was constructed. The remainder of the Assessment Area consisted of natural terrain. (Refer to **Appendix B-2**, Year 1993f).	Kung Um Road was constructed. No other significant change in land use was observed as compared with Year 1983.
2001	Yuen Long South Highway, Pok Oi Interchange, and Shap Pat Heung Interchange were constructed. (**Appendix B-2**, Year 2001c and 2001d).	Yuen Long Highway was constructed. No other significant change in land use was observed as compared with Year 1993. (Refer to **Appendix B-2**, Year 2001e).	Tin Shui Wai West Interchange and Yuen Long Highway was constructed. (Refer to **Appendix B-2**, Year 2001f).	No significant change in land use was observed as compared with Year 1993. (Refer to **Appendix B-2**, Year 2001f).	No significant change in land use was observed as compared with Year 1993.
2007	An open storage area was observed within the Assessment Area. (**Appendix B-2**, Year 2007c and 2007d).	No significant change in land use was observed as compared with Year 2001 (Refer to **Appendix B-2**, Year 2007e).	No significant change in land use was observed as compared with Year 2001 (Refer to **Appendix B-2**, Year 2007f).	No significant change in land use was observed as compared with Year 2001 (Refer to **Appendix B-2**, Year 2007f).	No significant change in land use was observed as compared with Year 2001.

Year of Aerial Photos	Assessment Area (Supporting Infrastructure)				
	Supporting Infrastructure 1	**Supporting Infrastructure 2**	**Supporting Infrastructure 3**	**Supporting Infrastructure 4**	**Supporting Infrastructure 5**
2012	No significant change in land use was observed as compared with Year 2007.	No significant change in land use was observed as compared with Year 2007 (Refer to **Appendix B-2**, Year 2012e).	No significant change in land use was observed as compared with Year 2007 (Refer to **Appendix B-2**, Year 2012f).	No significant change in land use was observed as compared with Year 2007 (Refer to **Appendix B-2**, Year 2012f).	No significant change in land use was observed as compared with Year 2007.

2.2 Site Geology

2.2.1.1 The Assessment Area (Within PDAs) and Assessment Area (Supporting Infrastructure) are located within an area of relatively complex geology. The district of Yuen Long is situated in a structurally complex Palaeozoic sedimentary basin surrounded by Mesozoic granitic and volcanic rocks, with an extensive amount of faulting and folding. The rocks originally deposited within the sedimentary basin have been heavily metamorphosed, leading to the formation of marble. The younger volcanic rocks of the Tsuen Wan Volcanic group overlay the marble bearing Palaeozoic rocks. Both the sedimentary and volcanic rocks have subsequently been intruded by granite.

2.2.1.2 The Assessment Area is located almost exclusively on the low-lying Yuen Long Plain, an ancient alluvial flood plain. The Assessment Area is bound to the south and southeast by mountainous terrain. The superficial deposits anticipated within the Assessment Area are largely expected to comprise alluvium and colluvium. The colluvium deposits occur upslope of the alluvial plains, filling the floors of incised valleys, but are also found beneath alluvial deposits, mainly filling irregularities in the karst marble surface. The alluvium was deposited under various conditions, ranging from periods of active erosion leading to the deposition of coarser grained materials, to quieter periods allowing far-travelled silts and clays to be deposited. Contours in the local area suggest the paleogeography of meandering channels, with some pools of standing water leading to the deposition of lacustrine type deposits.

2.3 Other Relevant Information

2.3.1.1 Acquisition of other relevant information from Fire Services Department (FSD) and the Environmental Protection Department (EPD) was summarized below:

2.3.2 Information Request from Fire Services Department

2.3.2.1 The FSD has been contacted between March and July of 2013, between December 2014 and January 2015 and March 2017 to obtain the following information:

(i) The records of Dangerous Goods License(s);

(ii) Information related to the use and/or storage of dangerous goods; and

(iii) The reported accidents of spillage/leakage within the surveyed premises.

2.3.2.2 Copies of enquiry by letter, follow up documents on the information request to FSD, and the formal reply from the FSD on 8 July 2013, 17 December 2014 and 9 June 2017 are given in **Appendix C**.

2.3.2.3 There are 40 locations used for the storage of dangerous goods that were on FSD records within or in the vicinity of the Assessment Area (Within PDAs and Supporting Infrastructure). From the information provided by FSD, 4 sites have been identified as being used for the storage of dangerous goods within the Assessment Area. All the locations are located along or in the vicinity of Tong Yan San Tsuen Road, in Area 1 within the Assessment Area (Within PDAs).

2.3.2.4 According to the information provided by FSD, no dangerous goods are present in Areas 2 and 3 within the Assessment Area (Within PDAs) and the Assessment Area (Supporting Infrastructure).

2.3.2.5 A summary of the records of dangerous goods for the Assessment Area, as identified in **Appendix C**, are shown in **Table 2.3** below.

Table 2.3: Summary of dangerous goods within the Assessment Area

No.	Type of Dangerous Goods	Quantity	Address	Method of Storage	Location within Assessment Area
1.	Petrol	20,000L	4 Tong Yan San Tsuen Road, Ping Shan, Yuen Long	Underground Tank	No
2.	Petrol	20,000L	4 Tong Yan San Tsuen Road, Ping Shan, Yuen Long	Underground Tank	No
3.	Diesel	20,000L	4 Tong Yan San Tsuen Road, Ping Shan, Yuen Long	Underground Tank	No
4.	Diesel	20,000L	4 Tong Yan San Tsuen Road, Ping Shan, Yuen Long	Underground Tank	No
5.	Diesel	20,000L	4 Tong Yan San Tsuen Road, Ping Shan, Yuen Long	Underground Tank	No
6.	Diesel	22,730L	G/F., Lot 2024 in DD121, Tong Yan San Tsuen, Yuen Long, N.T. (Hop Hing Building, No.9 Ping Tong Street East)	Above ground Tank	No
7.	Diesel	22,730L	20 Tong Yan San Tsuen Road, Yuen Long	Underground Tank	No

No.	Type of Dangerous Goods	Quantity	Address	Method of Storage	Location within Assessment Area
8.	Diesel	22,730L	20 Tong Yan San Tsuen Road, Yuen Long	Underground Tank	No
9.	Petrol	22,730L	20 Tong Yan San Tsuen Road, Yuen Long	Underground Tank	No
10.	Petrol	22,730L	20 Tong Yan San Tsuen Road, Yuen Long	Underground Tank	No
11.	Petrol	22,730L	20 Tong Yan San Tsuen Road, Yuen Long	Underground Tank	No
12.	Diesel	22,500L	Lot 1317 CRP, 1318 RP, 1319, 1321, 1322 RP & 1323 RP in DD121, Ping Shan, Yuen Long	Underground Tank	No
13.	Diesel	22,500L	Lot 1317 CRP, 1318 RP, 1319, 1321, 1322 RP & 1323 RP in DD121, Ping Shan, Yuen Long	Underground Tank	No
14.	Petrol	22,500L	Lot 1317 CRP, 1318 RP, 1319, 1321, 1322 RP & 1323 RP in DD121, Ping Shan, Yuen Long	Underground Tank	No
15.	Petrol	22,500L	Lot 1317 CRP, 1318 RP, 1319, 1321, 1322 RP & 1323 RP in DD121, Ping Shan, Yuen Long	Underground Tank	No
16.	Sodium Hydroxide	3,000kg	G/F, Hop Hing Building, 9 Ping Tong Street East, Tong Yan San Tsuen, Yuen Long	Dangerous Goods Store	No
17.	Petrol	400L	DD121, Lot 1997, Tong Yan San Tsuen, Ping Shan , Yuen Long	Dangerous Goods Store	No
18.	Diesel	22,730L	6 Ping Fuk Lane, Tong Yan San Tsuen, Yuen Long	Above ground Tank	No
19.	Diesel	9,000L	23 Tong Yan San Tsuen / Castle Peak Road, Yuen Long, NT	Underground Tank	No
20.	Diesel	22,692L	CRC Petrol Filling Station, 9 Tong Yan San Tsuen Road, Yuen Long	Underground Tank	No

No.	Type of Dangerous Goods	Quantity	Address	Method of Storage	Location within Assessment Area
21.	Petrol	22,692L	CRC Petrol Filling Station, 9 Tong Yan San Tsuen Road, Yuen Long	Underground Tank	No
22.	Petrol	22,692L	CRC Petrol Filling Station, 9 Tong Yan San Tsuen Road, Yuen Long	Underground Tank	No
23.	Kerosene	13,500L	Lot 1274 R.P. & 1795 R.P. in DD 121, Tong Yan San Tsuen, Yuen Long	Underground Tank	W24
24.	Kerosene	50L	Lot 1274 R.P. & 1795 R.P. in DD 121, Tong Yan San Tsuen, Yuen Long	Above ground Tank	W24
25.	Turpentine	1,200L	Lot 1274 R.P. & 1795 R.P. in DD 121, Tong Yan San Tsuen, Yuen Long	Dangerous Goods Store	W24
26.	Toluene	21,000L	Lot 1274 R.P. & 1795 R.P. in DD 121, Tong Yan San Tsuen, Yuen Long	Underground Tank	W24
27.	Halon 1301	1,000L	56 Tong Yan San Tsuen Road, Yuen Long	Dangerous Goods Store	W40
28.	FM200	500L	56 Tong Yan San Tsuen Road, Yuen Long	Dangerous Goods Store	W40
29.	Ammonia solution, Sodium Cyanide, Carbon Tetrachloride and Potassium cyanide	45,000Kg	Section D & F, Lot 2008, DD121, Tong Yan San Tsuen, Yuen Long	Dangerous Goods Store	W50a
30.	Potassium Nitrate and Sodium Nitrate	30,000Kg	Section D & F, Lot 2008, DD121, Tong Yan San Tsuen, Yuen Long	Dangerous Goods Store	W50a
31.	Chromic Acid	20,000Kg	Section D & F, Lot 2008, DD121, Tong Yan San Tsuen, Yuen Long	Dangerous Goods Store	W50a

No.	Type of Dangerous Goods	Quantity	Address	Method of Storage	Location within Assessment Area
32.	Isopropyl Alcohol and Acetone	12,000Kg	Section D & F, Lot 2008, DD121, Tong Yan San Tsuen, Yuen Long	Dangerous Goods Store	W50a
33.	Thinner	12,000Kg	Section D & F, Lot 2008, DD121, Tong Yan San Tsuen, Yuen Long	Dangerous Goods Store	W50a
34.	Nitric Acid	30,000Kg	Section D & F, Lot 2008, DD121, Tong Yan San Tsuen, Yuen Long	Dangerous Goods Store	W50a
35.	Hydrochloric Acid	20,000Kg	Section D & F, Lot 2008, DD121, Tong Yan San Tsuen, Yuen Long	Dangerous Goods Store	W50a
36.	Sulphuric Acid and Caustic Soda	30,000Kg	Section D & F, Lot 2008, DD121, Tong Yan San Tsuen, Yuen Long	Dangerous Goods Store	W50a
37.	Hydrogen Peroxide	50tonnes	Section D & F, Lot 2008, DD121, Tong Yan San Tsuen, Yuen Long	Dangerous Goods Store	W50a
38.	Halon 1301	4,800L	69 Tong Yan San Tsuen Road, Yuen Long	Dangerous Goods Store	W72
39.	Halon 1211	800L	69 Tong Yan San Tsuen Road, Yuen Long	Dangerous Goods Store	W72
40.	Nitrogen	336L	69 Tong Yan San Tsuen Road, Yuen Long	Dangerous Goods Store	W72

2.3.3 Information Request from Environmental Protection Department

2.3.3.1 The EPD was contacted in March 2013 and December 2014 to obtain the following information:

(i) The records for Chemical Waste Producers Registration, and

(ii) The reported accidents of spillage/leakage within the Assessment Area.

2.3.3.2 Based on the information provided by EPD via email on 18 April 2013, there is one chemical spillage / leakage record at Tong Yan San Tsuen within the Assessment Area. With regards to Chemical Waste Producer Records, EPD advised that there were 75 chemical waste producers

registration within the Assessment Area. Among the 75 registration, 48 of them are still valid while 27 of them had been de-registered. A copy of letter to EPD and the formal reply from EPD are given in **Appendix D**. The records have been matched with the locations of surveyed sites as mentioned in **Section 2.4** below and are summarised in **Appendix E**.

2.3.3.3 Based on information provided by EPD via email on 7 Jan 2015, there were no chemical spillage / leakage records with the Assessment Area (Supporting Infrastructure). With regards to Chemical Waste Producer Records, a review of EPD records revealed that there are no chemical waste producers within the Assessment Area (Supporting Infrastructure). A copy of letter to EPD and the formal reply from EPD are given in **Appendix D**.

2.3.3.4 A summary of the chemical waste producer records for the Assessment Area, as identified in **Appendix D**, are shown in **Table 2.4** below.

Table 2.4: Summary of chemical waste producers within the Assessment Area

No.	Business type	Address	Location Within Assessment Area	De-registered
1.	Automobile Maintenance	25, Western District, Tong Yan San Tsuen	Unknown due to limited information from the address provided by EPD.	
2.	Automobile Maintenance	99 Tong Yan San Tsuen Road	W52	
3.	Automobile Maintenance	G/F, No. 3 Tong Tai Road, Tong Yan San Tsuen	W23	
4.	Automobile Maintenance	Lot 982, DD121, Tong Yan San Tsuen	W155	
5.	Automobile Maintenance	Lot 984, DD121, Tong Yan San Tsuen	W151, W152, W153 and W154	Y
6.	Automobile Maintenance	Lot 1008 B, C, F, DD121 Tong Yan San Tsuen	W144m	
7.	Automobile Maintenance	Lot 1085, DD121, Tong Yan San Tsuen	W83	Y
8.	Automobile Maintenance	Lot 1085, DD121, Tong Yan San Tsuen	W83	
9.	Automobile Maintenance	Lot 1142B, 1142C, 1146a, 1148-49, DD121, Tong Yan San Tsuen Road, Tong Yan San Tsuen	W67	Y
10.	Construction site	Lot 2131, DD121, Tong Yan San Tsuen, Yuen Long, N.T.	No.	
11.	Construction site	Proposed Residential Development at Lot 2139 in DD 121, Tong Yan San Tsuen Road	W86a	
12.	Others	69 Tong Yan San Tsuen Road	W74	
13.	Others	Lot 596 in DD121, Tong Yan San Tsuen	W105	
14.	Others	Lot 1109, DD121, Tong Yan San Tsuen, Ping Shan	W75	

No.	Business type	Address	Location Within Assessment Area	De-registered
15.	Others	Lot 1161Sh, 1833Sb & 1161Sd/f, DD 121, Tong Yan San Tsuen	No.	Y
16.	Others	Lot 1207RP, 1208A, 1263RP (part), 1265RP, 1842RP & adjoining G.L., D.D. 121, Tong Yan San Tsuen	W9	
17.	Others	Lot 1874 & 1875 S.A., DD121, Tong Yan San Tsuen	W56, W57 and W60	
18.	Recycling	Lot 661 & 699A, DD121, Tong Yan San Tsuen	W124 and W125	Y
19.	Recycling	Lot 984RP, 993, 994 & 995RP, DD121, Tong Yan San Tsuen	W144m and W149	
20.	Trading	No. 71 Shan Ha Road	No.	Y
21.	Trading	Lot 984RP, DD121, Tong Yan San Tsuen	W149	
22.	Trading	Lot 1001 & 1002, DD121, Tong Yan San Tsuen	W143	
23.	Transportation	Lot 988, DD121, Shan Ha Tsuen, Long Hon Road	W144m	
24.	Transportation	Lot 1021 & 1024, DD121, Tong Yan San Tsuen	W150	
25.	Warehouse	No. 71 Shan Ha Road	No.	
26.	Warehouse	72 Tong Yan San Tsuen Road, Tong Yan San Tsuen	W73	
27.	Warehouse	Lot 603, DD121	W105 and W106	Y
28.	Warehouse	Lot 1191 DD121, Tong Yan San Tsuen	No.	Y
29.	Workshop (air conditioning)	G/F., 79 Shan Ha Road	No.	
30.	Workshop (metal)	37, Shing Yuen, Tong Yan San Tsuen, Ping Shan	No.	
31.	Workshop (metal)	Lot 550 in DD121, Tong Yan San Tsuen	W89a, W89b, W89c, W90, W91, W93, and W94	
32.	Workshop	Lot 982 (portion), DD121, Long Hon Road, Tong Yan San Tsuen	W155	Y
33.	Workshop	Lot 1451 & 1452, DD121, Sha Tseng Road, Ping Shan	W41-1	Y
34.	Workshop	Lot 1556, DD121, Shan Ha Tsuen	W178m	
35.	Automobile Maintenance	1A Pak Sha Tsuen	E128	
36.	Automobile Maintenance	1-B Lot 1486, DD119, Tin Liu Tsuen	E100	Y
37.	Automobile Maintenance	DD119, Ma Tin Village, Kung Um Road	No.	
38.	Automobile Maintenance	Lot 312, DD119, Shan Ha Tsuen	E81m	
39.	Automobile Maintenance	Lot 342, DD119, Sha Ha Tsuen, Sha Ha Road	E97 and E98a	

No.	Business type	Address	Location Within Assessment Area	De-registered
40.	Automobile Maintenance	Lot 1013 AB, DD119, Pak Sha Tsuen, Kung Um Road	E293	Y
41.	Automobile Maintenance	Lot 1466, DD119	E71 and E71a	
42.	Automobile Maintenance	Lot 1475, 1477-1481, DD119, Kung Um Road	E74	Y
43.	Automobile Maintenance	Lot 1484, DD119, Kung Um Road, Ma Tin	E99	
44.	Automobile Maintenance	Lot 1567-1663, DD119, Pak Sha Tsuen, Kung Um Road	E112, E115m, E118, E120-E124, E128	Y
45.	Automobile Maintenance	Lot 1567-1663, DD119, Pak Sha Tsuen, Kung Um Road	E112, E115m, E118, E120-E124, E128	Y
46.	Automobile Maintenance	Lot 1567-1663, DD119, Pak Sha Tsuen, Kung Um Road	E112, E115m, E118, E120-E124, E128	Y
47.	Automobile Maintenance	Lot 1572 & 1573, DD119, No. 1A Pak Sha Tsuen	E128	Y
48.	Automobile Maintenance	Lot 1577-1578, DD119, Kung Um Road	E128	
49.	Automobile Maintenance	Lot 1583, DD 119, Tin Liu Tsuen, Kung Um Road	E123	
50.	Automobile Maintenance	Lot 1583, DD 119, Tin Liu Tsuen, Kung Um Road	E123	Y
51.	Automobile Maintenance	Lot 2366, DD120, Tin Lung Tsuen	E4 and E5	
52.	Automobile Maintenance	Lot 2386, DD120, Kung Um Road	E23	
53.	Automobile Maintenance	Lot 2818 & 2848, DD120, Kung Um Road	E19	
54.	Recycling	Lot 333, DD119, Sha Ha Tsuen	E97	
55.	Recycling	Lot 1524, DD119, Tin Liu Tsuen	E136	
56.	Recycling	Lot 2360, DD120	E13	
57.	Warehouse	Lot 1488, DD119, Tai Sha Po	E104	Y
58.	Workshop	Lot 315, DD119, Shan Ha Tsuen	E83 and E84	
59.	Workshop	Lot 2818 & 2848, DD120, Kung Um Road	E19	Y
60.	Automobile Maintenance	DD117, Kung Um Road	Unknown due to limited information from the address provided by EPD.	Y
61.	Automobile Maintenance	Lot 734-735, DD117, Kung Um Road	E164	Y
62.	Automobile Maintenance	Lot 793, DD119, Pak Sha Tsuen	E244-1	
63.	Automobile Maintenance	Lot 800, DD117, Kung Um Road	E242	Y
64.	Automobile Maintenance	Lot 800RP, DD117, Kung Um Road	E242	Y

No.	Business type	Address	Location Within Assessment Area	De-registered
65.	Automobile Maintenance	Lot 980, DD119	E316,317,319,309	Y
66.	Automobile Maintenance	Lot 1153 (RP), DD119, Pak Sha Tsuen, Kung Um Road	E441 and 442	
67.	Automobile Maintenance	Lot 1247, DD119, Pak Sha Tsuen, Kung Um Road	E268	
68.	Automobile Maintenance	Lot 1255, DD119, Pak Sha Tsuen, Kung Um Road	E272a, E273, and E274	
69.	Construction site	Lot 1231SA SS1 & 1231SB RP, DD119	E250	
70.	Recycling	Lot 1295, DD119	No.	
71.	Trading	Lot 684, DD117	E177	
72.	Trading	Lot 774-775, DD117, Kung Um Road	E191	Y
73.	Warehouse	Lot 1318, DD119, Pak Sha Tsuen	E150	
74.	Warehouse	Lot 1205, DD119, Pak Sha Tsuen, Kung Um Road	E332	Y
75.	Workshop	Lot 1298, DD119	E251	

2.4 Site Survey

2.4.1.1 Site surveys were conducted from March 2013 to April 2014 for the Assessment Area (Within PDAs) and November 2014 for the Assessment Area (Supporting Infrastructure) to ground truth the findings of the desktop study and to identify any other land uses within the Assessment Area which may have potential to cause soil and groundwater contamination.

2.4.1.2 However, detailed site appraisal at each individual premise within the Assessment Area was restricted as the majority of the sites surveyed consisted of 1) private land of which most were still in operation; and 2) government land but was occupied and operated by private owners (refer to **Figure 2.1**). Therefore, access to the aforementioned premises was infeasible for both inspection and site investigation due to the ongoing operations, as both site survey and site investigation would both involve the suspension of operations on site. Peripheral inspection (i.e. from the entrance and / or boundary of the premises) was conducted in order to provide a general view of the Assessment Area (Within PDAs).

2.4.1.3 **Figure 2.2** illustrates the existing land uses within the Assessment Area for both PDAs and supporting infrastructures.

2.4.1.4 **Figures 2.3, 2.3a, 2.3b** and **2.3c** show the non-industrial and industrial land uses identified in the Assessment Area (Within PDAs) during the site surveys.

2.4.1.5 The Assessment Area (Supporting Infrastructure) is mostly within non-private lots as the majority of the Assessment Area covers existing roadworks and public facilities. However, a number of sites were able to be surveyed as a portion of the site boundary infringed upon the Assessment Area. These surveyed sites were partially within private lots and most were still in operation (as refer to **Figure 2.1b**). Therefore, only peripheral inspections (i.e. from the entrance and / or boundary of the premises) were conducted. **Figures 2.4, 2.4a, 2.4b, 2.4c, 2.4d** and **2.4e** show the non-industrial and industrial land uses identified within the Assessment Area (Supporting Infrastructure).

2.4.1.6 The sites surveyed that were considered to have the potential for contamination were given a Site ID, whilst the non-industrial sites shown in **Figure 2.3** and **Figure 2.4** were considered to have no land continuation and were not surveyed.

2.4.1.7 In addition, public facilities with the Assessment Area (Supporting Infrastructure) such as roads, which occupy the majority of the Assessment Area (Supporting Infrastructure) were accessible to be surveyed.

2.4.1.8 **Table 2.5** below summaries the sites that were accessible during the site survey.

Table 2.5 Summary of site survey accessibility for surveyed sites

Extent of Site Survey	Sites
Accessible for both site inspection within the site and ground investigation.	0
Accessible for site inspection within the site; but ground investigation is not permitted / infeasible.	0
Inaccessible for both inspection or ground investigation, and only peripheral inspection were conducted.	698

2.4.1.9 Individual site survey results for surveyed sites within the Assessment Area (Within PDAs) are summarised in **Appendices E-1a, E-1b and E-1c** for Areas 1, 2 and 3 respectively and Assessment Area (Supporting Infrastructure) is summarised in **Appendix E-2**.

2.4.1.10 It was observed from the site survey that the Assessment Area consisted of residential, agricultural and various industrial activities such as vehicle/repair maintenance facilities, waste recycling workshops, metal works and open storage areas etc.

2.4.2 Contamination Rating System

2.4.2.1 In order to determine those activities which pose the potential for contamination, a contamination rating was determined based on visual evidence from site survey, available historical records such as historical aerial photos, and the EPD's *Practice Guide for Investigation and*

Remediation of Contaminated Land. The rating categories used in the preliminary site evaluation are as follows:

- "***Yes***" *rating indicates sites which may have a potential for land contamination based on* visual evidence (i.e. spillage / leakage of oils and / or chemicals, heavy oil stains on the ground, burn pits, areas of uncontrolled dumping etc.) on site and / or through the review of historical records (i.e. historical aerial photograph and chemical waste producer / spillage records) that reflects the potential for soil and groundwater contamination. Due to limited access to verify the actual site condition, further inspection / investigation is required after land resumption.
- "***No***" rating indicates a low potential for land contamination, with no major concerns observed during the site survey or throughout the desktop review, including historical land use and other relevant information from government departments.

2.5 Future Land Use and Activities

2.5.1.1 The relevant Risk-Based Remediation Goals (RBRGs) would be adopted for the land contamination assessment. Four different post-restoration land uses have been developed for the RBRGs, namely "Urban Residential", "Rural Residential", "Industrial" and "Public Parks", to reflect the settings of which people could be exposed to contaminated soil or groundwater. Definition of post-restoration land uses are given in EPD's *Guidance Note for Contaminated Land Assessment and Remediation* and *Guidance Manual for Use of Risk-Based Remediation Goals* (RBRGs) for Contaminated Land Management.

2.5.1.2 The Recommended Outline Development Plan (RODP) of the Study is given in **Appendix F** which consists of different facilities, such as residential buildings, education institutions, outdoor sport facilities, commercial, mixed development, primary and district distributors, sewage treatment works, sewage pumping stations, pedestrian walkway, open space, car park and various public utilities etc. The relevant RBRGs for the identified contaminated sites should be decided with reference to the RODP. The most relevant RBRG corresponding to its future land use should be adopted in assessing its land contamination level. Where a site would be developed into more than one land use, the most stringent set of RBRGs would be adopted. RBRGs land uses corresponding to future land uses and the land uses proposed by the PODP are listed in **Table 2.6.**

Table 2.6 Post-restoration land use and RBRGs land use

Land use in RODP		**Land use**	**Corresponding RBRGs Land use**
RSc	Special Residential – Public Rental Housing (with commercial)	Residential - Urban High Rise	Urban Residential

Land use in RODP		**Land use**	**Corresponding RBRGs Land use**
(R1(HOS)c)	Residential – Zone 1 (Home Ownership Scheme) (with commercial) (R1(HOS)c)		
(R1c)	Residential - Zone 1 with Commercial		
(R2(HOS)c)	Residential – Area 2 (Home Ownership Scheme) (with commercial) (R1(HOS)c)		
(R2c)	Residential - Zone 1 with Commercial		
R3	Residential - Zone 3		
R4	Residential - Zone 4	Residential - Urban Low Rise	Rural Residential
R5	Residential -Zone 5		
(R5(EDA))	Residential – Zone 5 (Existing Development Area)		
R6	Residential - Zone 6		
V	Village Type Development		
G	Government, Institution and Community	Social Welfare Facility, Community Welfare Facility, Sports Centre, General Clinic, Divisional Fire Station and Ambulance Depot, District Police Station, Married Quarters	Urban Residential
		Government Reserve Intended for Government Depot	Industrial
IC	Institution or Community	Government Institution or Community facilities	Urban Residential
C	Commercial	Commercial / Business & Office / Commercial • Urban High Rise	
AGR	Agriculture	Agriculture	Note 1
E	Education	Schools	Rural Residential
GB	Green Belt	Open Space	Public Park
I	Industrial	Public Utilities	Industrial
LO(2)	Local open Space for Industrial Operations	Warehouse & Storage	
OS	Open Storage		
OU	Other Specified Uses	Public Utilities	
A	Amenity	Open Space	Public Park
DO	District Open Space		
LO	Local Open Space		
CP	Country Park		
Road Network within RODP	Proposed Road Network	Roads including Pedestrian Walkway	Lower of Industrial or Public Park
PTI	Public Transport Interchange		

Note:
Note 1: The corresponding land use for the RBRG is subject to an ecological risk assessment and would be confirmed in the detailed design stage.

2.5.1.3 The latest RODP has been adopted in the land contamination assessment and their corresponding future land uses have been used as the evaluation criteria. If the future land uses change after the approval of this CAP or are in doubt during further assessment (i.e. interpretation of the soil and groundwater testing results), the most stringent set of RBRGs should be adopted as the clean-up standard. During the detailed design stage, the design engineer should consider whether the remediated soils are required to be excavated during the construction stage and re-used off-site. If it is the case, the most stringent set of RBRGs should be adopted to ensure the remediated could be re-used in any situation. The RBRGs for soil and soil saturation limits, and RBRGs for groundwater and groundwater solubility limits are given in **Appendix G**.

3 Potentially Contaminated Sites

3.1 Identification of Potentially Contaminated Land Uses

3.1.1.1 According to Section 2.3.1 of EPD's *Practice Guide for the Investigation and Remediation of Contaminated Land*, through site survey and desktop review such as the review of aerial photographs and information from various government departments such as FSD and EPD, areas which may have potential to cause soil and groundwater contamination have been identified. Sites identified to have records of dangerous goods and chemical waste producers are considered as potentially contaminated sites. Furthermore, specific land uses which were identified as potentially contaminating sources include the below. The details of the surveyed sites are given in **Appendix E**.

- Open storage;
- Warehouse;
- Vehicle maintenance;
- Metal works;
- Waste recycling;
- Construction material and equipment storage;
- Open car park;
- Concrete batching plant; and
- Chemical store; and
- Dangerous Goods Stores; and
- Chemical Waste Producers.

3.1.1.2 It should be noted that the potentially contaminated land uses that have been identified at this stage are not exhaustive as changes of land use in future may give rise to further potentially contaminated sites. As such, site re-appraisal should cover the entire Assessment Area to ensure that any additional potentially contaminated sites are identified.

3.1.1.3 With reference to **Figures 2.3**, **2.3a**, **2. 3b** and **2. 3c**, several areas of potentially contaminated land uses have been identified in the Assessment Area (Within PDAs). Within Area 1 (**Figure 2. 3a),** the areas with the highest likelihood for potential contamination are located in the northern, southern and eastern areas. In Area 2 (**Figure 2.3b**), industrial activities are concentrated in the western section along Lam Tai West Road and western section along Kung Um Road, while Area 3 (**Figure 2.3c**) largely consisted of industrial activities.

3.1.1.4 With reference to **Figures 2.4**, **2.4a**, **2.4b, 2.4c**, **2.4d** and **2.4e**, several areas of potentially contaminated land uses have been identified in the Assessment Area (Supporting Infrastructure). The area with the highest

likelihood for potential contamination are located alongside Castle Peak Road - Yuen Long and Yuen Long Highway (**Figure 2.4a)**.

3.2 Potentially Contaminated Sites

3.2.1.1 Potentially contaminated sites within the Assessment Area have been identified based on the selected historical aerial photos, relevant information from FSD and EPD, existing land uses plans, and the information collected during site survey. **Table 3.1** summarises the potentially contaminated sites identified with respect to the contamination rating system outlined in **Section 2.4.2**:

Table 3.1 Summary of surveyed sites and contamination potential

Assessment Area	Total Number of Surveyed Sites	Number of Surveyed Sites with "Yes" Rating	Number of Surveyed Sites with "No" Rating.
Area 1	204	203	1
Area 2	183	183	0
Area 3	301	301	0
Supporting Infrastructure	10	10	0

Note:
Note 1: All sites were surveyed based on peripheral site inspections. Please refer to **Section 2.4.1.2** for details.

3.2.1.2 The details of the individual surveyed sites are summarised in **Appendices E-1a**, **E-1b** and **E-1c** for Areas 1, 2 and 3 respectively and Assessment Area (Supporting Infrastructure) is summarised in **Appendix E-2** in accordance with the best available information based on peripheral inspections. According to the site survey findings and the desktop research undertaken in Section 2, it is anticipated that 715 surveyed sites will be classified as potentially contaminated sites and most of them are located within private lots. Locations of these sites are given in **Figures 3.1, 3.2, 3.2a, 3.2b, 3.2c, 3.3** and **3.3a** and details of these potentially contaminated sites including potentially polluting activities, approximate site area, recommended number of sampling points, corresponding future land use etc. are summarised in **Appendix H**.

4 Potential Health Risk and Environmental Impacts

4.1 Potential Impact on Receptors

4.1.1.1 The potential impacts to the Project from contaminated soil and groundwater are judged by the following associated risks.

- Health risks to site workers;
- Disposal of contaminated soils, where encountered;
- Disposal of contaminated groundwater, where encountered; and
- Potential health risks to future users of the sites.

4.2 Health Risk to Workers

4.2.1.1 Site construction workers may be exposed to contaminated soils and groundwater during earth moving operations and the laying of pipelines or underground services. The main exposure routes for site construction workers are accidental direct ingestion of contaminated materials through poor hygiene and eating or smoking on site, or through direct contact with potentially toxic or harmful contaminants in excavated soil.

4.3 Remediation of Contaminated Soil

4.3.1.1 In the event that any contaminated soils are identified during SI works or further environmental investigations, they should be properly remediated or disposed of prior to the commencement of construction programme. Prior agreement with EPD should be sought so that these materials are dealt with appropriately in accordance with EPD's Guidance Note for Contaminated Land Assessment and Remediation. Any contaminated soils which are excavated would require treatment and/or off site disposal at an appropriate site which is licensed to accept "contaminated" soils. The possibility of carrying out in situ and ex situ remediation and recycling and reuse of remediated materials should be explored as priority. Off-site disposal of contaminated materials to landfills should be adopted as a last resort. The final remediation / disposal requirements should be presented and addressed in the RAP,

which should be submitted to EPD for agreement prior to the remediation / disposal.

4.3.1.2 Feasible measures should be implemented to minimize or avoid disposal of contaminated soils off site. Any contaminated soils would be handled, treated and re-used on site as far as practicable.

4.4 Remediation of Contaminated Groundwater

4.4.1.1 Where excavations take place below the groundwater table, there may be a need to dewater the pits for safety and construction purposes. Where dewatering takes place through layers of contaminated material or where any contaminated soil is being excavated, the groundwater may become contaminated, thereby requiring appropriate handling and remediation / disposal. The proposed remediation method and/ or disposal arrangement of the contaminated groundwater should be presented and addressed in the RAP which should be submitted to EPD for agreement prior to the remediation / disposal.

4.5 Potential Health Risks to Future Users of the Site

4.5.1.1 During the operational phase, there is little potential for impacts associated with contaminated soils as the entire project site should be properly remediated prior to the construction phase. However, whilst unlikely, in the event that contaminated material is identified during the construction stage, appropriate mitigation measures should be undertaken so that such material shall be properly treated, mitigated or removed. Any direct contact with such materials should be avoided.

5 Site Investigation and Re-appraisal of Potentially Contaminated Sites

5.1.1 Proposed Site Investigation for Potentially Contaminated Sites

5.1.1.1 As discussed in **Section 3.2**, 697 potentially contaminated sites have been identified within the Assessment Area. As the majority of the sites within the Assessment Area (Within PDAs and Supporting Infrastructure) are still in operation, site access for appraisal is very limited. Sampling should be carried out in these sites once access is available. The site survey results indicate that the recommended numbers of boreholes are 1495, 1387, 1933, and 75 in Area 1, Area 2, Area 3 and Supporting Infrastructure respectively (see **Table 5.1** below). In total, 4890 boreholes are recommended in the whole of Assessment Area.

Table 5.1 Summary of potentially contaminated sites require SI

Zoning	No. of Potentially Contaminated Sites	No. of Recommended Boreholes(1) (2)
1	203	1495
2	183	1387
3	301	1933
Supporting Infrastructure	10	75
Total	**697**	**4890**

Note:

(1) The no. of recommended boreholes is tentative and is subject to change based on on-site re-appraisal of contaminated sites at after land resumption by the PP's appointed consultant.

(2) The determination of the number of boreholes is based on Table 2.1 of the *Practice Guide for the Investigation and Remediation of Contaminated Land.*

5.1.2 Proposed Re-appraisal for Potentially Contaminated Landuses

5.1.2.1 Further site appraisal will be carried out by Project Proponent (PP)'s appointed consultants once site access is available (e.g. after land resumption), in order to identify the presence of "hot spots" for intrusive site investigation and confirm the evaluation of the contaminated site in initial land contamination assessment.

5.1.2.2 The PP's consultants should prepare a supplementary CAP to summarise the relevant findings of the further site appraisal. After approval of the supplementary CAP and upon completion of the SI works, if any, the PP should prepare a CAR to present findings of the SI works. If contamination has been identified, a RAP should be prepared to formulate appropriate remedial measures to deal with the contamination identified. Following completion of any necessary remediation works, a RR should be prepared to demonstrate adequate

clean-up and submit to EPD for approval prior to the commencement of any development works at the contaminated sites.

5.1.3 Proposed Re-appraisal for Industrial Site with No Potential for Contamination

5.1.3.1 Although one of the sites (W162-1) is not identified as potentially contaminated sites during the course of this land contamination assessment considering its past and present land use, this site is still private and the proposed redevelopment of this site will only commence in a number of years time. Change in the land use (e.g. change to use as chemical storage area, dismantling workshop, etc.) could take place on this site, which may cause potential land contamination. Hence, once the individual site is handed over to the PP for development, the PP's appointed consultants should revisit this site to assess the latest site situation.

5.1.3.2 The PP should prepare and submit a supplementary Contamination Assessment Plan (supplementary CAP) to present findings of the re-appraisal for EPD's review and approval prior to the commencement of the SI works.

5.1.3.3 After approval of the supplementary CAP and upon completion of the SI works, if any, the PP should prepare a CAR to present findings of the SI works. If contamination has been identified, a RAP should be prepared to formulate appropriate remedial measures to deal with the contamination identified. Following completion of any necessary remediation works, a RR should be prepared to demonstrate adequate clean-up and submit to EPD for approval prior to the commencement of any development works at the contaminated sites.

5.1.4 Proposed Re-appraisal for Non-Industrial Land Uses

5.1.4.1 Re-appraisal would also be required for the 'Non-Industrial uses' within the Assessment Area as the redevelopment of these land uses would only commence a number of years later, which may allow change in the land usage in the meantime, which may give rise to potential land contamination.

5.1.4.2 The PP should re-appraise the 'Non-Industrial uses' within the Assessment Area to assess the latest site situation once the land is handed over to the PP and prepare a supplementary CAP presenting the findings of the re-appraisal and strategy of the recommended SI, if required, and submit to EPD for review and approval.

5.1.4.3 After approval of the supplementary CAP and upon completion of the SI works, if any, the PP should prepare a CAR, to present findings of the SI works. If contamination has been identified, a RAP should be prepared to formulate appropriate remedial measures to deal with the contamination identified. Following completion of any necessary remediation works, a RR should be prepared to demonstrate adequate

clean-up and submit to EPD for approval prior to the commencement of any development works at the contaminated sites identified.

5.2 Sampling and Testing Strategy

5.2.1 General

5.2.1.1 Although SI within the potentially contaminated land uses within the Assessment Area could not be ascertained and carried out at this stage, the sampling and testing strategy for the SI works is provided below to facilitate the future SI works and preparation of the supplementary CAP.

5.2.1.2 The sampling work should follow appropriate protocols to minimise the potential for cross-contamination between samples and between different sampling locations. Soil sampling methods are based on techniques developed by the United States Environmental Protection Agency (USEPA). These methods include decontamination procedures, sample collection, preparation and preservation, and chain-of-custody documentation.

5.2.1.3 Samples for laboratory testing should be taken with clean stainless steel hand tools and clean latex gloves and placed in right containers made of a material that is non-reactive with the likely contaminants.

5.2.1.4 In addition to the samples collected for laboratory analysis, a strata log will be kept for record of additional data to aid in the interpretation of results. Information on the general structure of the subsurface strata including grain size, colour, wetness, and the depth and thickness of each soil/ rock layer should be noted. The presence of any foreign material such as metals, wood or plastics should also be recorded.

5.2.1.5 All field personnel should wear adequate personal protective equipment when working in contaminated areas.

5.3 Decontamination Procedures

5.3.1.1 Equipment in contact with the ground should be thoroughly decontaminated between each sampling event to minimise the potential for cross contamination. The equipment should be decontaminated by steam cleaning, then washed with phosphate-free detergent and finally rinsed with water. Moreover, water should not be used during drilling.

5.3.1.2 A clean area immediately adjacent to the sampling location should be established with a clean plastic sheet where all cleaned and foil wrapped equipment should be placed.

5.3.1.3 During the sampling and decontamination activities, disposable latex gloves should be worn to prevent the transfer of contaminants from

other sources to the samples/ the sampling equipments. Disposable accessories, such as latex gloves, should be discarded properly after use.

5.4 Soil Sampling

5.4.1.1 Collection of soil samples is proposed at depths of 0.5, 1.5, 3.0 and 6.0m below ground level (mbgl) using inspection pits (0.5 and 1.5mbgl) and boreholes (3.0 to 6.0mbgl). Borehole sampling should be undertaken by means of dry rotary drilling method (without the use of flushing medium to prevent cross-contamination during sampling). The on-site Land Contamination Specialist will decide on the appropriate depths of sampling at each point according to the actual site conditions.

5.4.1.2 An undisturbed U100 sample should be collected from each sampling depth except at the depths of 0.5 and 1.5mbgl where inspection pit should be employed for the collection of disturbed samples. The disturbed samples should be placed in pre-cleaned glass sample jars. The jars should be covered with laboratory solvent washed aluminium foils and lids. Each jar should be labelled properly and details of the sampling locations and other pertinent data should also be recorded. All samples should be stored in icebox between $2^{o}C – 4^{o}C$ while in the field or in transit and a chain-of-custody form for samples delivery should be completed after samples collection.

5.5 Strata Logging

5.5.1.1 Strata logging for boreholes should be undertaken during the course of drilling/digging and sampling by a qualified geologist. The logs should include the general stratigraphic description, depth of soil sampling, sample notation and level of groundwater (if encountered).

5.6 Groundwater Sampling

5.6.1.1 Groundwater samples should be collected at each drillhole when encountered. Since there is no available historical drillhole record at the time of preparation of this report, the decision on groundwater samples collection would rest with the on-site Land Contamination Specialists in accordance with the actual geological situation.

5.6.1.2 Each sample should be truly representative of the groundwater at the point from which it is taken, without dilution or contamination by water from other sources or by other materials.

5.6.1.3 A groundwater monitoring well should be installed at each borehole, and upon completion of installation of monitoring wells, distilled water of approximately five times the volume of the well should be used to flush and remove the silt and drilling fluid residues in 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 by dip meter and interface

probe respectively, before groundwater samples are taken. Moreover, prior to groundwater sampling, the well should be purged (by distilled water at least three times the volume of the well) to remove the fine-grained materials and before collecting the freshly refilled groundwater samples. After purging, one groundwater sample should then be collected at each sampling location with a Teflon bailer. The free products, if present, should be sampled to allow identification by the laboratory. Typical details of a groundwater monitoring well is shown in **Appendix I**.

5.6.1.4 If the permeability of the surrounding strata and storage is low, the process of well purging may dry up the hole, in which case the on-site Land Contamination Specialist should decide whether the requirements to purge three times the liquid volume should be waived.

5.6.1.5 After the dewatering process (and allowing groundwater to percolate back into the hole if it has been purged dry), enough quantity of groundwater sample should be collected from each drillhole, and then stored in different sample containers for analysis. Immediately after collection, samples should be transferred to labelled sample containers containing the necessary preservatives (supplied by the laboratory). Details of the sampling locations and other pertinent data should be recorded. All groundwater samples should be stored in icebox between $2^{o}C$ – $4^{o}C$ while in the field or in transit and a chain-of-custody form for samples delivery should be completed after samples collection.

5.7 Sample Size and Handling Criteria

5.7.1.1 Recommended sample size, sample containers and preservative procedures for each chemical analysis of the soil and groundwater is summarised in **Table 5.2**. The containers should be marked with sampling locations and the depths at which the samples were taken. Samples shall be stored between $2^{o}C$ – $4^{o}C$, and delivered to the laboratory within 24 hours.

Table 5.2: Summary of sample size and handling criteria

Analytical Parameters	Sample Size	Sample Containers	Preservation	Notes
Soil Sample				
All major analyses in soil sample	2 x 500g	Glass jar with Teflon lined lid	Refrigeration at $2^{o}C$ – $4^{o}C$	The sampling jar must be filled to minimise headspace when volatile parameters are to be determined.
Groundwater sample				
PCRs (C6 – C8)	2 x 40ml	Glass vial with Teflon lined lid	Hydrochloric aicd (HCL), refrigeration at $2^{o}C$ – $4^{o}C$	The vials must be filled for zero headspace.
VOCs				

Analytical Parameters	Sample Size	Sample Containers	Preservation	Notes
PCRs (C9 – C16)	1L	Amber glass bottle with Teflon lined cap	Refrigeration at 2°C – 4°C	-
PCRs (C17 – C35)				
SVOCs				
PCBs				
Mercury	250ml	Clear plastic bottle	Nitric acid (HNO^3), refrigeration at 2°C – 4°C	For Dissolved Metals, the sample must be filtered prior to acidification.

5.8 Analytical Parameters

5.8.1.1 Historical land use and the information collected during the site survey, with reference to RBRGs and EPD's *Practice Guide for Investigation and Remediation of Contaminated Land* have formed the basis for the selection of key chemicals of concern (COCs).

5.8.1.2 The collected soil and groundwater samples should be analyzed for the parameters in accordance with the historical and current land use types of the premises where the borehole is located. The proposed soil and groundwater testing schedule for the potentially contaminated sites as identified in **Section 5.1** is summarized in **Appendix J**. The soil and groundwater samples should be analysed by a HOKLAS accredited laboratory in accordance with the analytical methods given in **Table 5.3**. The proposed testing parameters include:

- ***Volatile Organic Compounds (VOCs)****:* Acetone, Benzene, Bromodichloromethane, 2-Butanone, Chloroform, Ethylbenzene, Methyl tert-Butyl Ether, Methylene Chloride, Styrene, Tetrachloroethene, Toluene, Trichloroethene, Xylenes (total)
- ***Semi Volatile Organic Compounds (SVOCs)****:* Acenaphthene, Acenaphthylene, Anthracene, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(g.h.i)perylene, Benzo(k)fluoranthene, Bis-(2-Ethylhexyl)phthalate, Chrysene, Dibenzo(a,h)anthracene, Fluoranthene, Fluorene, Hexachlorobenzene, Indeno(1,2,3-cd)pyrene, Naphthalene, Phenanthrene, Phenol, Pyrene
- ***Metals****:* Antimony, Arsenic, Barium, Cadmium, Chromium III, Chromium VI, Cobalt, Copper, Lead, Manganese, Mercury, Molybdenum, Nickel, Tin, Zinc
- ***Petroleum Carbon Ranges (PCRs)****:* Carbon Ranges C6-C8, C9-C16 and C17-C35

- ***Dioxins / Polychlorinated Biphenyls (PCBs)***: Dioxins (I-TEQ), PCBs

5.8.1.3 The testing parameters outlined above are tentative and are based on the contaminated land use types which were identified through desktop review and peripheral site inspections. The testing parameters should be revisited upon re-appraisal of the identified contaminated sites after land resumption.

5.8.1.4 A HOKLAS accredited testing laboratory should be appointed to conduct chemical analysis for the soil and groundwater samples. All laboratory test methods should be accredited by the HOKLAS or one of its Mutual Recognition Arrangement Partners.

Table 5.3: Proposed analytical method for soil and groundwater samples

Parameter	Referenced Analytical Method	Reporting Limit for Soil (mg/kg)	Reporting Limit for Groundwater (mg/L)
VOCs			
Acetone	USEPA(1) Method 8260	50	0.5
Benzene		0.2	0.005
Bromodichloromethane		0.1	0.005
2-Butanone		5	0.05
Chloroform		0.04	0.005
Ethylbenzene		0.5	0.005
Methyl tert-Butyl Ether		0.5	0.005
Methylene Chloride		0.5	0.05
Styrene		0.5	0.005
Tetrachloroethene		0.04	0.005
Toluene		0.5	0.005
Trichloroethene		0.1	0.005
Xylenes (Total)		2	0.02
SVOCs			
Acenaphthlene	USEPA Method 8270	0.5	0.002
Acenaphthene		0.5	0.002
Anthracene		0.5	0.002
Benzo(a)anthracene		0.5	-
Benzo(a)pyrene		0.5	-
Benze(b)floranthene		1.0	0.001
Benzo(g,h,i)perylene		0.5	-
Benzo(k)fluoranthene		1.0	-

Parameter	Referenced Analytical Method	Reporting Limit for Soil (mg/kg)	Reporting Limit for Groundwater (mg/L)
Bis-(2-Ethylhexyl)phthalate		5.0	-
Chrysene		0.5	0.001
Dibenzo(a,h)anthracene		0.5	-
Fluoranthene		0.5	0.002
Fluorene		0.5	0.002
Hexachlorobenzene		0.2	0.004
Indeno(1,2,3-cd)pyrene		0.5	-
Naphthalene		0.5	0.002
Phenanthrene		0.5	0.002
Phenol		0.5	-
Pyrene		0.5	0.002
Metals			
Lead	USEPA Method 6020	1	-
Antimony		1	-
Arsenic		1	-
Barium		1	-
Cadmium		0.2	-
Cobalt		1	-
Copper		1	-
Manganese		1	-
Molybdenum		1	-
Nickel		1	-
Tin		1	-
Zinc		1	-
Mercury	APHA[(2)] Method 3112B	0.2	0.0005
Chromium III	By Calculation[(3)]	1	-
Chromium VI	USEPA Method 3060 APHA[(2)] Method 3500 Cr: D	1	-
PCRs			
C6-C8	USEPA 8260/8015	5	0.02
C9-C16		200	0.5
C17-C35		500	0.5
Dioxins/ PCBs			
Dioxins (I-TEQ)	USEPA 1613B USEPA 8290	0.0001	-

Parameter	Referenced Analytical Method	Reporting Limit for Soil (mg/kg)	Reporting Limit for Groundwater (mg/L)
PCBs	USEPA 8270	0.1	0.001

Notes:

1. "USEPA" refers United States Environmental Protection Agency
2. "APHA" refers American Public Health Association.
3. Chromium III = Total Chromium – Chromium VI.

5.8.1.5 It should be noted that the aforementioned sampling and testing strategy is tentative and will be updated based on the information gathered from the re-appraisal of potentially contaminated land uses as mentioned in **Section 5.1**. Once the future development layout has been confirmed by the final Development Plan and the area is handed over to the PP, the PP should further re-appraise the Assessment Area to assess the latest site situation and to identify any further areas which require environmental SI. The latest information from the re-appraisal should be taken into consideration for selecting the site specific chemical of concerns (COCs) with reference to RBRGs and EPD's *Practice Guide for Investigation and Remediation of Contaminated Land*. All updated information including the proposed hot spots locations and site specific COCs should be included in the supplementary CAP and submitted to EPD for agreement prior to commencement of the SI.

5.9 Storage of Surplus Soil Samples

5.9.1.1 The possibility of carrying out in situ and ex situ remediation and recycling and reuse of remediated materials should be explored as priority. Off-site disposal of contaminated materials to landfills should be adopted as a last resort. In the event that landfill disposal is required, additional tests in terms of Toxicity Characteristics Leaching Procedure (TCLP) should be required to meet the criteria for disposal to landfills. Hence, surplus soil samples obtained during the site investigation should be stored for subsequent TCLP tests if deemed necessary."

5.9.1.2 The allowable storage time for mercury in soil samples is 8 days while the storage time for the rest of the parameters in **Table 5.3** in soil samples could be up to 6 months. Soil samples, if stored beyond the allowable storage time, are not considered representative of the actual site conditions.

5.9.1.3 Nevertheless, as mentioned in **Section 4.3**, feasible measures should be implemented to minimize or avoid disposal of contaminated soils off site. Any contaminated soils would be handled, treated and re-used on site as far as practicable.

5.9.1.4 The landfill disposal criteria for contaminated soil are shown in **Table 5.4.**

Table 5.4: Landfill disposal criteria for contaminated soil

Parameter	TCLP Limit (mg/L)	Referenced Analytical Method	Reporting Limit (mg/L)
Cadmium	10	USEPA Method 1311 and 6020	0.01
Chromium	50		0.1
Copper	250		0.1
Nickel	250		0.1
Lead	50		0.1
Zinc	250		0.1
Mercury	1	USEPA Method 1311 and 6020	0.002
Tin	250		0.1
Silver	50		0.1
Antimony	150		0.1
Arsenic	50		0.1
Beryllium	10		0.1
Thallium	50		0.01
Vanadium	250		0.1
Selenium	1		0.02
Barium	1000		0.1

Ref: EPD's *Practice Guide for Investigation and Remediation of Contaminated Land*

5.10 Quality Control and Quality Assurance (QA/QC)

5.10.1.1 A proper QA/QC programme should be established to ensure that the data collected are accurate and representative of the actual soil and groundwater conditions. The QA/QC programme should include the following:

- 1 duplicate per 20 samples;
- 1 equipment blank per 20 samples;
- 1 field blank per 20 samples; and
- 1 trip blank per trip for the analysis of volatile parameters.

5.11 Sample Handling, Packaging and Transport

5.11.1.1 The soil and groundwater sampling should be conducted by an experienced sampling technician (provided by the GI Contractor) and supervised by an on-site Land Contamination Specialist. Appropriate procedures should be adhered to. Sampling methodologies are based on the techniques developed by the USEPA. Sampling tools should be cleaned thoroughly before, in-between and after each sampling. Special care should be taken to prevent any cross contamination of samples during collection, handling and storage.

5.11.1.2 Sample containers should be laboratory cleansed, airtight, and made of glass or other suitable materials with Teflon-lined lids so that the container does not reach with the sample or absorb contaminants. Care should be taken when recording and labelling the sample information

on the containers. Information such as the sampling date/ time, sampling locations, depths, and any other relevant data should be recorded. Samples should be stored in an icebox (at about $2^{o}C – 4^{o}C$) immediately after collection and labelled, until they are transported to laboratory for analysis.

6 Remedial Measures

6.1.1.1 Following the submission of the supplementary CAP and completion of the SI and laboratory testing works, a CAR should be prepared. The CAR should present findings of the SI works and evaluate the level and extent of potential contamination of the Assessment Area. The CAR should evaluate the potential environmental and human health impact based on the extent of potential contamination identified, and make recommendation for further site investigation if necessary. If remediation is required, a RAP will be prepared. The objectives of the RAP are:

- To evaluate and recommend appropriate remedial measures for the contaminated materials identified in the assessment;
- To recommend good handling practices for the contaminated materials during all stages of the remediation works;
- To recommend approximate handling and disposal measures; and
- To formulate optimal and cost-effective mitigation and remedial measures for EPD's agreement.

6.1.1.2 A RR should be prepared to demonstrate adequate clean-up prior to the commencement of any construction works within the Assessment Area.

6.2 Possible Remediation Methods

6.2.1.1 The possible contaminants that might be found in the potentially contaminated land uses include, as previously mentioned, VOCs / SVOCs / Metals / PCRs / Dioxins / PCBs.

6.2.1.2 The criteria listed below should be used as the basis on which to address soil remediation options applicable to the subject contaminants identified:

- Technical and cost effectiveness;
- Technology development status;
- Environmental benefits and disbenefits;
- Commercial availability;
- Time allowable;
- Experience; and
- Expertise requirement.

6.3 Remediation Methods for Contaminated Soil

6.3.1.1 Common in-situ and ex-situ treatment technologies that were screened for the targeted soil contaminants are presented in **Table 6.1** below. The technologies are classified into biological treatment, physical /

chemical treatment and removal, and grouped under *in-situ* and *ex-situ* methods.

Table 6.1: Treatment technologies for contaminated soil

Technology	***In-situ* Treatment**	***Ex-situ* Treatment**
Biological Treatment	Natural Attenuation Soil Venting	Biopiling Landfarming
Physical / Chemical Treatment	Electrokinetic Separation	Solidification/Stabilization Soil Washing
Removal	NA	Excavation and Landfill Disposal

6.3.1.2 The applicability, limitations and environmental benefits and disbenefits of the above remediation techniques for VOCs / SVOCs / Metals / PCRs / Dioxins / PCBs contaminated soil are described in **Table 6.2**.

6.3.1.3 In assisting the formulation of appropriate remedial measures, the Practice Guide issued by EPD suggest the following factors to be taken into consideration when evaluating different available remediation methods:

- Degree and extent of the contamination;
- Anticipated future use of the site;
- Nature of the contaminants;
- Soil characteristics; and
- Time available for remediation.

6.3.1.4 The PP should take the aforementioned factors into consideration when formulating the remediation strategy after land resumption and completion of the SI works.

6.3.1.5 It should be noted that the "Excavation and Landfill Disposal" (i.e. off-site disposal of the treated contaminated soil) should only be considered as the last resort and contaminated soil should be remediated and reused onsite as far as practical. If landfill disposal is deemed necessary, prior agreement to the proposed disposal arrangement should be sought from the Waste Facilities Management Group, and Waste Policy and Service Group of the EPD. The final remediation / disposal requirements should be presented and addressed in the RAP which should be submitted to EPD for agreement prior to the remediation / disposal. Please revise the last sentence of the section accordingly.

6.4 Remediation Methods for Contaminated Groundwater

6.4.1.1 The applicability, limitations and environmental benefits and disbenefits of different remediation techniques for VOCs / SVOCs /

Metals / PCRs / Dioxins / PCBs contaminated groundwater are described in **Table 6.3**.

6.5 Surmountability of Potentially Contaminated Land Uses

6.5.1.1 The contamination problem in the land uses that are identified as potentially contaminated would not be considered insurmountable in the supportive view that any contaminated soil should be remediated by the Project Proponent based on the following factors below:

Size and Scale of Individually Surveyed Sites

6.5.1.2 Based on the site survey and desktop review, the vast majority of the sites have been identified as open storage or warehouses. As discussed previously, due to site access issues, only peripheral site inspections were undertaken. As such, the site inspections were unable to determine what type of goods are stored within these sites. For example, a warehouse containing office furniture supplies is unlikely to have any contamination potential, whilst a warehouse containing chemicals is likely to. Furthermore, for open storage areas and warehouses, the majority of these sites are usually kept for the storage of goods, whilst only a small portion of the site is reserved for chemical storage. As such, it is considered that if there is indeed any land contamination present at these sites, it is expected that it would be localised. Furthermore, apart from the sites which are currently used as open area storage and warehouse, over 90% of the remaining sites are less than 2,000m^2 in area w which is considered relatively small in scale. Therefore, the contamination extent, if any, caused by the operations of the identified potentially contaminated sites is anticipated to be localised.

Chemicals of Concern

6.5.1.3 Based on the COC's identified in this site appraisal (including metals, VOCs, SVOCs, PCRs and PCBs), it is considered that the remediation measures outlined in **Table 6.2** and **6.3** below have been demonstrated to effectively treat such contamination, both in soil and groundwater.

Local Remediation Experience

6.5.1.4 In addition, there are a number of relevant case studies in Hong Kong which can be referred to where these COCs have been effectively remediated, using the techniques in **Table 6.2** and **6.3** below. Such examples range from the decontamination works at the Cheoy Lee Shipyard to the decommissioning of the Kwai Chung Incinerator.

Table 6.2: List of soil remediation technologies for VOCs / SVOCs / Metals / PCRs / Dioxins / PCBs contaminated soil

Remediation Option	Applicability / Environmental Benefits	Limitations / Environmental Dis-benefits
Biopile	• Applicable for treatment of soil contaminated with PCRs , PAHs, VOCs, and SVOCs. • Effective for treatment of soil contaminated with non-halogenated VOCs and fuel hydrocarbons. • Some successful local case studies, e.g. decontamination works at the Cheoy Lee Shipyard at Penny's Bay, reclamation works at North Tsing Yi Shipyard site. • Most cost-effective for large volumes of contaminated soil • All materials and equipment are commercially available • Can be designed to be a closed system; vapour emissions can be controlled	• Labour-intensive; require considerable maintenance • Time-consuming (~1 year may be required) and not cost-effective for treating small volume of soil. • Space required for biopile construction • Halogenated VOCs, SVOCs, and pesticides can also be treated, but the process effectiveness will vary and may be applicable only to some compounds within these contaminant groups. • May not be effective for high levels of contamination.
Electrokinetic Separation	• Applicable to treat soil with low permeability and heavily contaminated with metals.	• Effectiveness dependent on moisture content of soil and decreases with moisture content less than 10%. • Require further treatment for removal of desorbed contaminants and thus increase cost of remediation. • Variability of electrical conductivity in soil may be induced by presence of anomalies such as large gravels and insulating material. This may reduce treatment effectiveness.
Soil Vapour Extraction (SVE)	• Applicable for treating soil contaminated with PCRs, VOCs and SVOCs. • Very effective at removing VOCs from unsaturated Area. With the addition of an air sparging system, contaminants can be removed from saturated Area as well.	• Treatment/ disposal of residuals liquids required. Also, regeneration or disposal of the spent activated carbon will be required. • To eliminate possible harm to the public and the environment, exhaust air from in situ SVE system may require treatment. • Soil with high organic content or is extremely dry has a high sorption capacity of VOCs, which results in reduced removal rates. • Fine grained soil or soil with a high degree of saturation will require higher vacuums (increasing costs) and/or hindering the operation of the in situ SVE system.

Remediation Option	Applicability / Environmental Benefits	Limitations / Environmental Dis-benefits
Soil Washing	• Applicable to clean inorganic contaminants such as heavy metals from coarse-grained soils.	• Effectiveness of treatment dependent on soil coarseness. • Fine soil particles may require addition of polymer for removal of contaminant by the washing fluid. • Complex waste mixtures make formulating washing fluid difficult. • Further treatment and disposal for residuals required.
Solidification /Stabilisation (S/S)	• Applicable to clean-up inorganic contaminants such as heavy metals. • Solidification/stabilisation has been used on certain contaminated sites in Hong Kong and demonstrated as a successful treatment method for inorganic contaminated soil, e.g. decontamination works at the Cheoy Lee Shipyard at Penny's Bay, reclamation works at North Tsing Yi Shipyard site and few isolated sites identified in the Deep Bay Link project.	• The effectiveness reduces with the presence of organic contaminants • Large boulders may hinder the mixing process. Soil sorting is necessary before the treatment taken place. • Organics are generally not immobilised. • Long-term effectiveness has not been demonstrated for many contaminant/ process combinations. • If VOCs/ SVOCs is present underneath, it should be removed before stabilisation/ soil solidification
Thermal Desorption	• Applicable for treating soil contaminated with PCRs, VOCs, PAHs, Dioxins, and PCBs.	• Thermal desorption have varying degrees of effectiveness against the full spectrum of organic contaminants. • Clay, silty soils and high humic content soils increase reaction time as a result of binding of contaminants. Highly abrasive feed potentially can damage the processor unit.
Excavation and Landfill Disposal	• Most simple and quickest way to dispose of large volume of contaminated soil • Contamination is removed definitely • Higher certainty of success • Wide experience in Hong Kong • Applicable to all waste or mixture that meet land disposal restriction treatment standards. • Common practice for shallow, highly-contaminated soils.	• Pre-treatment may be required for contaminated soil to meet landfill disposal criteria • Landfill space limited and valuable. • Indirect costs to the landfill management on monitoring and maintenance. • Potential long-term liabilities to landfill • Need large volume of clean backfill materials • No access to the working site until completion of backfilling • Least desirable management option.

Table 6.3: List of groundwater remediation technologies for VOCs / SVOCs / Metals / PCRs / PCBs contaminated groundwater

Remediation Option	Applicability and Environmental Benefits	Limitations and Environmental Disbenefits
Air Sparging	• Applicable for treating contaminants including PCRs, VOCs, and SVOCs. But most effective for VOCs and PCRs.	• Should ensure that there is no uncontrolled movement of potentially dangerous vapours. • Less effective in fine-grain/ low permeability soil with restricted air flow and also where depth of contaminated groundwater is shallow. • If free-floating products are present underneath, it should be removed before air sparging.
Recovery Trenches or Wells	• Applicable for treating PCRs. • To be used for free products recovery from plume. Works well for high permeability soil.	• Treatment/ disposal of recovered liquids required. • The method does not treat residual contamination in saturated soil. • The method is not applicable to contaminants with high residual saturation, contaminants with high sorption capabilities, and homogenous aquifers with hydraulic conductivity less than 10^{-5} cm/second. • Biofouling of the extraction wells and associated treatment stream is a common problem.

7 Programme Schedule

7.1.1 At this stage, the land resumption programme has yet to be confirmed as the planning and engineering study is still in progress. Nevertheless, owing to the large size of the proposed development area, it is expected that the land will be resumed at different stages of the development. Therefore, the environmental site investigation will be carried out at each potentially contaminated site once the land is resumed and the access is granted. The assessment will comprise of the following activities:

- Preparation and submission of the supplementary CAP to EPD for agreement;
- Mobilisation of the SI Contractor (pending private property access arrangements) and contracting analytical laboratory;
- Field sampling programme (number of days in field depends on the number of sites and sampling locations);
- Analytical programme/ laboratory turnaround (normal turnaround time is expected 10 days to two weeks depending on the number of samples);
- Assessment and reporting of results in a draft CAR, including, if required, development of RAP (estimate minimum of three weeks); and
- Preparation and submission of RR after the completion of remediation works.

7.1.2 A tentative programme for land contamination assessment and remediation work after land resumption is shown in **Figure 7.1**. The programme is for reference only and the actual time span will subject to the actual site condition of each concerned site.