11. LAND CONTAMINATION

11.1 Introduction

11.1.1 Contaminated land refers to the land which has been polluted by hazardous substances as a result of industrial operations carried out on site over a number of years. These contaminants, if present, may pose hazardous risks or cause adverse effects to the land users and the nearby environment.

11.1.2 The implications of land contamination associated with the Project and its works areas have been assessed with reference to the EIA Study Brief. This section summarizes the Project site appraisal results from the Contamination Assessment Plan (CAP), evaluation of potential impacts, and any recommended mitigation works, together with overall findings and recommendations relevant to the EIA.

11.2 Environmental Legislation, Standards & Guidelines

11.2.1 The relevant environmental legislation, guidelines and standards on land contamination aspect include the followings:

(i) *Section 3 (Potential Contaminated Land Issues)* of *Annex 19 "Guidelines for Assessment of Impact on Sites of Cultural Heritage and Other Impacts"* of the *Technical Memorandum on Environmental Impact Assessment Process* (EIAO-TM).

(ii) *Guidance Note for Contaminated Land Assessment and Remediation" (Guidance Note).*

Guidance Note sets out the requirements for proper assessment and management of potentially contaminated sites such as oil installations (e.g. oil depots, petrol filling stations), gas works, power plants, shipyards/boatyards, chemical manufacturing/processing plants, steel mills/metal workshops, car repairing/dismantling workshops and scrap yards. In addition, this Guidance Note provides guidelines on how site assessments should be conducted and analysed and suggests practical remedial measures that can be adopted for the cleanup of contaminated sites.

(iii) *Practice Guide for Investigation and Remediation of Contaminated Land (Practice Guide).*

Practice Guide, newly published in August 2011, presents the standard investigation methods and remediation strategies for the range of potential contaminated sites and contaminants typically encountered in Hong Kong. It has superseded the 1999 *Guidance Notes for Investigation and Remediation of Contaminated Sites of Petrol Filling Stations, Boatyards and Car Repair /Dismantling Workshop*.

(iv) *Guidance Manual for Use of Risk-based Remediation Goals for Contaminated Land Management (Guidance Manual).*

Guidance Manual introduces the risk based approach in land contamination assessment and present instructions for comparison of soil and groundwater data to the Risk-based Remediation Goals (RBRGs) for 54 chemicals of concern commonly found in Hong Kong. The RBRGs were derived to suit Hong Kong conditions by following the international practice of adopting a risk-based methodology for contaminated land assessment and remediation and were designed to protect the health of people who could potentially be exposed to land impacted by chemicals under four broad post restoration land use categories. The RBRGs also serve as the remediation targets if remediation is necessary.

11.3 Assessment Methodologies

11.3.1 The first step was to assess and identify any potentially contaminated hotspots within the Project Area. The following tasks have been undertaken to identify and evaluate the potential land contamination impacts associated with the Project:

- Desktop study to review the current and historical land uses;
- Acquisition of information related to potential land contamination from Environmental Compliance Division of Environmental Protection Department (EPD), Fire Services Department (FSD) and Water Supplies Department (WSD); and
- Site reconnaissance to identify the existing land uses and potential contamination hotspots.

11.3.2 In addition, the following sources of information have been collated and reviewed:

- Selected aerial photographs from Lands Department;
- Selected geological reports from Civil Engineering and Development Department;
- Hong Kong Geological Survey Maps (Series HGM20) – Sheet No. 7 (1:20,000);
- Information on dangerous goods and spillage incident from FSD; and
- Information on chemical wastes, records and photographs obtained during the Project site visit.

11.3.3 After completion of the Project site appraisal, the final CAP was prepared and submitted to EPD for endorsement. Based on the desktop review and site inspection, sampling locations and depths for soil and groundwater at potentially contaminated hotspots have been proposed for the Project site investigation (SI) works. The CAP also specified the sampling and testing requirements for the SI works. The endorsed CAP is given in **Appendix 11.1**.

11.4 Description of the Environment

11.4.1 The Sha Tin WTW is the largest water treatment works in Hong Kong located at Keng Hau Road, Tai Wai, New Territories. The project site covers a total area of approximately 10 hectares. The in-situ reprovisioning works under this Project comprises mainly the South Works of the existing Sha Tin WTW. The study area of the land contamination impact assessment will focus on areas within the boundary of the Project site and is shown in **Figure 11.1**.

11.4.2 The Project site is situated in a generally rural residential setting and located on flat terrain and surrounded by hills on its south, west and north direction. Mass Transit Railway Corporation (MTRC) East Rail and Old Beacon Hill Tunnel Shatin side entrance is aligned on the east side of the Project site. Hin Keng Estate is located further to the east direction of the Project site.

11.4.3 Major buildings and facilities within the Project site (**Figure 11.1**) include:

(i) *Energy Dissipating Chamber;*

(ii) *Raw Water Inlet Channel, Overflow Channel, Dividing Chamber and its Extension;*

(iii) *Clarifiers No. 1-4 and associated Distribution Chamber;*

(iv) *Filter Beds (South Works) and Filtered Gallery (South Works);*

(v) *Filtered Water Pumping Station (South Works);*

(vi) *Grit Trap and Washwater Recovery Tanks No. 1-3;*

(vii) *Chemical House and Lime Chloride Solution Preparation Tank;*

(viii) *Chlorination House (To be maintained under this Project);*

(ix) *Alum Saturator Tanks;*

(x) *Covered Storage Area (Workshops);*

(xi) *Open Storage Area;*

(xii) *Dangerous Goods Store and Chemical Waste Storage Area;*

(xiii) *Generator House;*

(xiv) *Transformer House;*

(xv) *Administration Building;*

(xvi) *Staff Quarters; and*

(xvii) *Bungalow (NTE1 Region & INSTRUMENT/M (NTE2)).*

11.4.4 Various chemicals are used in water treatment, daily maintenance and laboratory activities. The chemicals used/stored in the Project site are summarized in **Table 11.1**.

Table 11.1 Details of Chemical Storage and Usage Areas within the Project site

Usage/ Stored Location	Involved Chemicals	Purpose
Clarifiers No. 1-4	Lubrication oil and grease	Maintaining motors
Filtered Water Pumping Station (South Works)	Lubrication oil and grease	Maintaining pumps
Chemical House & Lime Chloride Solution Preparation Tank	1. Lubrication oil and grease 2. Sodium hexafluorosilicate, alum, polyelectrolyte, lime and lime chloride	1. Maintaining pumps 2. Water treatment
Alum Saturator Tanks Pump House	Lubrication oil and grease	Maintaining pumps
Generator Set for Chlorination House	Lubrication oil, grease, fuel and diesel	Driving and maintaining backup generator
Covered Storage Area (Workshops)	Lubrication oil and grease	Small scale maintenance
Open Storage Area	1. Lubrication oil or scraped metals parts from disused mechanics 2. Lubrication oil and grease	1. Temporarily storing the scraped mechanics for further collection and disposal 2. Small scale workshop and storage area for sub-contractor
Dangerous Goods Store	Lubrication oil, grease, fuel, diesel, transformer oil and laboratory used agents	Storing the chemicals for daily operation of the treatment works
Chemical Waste Storage Area	Spent lube oil	Temporarily storing the spent chemicals and containers for further collection and disposal
Transformer	Transformer oil	Electrical insulating and cooling
Generator House	Lubrication oil, grease, fuel and diesel	Driving and maintaining backup generator
Storage Compound in Staff Quarter	Bleaching solution, paint and lubricants	Storing the chemicals for daily maintenance
Bungalow	Paint and household cleansing agents	Storing the chemicals for daily maintenance

11.4.5 According to the updated information from WSD, there was one abandoned underground storage facility for diesel located next to the Transformer House beside the Administration Building. This fuel tank had been disused and emptied for more than ten years and was later filled with concrete in 2010.

11.5 Identification of Sensitive Receptors

11.5.1 Onsite construction workers have the potential to be exposed to potentially contaminated materials during the decommissioning and construction stage. Based on the EIA Study Brief, the future land uses of the Project site would remain the same presently as water treatment facilities. The operational staff and workers in the Project site have the potential to be exposed to potentially contaminated materials during the operational stage. The principle exposure pathways for onsite workers include:

- Direct ingestion of contaminated soil through eating, drinking or smoking onsite; and
- Dermal contact with contaminated soil.

11.5.2 Through the correct implementation of occupational health and safety guidelines and usage of correct personal protective equipment these potential pathways can be successfully managed.

11.6 Assessment of Environmental Impacts

11.6.1 Land contamination impacts refers to the potential impacts arisen from the land which has been polluted by contaminants as a result of its operations carried out onsite over a period of time. Site investigation should be conducted before construction commences in order to identify any contaminants that may pose hazardous risks or cause adverse effects to the future uses. If present, remediation works should be carried out to clean up the contaminants to below corresponding RBRGs.

Construction Stage

11.6.2 Potentially contaminated land within the Project site has been identified in the CAP through the Project site appraisal exercise. The list of potentially contaminated hotspots identified within the Project site is summarised in **Table 11.2** below and shown in **Figure 11.2**.

Table 11.2 Potentially Contaminated Hotspots Identified

Area ID	Current Land Use (Size)	Reference Figure
A	Filtered Water Pumping Station (South Works) (~540 m^2)	Figure 11.3
B	Chemical House (~2,600 m^2)	Figure 11.4
C	Pump House of Alum Saturator Tanks (~20m^2)	Figure 11.5
D	Generator Set for Chlorination House (~30m^2)	Figure 11.6
E	Covered Storage Area (Maintenance Workshop) (~500 m^2)	Figure 11.6
F	Open Storage and Contractor Workshop (~1,400 m^2)	Figure 11.7
G	Dangerous Goods Store and Chemical Waste Storage Area (~100 m^2)	Figure 11.8
H	Generator House (~18m^2)	Figure 11.9
I	Transformer (~30m^2)	Figure 11.9
J	Lawn beside Access Road to Washwater recovery Tanks (The Scene of Crane Lorry Overturn Incident) (~25m^2)	Figure 11.10
K	Staff Quarters Storage Compound (~240m^2)	Figure 11.11
L	Disused Diesel Storage Tank (~4m^2)	Figure 11.9

11.6.3 Potential contaminants in the soils and groundwater have been identified in CAP according to the Project site appraisal findings (e.g. chemicals used/ stored) and the Practice Guide. A total of 44 sampling locations were proposed at the Project site as scheduled in the CAP. The proposed locations are shown in **Figure 11.3** to **11.11**.

11.6.4 The Project site is a part of the water treatment works and a secure and safe water supply is crucial to the operation of the whole water treatment works. As all the SI works are proposed underneath the equipment and processing tanks which might cause process interruption and potential contamination of drinking water, it is not possible to be conducted during the operational period of the Project site. Therefore, SI will be conducted upon decommissioning and prior to the commencement of construction works at the potentially contaminated hotspots.

11.6.5 Further site inspection should be carried out before conducting SI to confirm the latest site conditions and verify the applicability of the CAP. If there are any changes in site conditions, a revised CAP detailing the revised sampling and testing plan should be submitted to EPD for endorsement.

11.6.6 Based on the EIA Study Brief, the future land uses of the Project site would remain the same presently as water treatment facilities. According to the Guidance Manual, the corresponding RBRGs land use for public utility would be "Industrial", which would be adopted as the assessment criteria for this land contamination assessment. As fluoride is not included in the RBRG list, a "ceiling limit" of 10^4 mg/kg applicable for relatively less toxic inorganic in soil would be adopted for assessing soil contamination for Fluoride; another guideline "US Environmental Protection Agency Regional Screening Levels for Chemical Contaminants at Superfund Sites" (RSLs) which has been widely used in other countries for initial soil screening for remediation would be adopted for assessing groundwater contamination for fluoride.

11.6.7 A Contamination Assessment Report (CAR) and if contamination is found, a Remediation Action Plan (RAP) will be prepared according to the abovementioned guidelines and submitted to EPD for endorsement after SI to summarize the analytical results and propose any necessary remedial actions. A Remediation Report (RR) will be prepared and submitted to EPD to demonstrate that the decontamination work is adequate and is carried out in accordance with the endorsed CAR and RAP. Information such as soil treatment/ disposal records (including trip tickets), confirmatory sampling results, and photographs will be included in the aforesaid RR. No construction work will be carried out prior to the endorsement of the RR by EPD.

Operational Stage

11.6.8 As SI will be conducted prior to the commencement of construction works, any contaminated soil and groundwater, if present, should be treated before carrying out any construction works. Therefore, there should be no impact during the operational stage.

11.7 Mitigation of Environmental Impacts

Review of Remediation Options, Methods and Targets

11.7.1 Based on the findings of SI, if contamination is found, appropriate remediation methods should be investigated. The following factors should be considered when evaluating different remediation methods:

- Nature and level of contamination;
- Extent of contamination;
- Site characteristics (such as site hydrogeology, soil and groundwater chemical characteristics);
- Site constraints (such as available space, surrounding areas); and
- Time available for remediation.

11.7.2 Remediation options applicable to the Project site should be addressed based on the following criteria:

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

11.7.3 According to the CAP, the potential contaminants at the Project site will be determined after site investigation works. Towards the potential contaminants, the applicability and limitations of potential remediation techniques for soil and groundwater for this Project are detailed in **Table 11.3** below.

Table 11.3 Potential Remediation Techniques

Remediation Measures	Descriptions	Applicability	Limitations
Soil			
Biopile	Bioremediation method that bacteria grow in the piled contaminated soil and degrade the waste into harmless products.	• Very effective to petroleum carbon ranges with few successful local case studies • Most cost-effective for large volumes of contaminated soil • Can be designed to be a closed system; vapor emissions can be controlled	• Labour-intensive; require considerable maintenance • Space required for biopile construction • Time-consuming (~1 year required) and not cost-effective for treating small volume of soil.
Soil venting	*in situ* bioremediation method that uses indigenous bacteria to degrade contaminants. Activity of the bacteria is enhanced by inducing air flow (using extraction or injection wells) and, if necessary, by adding nutrients.	• Very effective to petroleum carbon ranges • Suitable for remediation in built up areas because wells can be placed between or below buildings • Applicable to large sites with widespread contamination • Uses readily available equipment; easy to install • Vapour emissions can be controlled but not to the extent of biopiling due to underground soil *in situ* properties	• This method is usually applied for the case with large area of organic contaminated soil. • Effectiveness is limited by underground soil features e.g. soil moisture content, permeability, etc. • May induce possible air emission to the sensitive receivers. • Require large space for the system development.

Remediation Measures	Descriptions	Applicability	Limitations
Soil Washing	*ex situ* soil separation processes mostly based on mineral processing techniques. It is a water-based process for scrubbing soils *ex-situ* to remove contaminants.	• Applicable to clean organic and inorganic contaminants from coarse-grained soils	• The effectiveness of the treatment depends on soil particle size. Fine soil particles (e.g. silt) may require the addition of a polymer to remove them from the washing fluid. • Complex waste mixtures make formulating washing fluid difficult. • Require further treatment and disposal for residuals.
Chemical Methods	Include chemical oxidation, dehalogenation, soil flushing, solvent extraction, etc. Use chemicals to destroy pollutants in soil.	• Destroys pollution *in situ* without having to dig it up for transport to a treatment system • Significant cost savings	• Chemicals used are site specific and depend on the contaminants present. Very specialized contractors required. • Requires handling of large quantity of hazardous oxidizing chemicals. • Effectiveness less certain when applied to sites with low-permeability soil or stratified soils
Solidification/ Stabilization	*ex-situ* immobilization technique treats contaminated soil by mixing soil with binding agents, e.g. cement so that the contaminants become physically bound within stable mass.	• Applicable to clean-up inorganic contaminants such as heavy metals • Solidification/stabilization has been used on certain contaminated sites in Hong Kong and demonstrated as a successful treatment method for inorganic contaminated soil.	• 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.
Landfill Disposal	*ex-situ* method whereby contaminants are removed by excavation of the contaminated soil and direct disposal to landfill	• Applicable to all waste or mixture but it should be considered as the last resort • Cost-effective for localized and small quantity of soil contamination • Short clean-up time • Contamination is removed definitely	• Landfill space limited and valuable • Indirect costs to the landfill management on monitoring and maintenance • Least desirable management option. • All contaminated soil to be disposed in the landfill should meet the Landfill Disposal Criteria, as stipulated in Table 4.4 of Practice Guide and obtain EPD's approval.
Groundwater			

Remediation Measures	Descriptions	Applicability	Limitations
Air Sparging	*in situ* technology in which air is injected into the subsurface saturated zone to remove the contaminants dissolved in groundwater	• The target contaminant groups are VOCs and fuels. • Implemented with minimal disturbance to site operations • Requires no removal, treatment, storage, or discharge considerations for groundwater.	• Cannot be used if free product exists. • Requires detailed pilot testing and monitoring to ensure vapor control and limit migration. • Air injection wells must be designed for site-specific conditions. • Stratified soils may cause air sparging to be ineffective.
Recovery Wells/ Trenches	Free product is recovered from a pit or trench without recovering groundwater	• Applicable to settings in which the amount of free product is small and exists in permeable conduits such as utility bedding or buried underground open structures • Low cost and simple operation and maintenance • Ideal for shallow groundwater level and soil excavation works	• Recovery rates depend on pit/trench size • Frequent media replacement • Requires manual adjustment
Chemical Methods	Include chemical oxidation, dehalogenation, soil flushing, solvent extraction, etc. Use chemicals to destroy pollutants in groundwater.	• A wide range of contaminants are treatable. • Destroys pollution *in situ* without having to pump it out for transport to a treatment system. • Relatively low cost	• Chemicals used are site specific and depend on the contaminants present. Very specialized contractors required. • Requires handling of large quantity of hazardous oxidizing chemicals. • Effectiveness less certain when applied to sites with low-permeability soil or stratified soils.

11.7.4 For any contamination found, in-situ remediation measures and possible recycling and reuse of remediated materials should be considered as the preferred remediation options whereas ex situ remediation the second. Due to limited space in landfills, offsite disposal to landfill will only be considered as the last resort. For any soil or groundwater contaminated with both organic carbon and heavy metals, the remediation method should be chosen with caution as certain contaminants present may affect the effectiveness of other remediation methods.

11.7.5 Closure assessment should be carried out to confirm the completion of remediation of the Project site and ensure that the soil and groundwater are treated to meet the cleanup targets. Confirmatory samples should be collected to analyze for the targeted contaminants. A RR shall be submitted to EPD to report on the remediation process and demonstrate that contaminated soils and groundwater are all treated to meet the relevant standards or properly handled. All relevant information, including details of closure assessment, sampling results, photographs and certification of independent checker, the quantities of treated soil and recovered free product, final backfill site of treated soil and disposal site of free product shall be included in the RR.

11.7.6 According to the findings from the desktop review and site appraisal, if land contamination was identified, the impact should not be insurmountable as the remediation options recommended in the Practice Guide would be applicable.

Proposed Precautionary Measures to Be Undertaken during Construction

11.7.7 Although no SI is proposed for other areas (e.g. Administration Building and Bungalow) within the Project site, to be conservative, precautionary measures such as visual inspection are recommended to be undertaken during soil excavation and handling activities. The inspection process shall involve a visual observation of excavated soils for discolouration and the presence of oils, together with identifying the presence of odours, which may also indicate soil and/or groundwater contamination.

11.7.8 If soil materials suspected to be contaminated are encountered during excavation, sampling and testing shall be undertaken to verify the presence of contamination. The soil extracted during demolition and excavation shall be temporary stockpiled. Should the concentrations of contaminants of concern (COCs) exceed relevant RBRGs as indicated by laboratory analyses, remediation works shall be undertaken with reference to the CAR and RAP.

Recommended Health and Safety Measures and Environmental Mitigation Measures during Remediation

11.7.9 In order to minimise the potential environmental impacts arising from the handling of potentially contaminated materials, the following environmental mitigation measures are recommended during the course of the Project site remediation:

- Excavation profiles must be properly designed and executed with attention to the relevant requirements for environment, health and safety;
- Excavation should be carried out during the dry season as far as possible to minimise contaminated runoff from contaminated soils;
- Supply of suitable clean backfill material is needed after excavation;
- In case chemicals are used in remediation, they should be stored securely, separately and away from sources of ignition or oxidizable items. Handling should be undertaken by persons specifically trained and wearing appropriate PPE.
- Vehicles containing any excavated materials should be suitably covered to limit potential dust emissions or contaminated wastewater run-off, and truck bodies and tailgates should be sealed to prevent any discharge during transport or during wet conditions;
- Speed control for the trucks carrying contaminated materials should be enforced;
- Vehicle wheel and body washing facilities at the Project site's exit points should be established and used; and
- Pollution control measures for air emissions, noise emissions, and water discharges should be implemented and complied with relevant regulations and guidelines.

11.7.10 In order to minimise the potential adverse effects on health and safety of construction workers during the course of site remediation, the Occupation Safety and Health Ordinance (OSHO) (Chapter 509) and its subsidiary Regulations should be followed by all site personnel working on the Project site at all times. In addition, basic health and safety measures should be implemented, but not limited to the followings:

- Set up a list of safety measures for site workers;
- Provide written information and training on safety for site workers;
- Keep a log-book and plan showing the contaminated zones and clean zones;
- Maintain a hygienic working environment;
- Avoid dust generation;
- Provide face and respiratory protection gear to site workers if necessary;

- Provide personal protective clothing (e.g. chemical resistant jackboot, liquid tight gloves) to site workers if necessary; and
- Provide first aid training and materials to site workers.

11.8 Evaluation of Residual Impacts

11.8.1 SI is proposed for the potentially contaminated hotspots within the Project site. In terms of the potential soil and groundwater contamination detected in SI, options of remediation methods will be reviewed and implemented so that contaminants will be removed to achieve the remediation targets. After completion of remediation for any identified contaminated areas, no adverse impact in respect of land contamination on the future users is anticipated. Apart from these, precautionary measures as mentioned in **Sections 11.7.7** through **11.7.8** should be implemented during the construction phase for conservancy.

11.9 EM&A Requirements

11.9.1 SI works should be conducted upon decommissioning and prior to the commencement of construction works at the potentially contaminated hotspots according to the CAP. Further site inspection should be carried out before conducting SI to confirm the latest site conditions and verify the applicability of the CAP. If there are any changes in site conditions, a revised CAP detailing the revised sampling and testing plan should be submitted to EPD for endorsement.

11.9.2 After SI, CAR and if contamination is found, RAP should be prepared and submitted to EPD for endorsement. A RR should be prepared and submitted to EPD to demonstrate that the decontamination work is adequate and is carried out in accordance with the endorsed CAR and RAP. No construction works should be carried out prior to the completion of remediation.

11.10 Conclusion

11.10.1 This assessment has examined the potential contaminating land uses within the Project site. It also covers potential impacts of the contamination on future use. The assessment involved site appraisal and preparation of CAP. Site investigation will be carried out at the decommission stage of the Project site due to site access and sensitive nature of the water works. Based on the findings in the site investigation, if any contamination is found, appropriate remediation measures shall be identified and carried out before construction commences, so as to clean up the Project site to the relevant RBRGs. With the remediation and mitigation measures in place, the potential land contamination impacts to the sensitive receptors and future use as water treatment facilities are thus not considered to be insurmountable. As a precaution, mitigation measures are proposed for the excavation of soil, treatment of soil and general environmental, health and safety on site during the construction stage.

~ End of Section 11 ~