11. LAND CONTAMINATION

11.1 Introduction

11.1.1 Since Kau Sai Chau has been used as an artillery range in between 1930's and mid-1970's, there may be potential land contamination problem arising from the former artillery range. This section presents the assessment of the potential environmental issues related to land contamination and the potential for the occurrence of ground contamination within the project boundary. Operation phase impacts due to the use of turfgrass chemicals (fertilizers and pesticides) are also addressed in this section.

11.2 Environmental Legislation, Policies, Plans, Standards and Criteria

11.2.1 Two publications issued by the Environmental Protection Department (EPD), *Professional Persons Environmental Consultative Committee Practice Note 3/94 - Contaminated Land Assessment and Remediation* (ProPECC PN 3/94) and *Guidance Notes for Investigation and Remediation of Contaminated Sites of Petrol Filling Stations, Boatyards, and Car Repair/Dismantling Workshops* (EPD's Guidance Notes), provide the guidance on land contamination assessment. In the absence of any formal legislation for the cleanup of soil and groundwater contamination in Hong Kong, the "*Dutch Ministry of Housing, Planning and Environmental Soil and Groundwater Standards*" (the Dutch Guidelines) (1994) are used as reference criteria by the EPD for the classification of contaminated materials. The Dutch B level is normally used as the cleanup target for soil while for groundwater concentrations exceeding Dutch B level, a risk-based assessment is needed to establish the nature and extent of remediation required.

11.2.2 Land contamination assessments and the potential impacts are guided in 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* (EIA-TM). Considerations shall be given to a number of potentially contaminating historical land uses, including petrol filling stations, oil installations, shipyards/boatyards, car repairing and dismantling, power plants and gas works. If these land uses are identified, then the applicant is required to generate a Contamination Assessment Plan (CAP).

11.2.3 The following legislation, documents and guidelines are also relevant to the land contamination issues due to the handling, treatment and disposal of contaminated waste in Hong Kong:

- *Water Pollution Control Ordinance (Cap 358)*;
- *Waste Disposal Ordinance (Cap 354)*;
- *Waste Disposal (Chemical Waste) (General) Regulation (Cap 354)*; and
- *Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes, EPD (1992).*

11.2.4 According to Lands Department Technical Circular No. 735A, the proposed golf course is regarded as a contaminated usage.

11.3 Assessment Methodology

11.3.1 The objectives of the current land contamination study are listed as follows:

- to identify any potential land contamination problem arising from the former artillery range;
- to predict and evaluate the potential risks or impacts generated by the land contaminated by the former artillery range; and
- to recommend the possible remediation options.

11.3.2 In order to accomplish the objectives, the following methodology has been adopted in this land contamination study:

- a desktop study to review the current and historical land uses of Kau Sai Chau in order to identify any potential contamination areas based on a clear and detailed account of the relevant past and present records;
- a description of the likely nature of any potential contamination;
- a review of relevant literature or information related to the former artillery range on Kau Sai Chau; and
- a site reconnaissance to identify the existing land uses.

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

- aerial photographs of Kau Sai Chau between 1991 and 2000;
- Hong Kong Government Survey Map of Kau Sai Chau; and
- records and photographs from site visits.

11.4 Identification of Sensitive Receivers

11.4.1 Construction workers are more likely to be exposed to any potential contaminated material than the future land users within the Study Area. It is because the construction workers could be exposed to potential contamination during excavation and preparation of foundation works. Depending on the nature of the contaminants, hazard during preparation of foundations and subsurface services may be significant. The principal exposure routes for workers include:

- direct ingestion of contaminated soils through eating, drinking or smoking on site;
- dermal contact with contaminated spoil; and
- inhalation of contaminations if they are volatile.

11.4.2 If there is severe groundwater contamination, it can also be regarded as a source of water pollution in coastal areas or near natural streams as a result of percolation and infiltration.

11.5 Description of Existing Environment

11.5.1 The Study Area of the land contamination assessment includes the area within the project boundary.

11.5.2 Based on the site reconnaissance conducted in July 2005, majority of the proposed works has been visited. Most areas were grassland, shrubland and woodland, where plants were grown prosperously, except for some eroded areas. There were few streams flowing towards the coast. As the artillery range has been closed for twenty years, no obvious land contamination was observed during the site visit.

11.6 Review of Historic and Current Land Uses

11.6.1 According to the report written by William Meacham published at the website http://www.hku.hk/hkprehis/earliest.htm, most of the land on Kau Sai Chau was used as an artillery range from 1936 to the mid-1970's, except for the period of Japanese occupation in between 1941 and 1945. However, the exact location of the artillery range cannot be located.

11.6.2 The site history information of the Study Area was also obtained by reviewing the relevant aerial photographs. Table 11.1 summaries the aerial photographs which have been reviewed.

Table 11.1 Aerial Photographs Reviewed

Year	Photograph Reference No.	Altitude (Feet)	Notes
1991	CN17350	-	Before construction of public golf course
2000	CN26878	4,000	Public golf course in place
	CN26876		Outlook of the project area

11.6.3 A review of selected historical aerial photographs indicates that the appearance of Kau Sai Chau in different years. The historical changes in land uses within the Study Area are described below:

- In 1991, the rural area with small villages in both northern and southern parts of the island. main land uses of the Study Area were village and farmland. It can be observed that there were some eroded slopes running from the northwest direction to the centre of the island. Perhaps they were caused by the wind erosion or the ordnance. Besides, there was no deep scare on Kau Sai Chau. At the time, the construction of the public golf course has not been planned.
- In 2000, the public golf course was in place in the northern part of Kau Sai Chau. A reservoir was built in the north of the island. Some eroded slopes were recovered but some still existed in the centre of the island. The village in the north were removed while that in the south still existed.

11.6.4 Except for the use of artillery range in between 1930's and 1970's, no other land use having potential land contamination is envisaged.

11.7 Impact Evaluation

Potential Sources of Land Contamination

11.7.1 The expected contaminants that may be found on Kau Sai Chau are mainly bullets, gun powder, residues of exploded ordnance or even some buried ordnance. The potential contaminants associated with the artillery range are listed in Table 11.2

Table 11.2 Potential Contaminants associated with the Artillery Range

Land Use	Potential Contaminant
Artillery Range	Heavy Metals and Sulphur

Prediction and Evaluation of Environmental Impacts

11.7.2 A preliminary site investigation was conducted on 12th July 2005. The purpose of the site investigation is to confirm if there is any contaminated area within the project boundary.

11.7.3 During the site investigation, eight sampling areas were selected at the proposed work areas of the third golf course and their locations are shown in Figure 11.1. These sampling points were chosen randomly within the work areas but the eroded areas are the primitive. The sampling size is considered adequate for the purpose of assessing the level of contamination caused by the artillery range.

11.7.4 Nevertheless, soil sampling at location 2 could not be performed during the EIA stage due to access problem. It is therefore proposed to carry out the assessment at this point during the construction stage.

Sampling Depth

11.7.5 Surface contamination is considered to be the major area of contamination due to the artillery range at Kau Sai Chau unless there were aircraft and artillery ordnance which could be embedded up to five metres beneath the surface and of course there would also be a deep scare to the victim area. Samples at the surface (5cm to 10cm) were collected at each sampling location to confirm any contamination.

Sampling Method

11.7.6 The sampling procedures were carried out according to the requirements in the EPD's Guidance Notes. The site investigation for the land contamination was supervised by an experienced environmental scientist.

11.7.7 Sampling was undertaken by means of trail pits dug by a shovel or hoe. A total of 7 soil samples were taken, and all the samples were uniquely labelled and described on-site prior to sending to a HOKLAS accredited laboratory for analysis.

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

11.7.9 All equipments in contact with the ground were thoroughly decontaminated prior to use at each sampling location by scrubbing with a lab-grade detergent. The following was the standard procedure for cleaning drilling equipment and sampling equipment on site:

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

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

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

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

11.7.10 The samples were scooped directly from the sampling tool into the sample containers. A plastic scoop was employed. If a gloved hand came into contact with the sample, then new gloves were used for each sample.

Laboratory Analysis

11.7.11 As described in Table 11.2, the expected contaminants that may be found are mainly heavy metals and sulphur. The collected soil samples were therefore dispatched to a HOKLAS accredited laboratory for analysis of the contaminants described in Table 11.3.

Table 11.3 Contaminants Analyzed

Samples	Contaminants Analyzed
All	Heavy Metals and Sulphur

11.7.12 The detection limits for the soil samples are provided in Appendix A11.1.

Assessment Criteria for Soil

11.7.13 In principle, the Dutch 'ABC' criteria are considered by the EPD as the remediation standards. The Dutch 'ABC' criteria consist of 3 levels of standards, namely A, B, and C, which generally indicate the follows:

- 'A' level implies unpolluted;
- 'B' level implies potential pollution present and requires further investigation or remediation; and
- 'C' level implies pollution, which requires remediation.

11.7.14 In general, the EPD requires remediation for soil contamination above the Dutch B level. The Dutch guidelines relevant to this assessment are tabulated in Appendix A11.2.

Analytical Results

11.7.15 The laboratory analytical results are summarized in Appendix 11.2 and the details of the laboratory results are presented in the Soil Testing Report as given in Appendix A11.3.

11.7.16 Results indicate that all soil samples are below the Dutch B levels except 1 soil sample collected from sampling location 3, of which the lead concentration exceeded the Dutch B level but within the Dutch C level (Table 11-1) and 3 samples collection from locations 6, 7 and 8, of which the total sulphur concentrations also exceeded the Dutch B level but within the Dutch C level. Table 11.4 summarizes the details of the soil samples exceeding Dutch B levels.

Table 11.4 Summary of Soil Samples Exceeding Dutch B Level

Sampling Location	Contaminant	Concentration (mg/kg dry soil)	Dutch Limit (mg/kg dry soil)		Exceedance
			B	C	
3	Lead	240	150	600	≥ B and < C
6	Sulphur (Total)	48	20	200	≥ B and < C
7	Sulphur (Total)	20	20	200	≥ B and < C
8	Sulphur (Total)	21	20	200	≥ B and < C

11.7.17 The nature and distribution of the contaminated soil samples indicate that contamination of lead is present at a discrete hotspot. The contamination of sulphur at locations 6-8 suggested that the area might have been the use for artillery range. The analytical results also suggest that contamination of sulphur is not spatially continuous and is confined with the area near sampling locations 6-8.

11.7.18 Based on the results of the preliminary site investigation, the site is considered as a potentially

land contaminated site as hotspots of contamination were identified. Further investigation for land contamination at this site is required and is detailed in the Contamination Assessment Plan (CAP) in the following section.

11.8 Preliminary Contamination Assessment Plan (CAP)

This is a preliminary CAP providing guidelines for a land contamination assessment during construction stage. A CAP should be prepared according to two publications stated in section 11.2.1 issued by EPD.

Sampling Locations and Parameters

11.8.1 Land contamination site investigation has to be undertaken prior to commencement of excavation works. Soil samples should be taken at 5 sampling points, which are the sampling locations 2, 3, 6, 7 and 8 as shown in Figure 11.1 to determine the distribution of the contaminants. These locations are the hotspots found based on the results of the preliminary site investigation (sampling locations 3, 6, 7 and 8) and the location (location 2) that could not be accessed during the preliminary site investigation.

11.8.2 Table 11.5 presents the proposed sampling locations and summarizes the justification for proposing these sampling locations.

Table 11.5 Proposed Sampling Locations and their Justifications

ID of Sampling Location	Justification
2	Preliminary site investigation could not be carried out at this point due to access problem.
3	A discrete hotspot of contamination of lead was identified based on the results from the preliminary site investigation.
6	The surrounding area is potentially contaminated with sulphur as identified in the preliminary site investigation.
7	
8	

11.8.3 Based on the results from the preliminary site investigation, the parameters chosen for analysis should include lead and total sulphur.

Sampling Method

11.8.4 Sampling should be undertaken by means of borehole or trial pits for the above-mentioned 4 sampling points.

11.8.5 Drilling of boreholes should be accomplished using standard rotary core drilling method. All equipments in contact with the ground should be thoroughly decontaminated prior to use by scrubbing with a lab-grade detergent. After sampling, all boreholes should be refilled immediately for safety reason. The refilling also avoids accumulation of stagnant water in the boreholes.

Depth of Sampling

11.8.6 Three samples per sampling location should be taken to ascertain the vertical distribution of contaminations. The depths of sampling are:

i) at 0.5 m below ground;

ii) at 1.5 m below ground;

iii) at 3.0 m below ground.

Sample Size and Handling Procedures

11.8.7 A total of 15 soil samples are expected to be taken, and all the samples must be uniquely labelled and described on-site prior to sending to a HOKLAS accredited laboratory for analysis. Description should include, but not be restricted to:

i) test site where sample collected;

ii) sample identification number;

iii) soil sampling depth (with respect to lowest level of concrete slab);

iv) estimated physical characteristics (clay, silt, sand, gravel, stone, cobble, colour, odour, moisture);

v) colour photograph; and

vi) any other relevant information.

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

11.8.9 An environmental scientist with experience in contaminated land assessment should be on site to monitor the first few boreholes to confirm the sampling procedures to be taken at the right locations and in the correct manner. A laboratory analysis schedule is presented in Table 11.6.

Table 11.6 Laboratory Analysis Schedule

No. of Locations	No. of samples	Parameters for each sample
5	15	Lead and Sulphur (total)

Decontamination

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

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

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

iii) After field cleaning, the equipment shall be handled by personnel wearing clean gloves to

avoid re-contamination. If the equipment is not to be used immediately it should be covered with clean plastic sheeting or wrapped in aluminium foil to avoid re-contamination.

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

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

11.8.12 A chain of custody system should be operated as part of the QA/QC procedure.

Groundwater Sampling

11.8.13 ONE groundwater sample should be collected at EACH of the sampling locations / boreholes and tested in laboratory where groundwater is encountered.

11.8.14 Purging of groundwater in the boreholes shall be undertaken prior to sampling to remove fine-grained materials and to collect freshly refilled representative samples. The boreholes shall be purged by removing about five times the volume of groundwater within the boreholes with a WaTerra Pump.

11.8.15 After two hours have lapsed since purging, the presence of any free product floating on the top of the groundwater and the thickness should be recorded. The floating layer should be removed/recovered and analyzed.

11.8.16 The depth to water table shall be measured. ONE groundwater sample shall then be collected at the boreholes using a WaTerra Pump. All samples should be uniquely labelled.

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

11.8.18 A chain of custody system should be operated as part of the QA/QC procedure. The laboratory accredited QA/QC procedures should be followed.

Laboratory Analysis

11.8.19 Based on the results in the preliminary site investigation, the expected contaminants that may be found are mainly lead and sulphur. The soil and groundwater samples should be dispatched to the HOKLAS accredited laboratory for analysis. The schedule for laboratory analysis is listed in Table11.6. The detection limits for the soil samples are provided in Appendix A11.1.

11.8.20 Toxicity Characteristics Leaching Procedure (TCLP) test should also be carried out for all soil samples if exceedance of land contamination standards is confirmed and “excavation and disposal” is selected as the remediation method.

Assessment Criteria

11.8.21 The Dutch 'ABC' criteria presented in Sections 11.7.12 and 11.7.13 should be adopted as assessment criteria for soil. The Dutch B Levels should be referred to for assessing soil contamination.

11.8.22 If exceedance of Dutch B levels is found, additional sampling is required to determine the extent of the contamination at sites where contaminants have been detected. A 5 m diameter will be assumed around each borehole at which Dutch B levels have been exceeded and this area will be excavated. A minimum of 5 samples, comprising 4 from around the boundary and 1 from the centre of the base of excavation will be taken. Excavated material should be stockpiled and bunded using appropriate measures while the 5 samples are tested. If Dutch B levels are still exceeded excavation will be extended outwards in 0.5 m increments and further samples tested until levels below Dutch B standards are reached.

11.8.23 Samples will be tested for limited parameters dependent on previous exceedances of Dutch B at the original location. Testing for TCLP will also be carried out in order to determine the potential for disposal to landfill. Disposal of contaminated soil at landfill should only be regarded as the last resort. Approval should be sought from EPD for landfill disposal.

11.8.24 If the exceedance is recorded for soil sample at 4.5 m below ground, at where necessary construction works will be conducted, soil sampling with greater depth will also be required in order to determine the depth of contamination.

11.8.25 For the evaluation of groundwater results, some kind of risk assessment is essential although groundwater is seldom used for drinking purpose in Hong Kong. It is prudent to assess the risk that contaminated groundwater may pose to the general pubic, future users of the site and construction workers, etc., and to determine if some remediation or precautionary measures are necessary.

11.8.26 A Contamination Assessment Report (CAR) should be prepared. If the results of the site investigation reveal contamination at the subject site, a Remediation Action Plan (RAP) should also be prepared and submitted together with the CAR to EPD for approval. It is recommended that the contaminated soil should be treated on-site and used as filling material. After the completion of the remediation, a Remediation Report should be prepared and submitted to EPD to demonstrate that the clean-up is adequate. Information such as soil treatment records, sampling results, photographs and certification of independent checker should be included in the report.

Health and Safety

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

- Site workers should wear gloves, masks, and other protective clothing where exposure to vapours or contaminated soil may be encountered.
- Contaminated materials should be moved with bulk earthmovers to prevent human contact.
- Adequate washing facilities should be provided and smoking/eating should be prohibited in the area.
- Contaminated soils, which have been stockpiled or are being transported, should be covered with tarpaulin.
- Leakage of pollutants or leaching from excavated soil should be prevented by storing on an impermeable surface.

11.9 Mitigation Measures for Land Contamination during Construction Stage

11.9.1 Based on the preliminary site investigation results, the site area contains hotspots of contamination of lead and sulphur. The contamination levels of these hotspots should be further assessed during the construction stage with a proper implementation of the CAP and RAP.

11.9.2 In addition, since the exact cut areas on site during construction by the Contractor have not been determined at this stage, the Contractor should implement the suitable precautions and preventive measures for the discovery of buried or abandoned ordnance during the construction. Moreover, it is recommended that standard good practice should be implemented during the construction phase in order to minimize any potential exposure to contaminated soils or groundwater. These measures include:

- The Contractor should sweep the area of intended excavation with a metal detector to check any ordnance underneath the ground prior to any excavation.
- For any detection of metals under the ground, the Contractor should cease work immediately before confirming the identity of the cause. For any suspect of artillery ordnance, Hong Kong Police Force should be informed.
- The use of bulk earth-moving excavator equipment would minimise construction workers' potential contact with the contaminated materials;
- Exposure to any contaminated materials can be minimised by the wearing of appropriate clothing and personal protective equipment such as gloves (when interacting directly with suspected contaminated material), providing adequate hygiene and washing facilities and preventing smoking and eating during such activities;
- Stockpiling of contaminated soil should be avoided as far as possible. If this cannot be avoided, the stockpile of contaminated materials should be segregated from the uncontaminated ones. Moreover, the contaminated materials should be properly covered with waterproof material (e.g. tarpaulin sheet) to avoid leaching of contaminants, especially during rainy season.
- 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 leakage during transport or during wet conditions;
- Only licensed waste haulers should be used to collect and transport any contaminated material to an appropriate disposal site and procedures should be developed to ensure that illegal disposal of waste does not occur;
- Necessary waste disposal permits should be obtained, as required, from the appropriate authorities, in accordance with the *Waste Disposal Ordinance (Cap 354)*, *Waste Disposal (Chemical Waste) (General) Regulation (Cap 35)*, as required;
- Records of the quantities of wastes generated and disposed of should be maintained;
- Adequate washing facilities should be provided on site; and
- In accordance with good construction practice, silt traps should be used to reduce the impact to drainage caused by suspended solids arising from disturbed ground, or any construction materials such as cement and gravel. Groundwater should be disposed of in accordance with the *Water Pollution Control Ordinance (Cap 358)*.

11.10 Potential for Future Land Contamination

11.10.1 As presented in Section 11.2.4, the proposed golf course is regarded as a contaminated usage

according to Lands Department Technical Circular No. 735A – *Identification of Possible Contamination Sources During Operation Phase*.

11.10.2 The most potentially significant future sources of contamination are:

- The use of turfgrass chemicals (fertilizers and pesticides)
- Accidental spillage of chemicals to be used

Prevention of Contamination Impact

11.10.3 In order to prevent the chemicals from contaminating the land, a Turfgrass Management Plan (TMP). The latest version of the HKJC Kau Sai Chau Golf Course "Turfgrass Management Guidelines" is appended to this report as Appendix A6.4.

11.10.4 As present in the water quality assessment section, four main chemicals are used for existing golf courses, they are nitrogenous fertilizers, herbicides, fungicides and insecticides. The approach should be to minimize application of fertilizers as far as possible and this is also driven by economic requirements to minimize recurrent costs (A case where environmental protection and economic expediency work together). Healthy growth rates are achieved when the grass is not over fertilized or over watered. A balanced programme allows the grass to stand up to wear and develop disease resistance. In line with existing practice, the following mitigation measures will be implemented:

- Nutrient status will be monitored every 6 months of the year through the aid of soil and leaf tissue tests. Tests help determine the optimum nutrient provisions for turf grass.
- A slow release fertilizer will be used to help minimize the amount of nitrate leached from the soil.
- Applying low quantity of fertilizer is recommended to minimize the leaching due to the active uptake.
- Applications will not be made if heavy rain is forecast to minimize the significant nitrogen runoff.

11.10.5 All pesticides used on the proposed third golf course must be registered under the Pesticide Ordinance. The following pesticide inventory has been identified for more regular use on the proposed third golf course and will be stored at the golf course maintenance workshop:

a) Fungicides, including Iprodione (Rovral), Chlorothalonil (Daconil), Manocozeb and Fosetyl AL (Alliete).
b) Herbicides, including Oxadiazon (Ronstar), Imazaquin (Image), Glyphosate (Roundup) and 2,4-D/ Mecoprop (MCPP).
c) Insecticides, including Chlorpyrifos, Fipronil (Chiplo Choice) and Imadiachloprid (Merit).
d) Biopesticides products include (spinosad and *Bacillus thuringiensis*).

11.10.6 Details of Turfgrass management guidelines for the proposed third golf course are shown in Appendix A6.4 of the EIA report. The performance of the TMP will be assessed in terms of the quality of turf produced in time with the stated objectives of water and nutrient conservation and chemical minimization.

Monitoring during Operation Stage

11.10.7 The land contamination impact can be monitored via the TMP in terms of the quality of turf

produced in time with the stated objectives of water and nutrient conservation and chemical minimization.

11.10.8 In addition, routine soil testing for nutrients as described in the TMP will be conducted to ensure that nutrient applications to the golf course are having the desired effect. Adjustments are made to the applications program to amend any soil imbalances or deficiencies in nutrients. To monitor whether there is any land contamination during the operation stage, regular soil sampling and testing (e.g. say for every 6 month or a period agreed by EPD) will be taken according to the two publications issued by EPD (see section 11.2.1) and the certified test results reports should be submitted to EPD for information.

11.10.9 All fertilizers and pesticides will be well-documented including following details:

- Location of applications;
- Type of fertilizer applied;
- Amount applied in kg per hectare;
- Date of applications; and
- Product applied.

Recommendations

11.10.10 Provided the above measures are implemented properly, the likelihood of uncontrolled leakage of fertilizers and pesticides giving rise to land contamination is low. If in the future the proposed golf course is decommissioned, contamination testing will be required in order to identify and delineate any contamination that may have occurred. No additional land contamination impacts are envisaged during the transitional stage of the project.

Actions to be taken if Contamination found

11.10.11 In the event that any contamination / spillages occur on the golf courses, the following actions should be taken:

- Make every effort to contain the spillage responsibly and safely;
- Block drainage downstream flows and divert upstream flows where practicable;
- Notify Environmental Protection Department;
- Collect samples of downstream water for analysis;
- Continue sampling until the impact of the contamination / spillage can no longer be detected.

11.10.12 The extent of the contamination (e.g. volume of the contaminated soil) should be identified and confirmed by taken samples of contaminated soil for testing. Remediation action should also be carried out and completed within 3 to 6 months.

11.11 Conclusion

11.11.1 Based on preliminary site investigation, the site is considered as a potentially land contaminated site as hotspots of contamination of lead and sulphur were identified. Further investigation for land contamination at this site is therefore required and is detailed in the Contamination Assessment Plan (CAP) of this section to be undertaken prior to commencement of excavation works. A Contamination Assessment Report (CAR) should be prepared and if the results of the site investigation reveal contamination at the subject site, a Remediation Action Plan (RAP) should also be prepared and submitted

together with the CAR to EPD for approval.

11.11.2 The proposed golf course is regarded as a contaminated usage. The most potentially significant future sources of contamination are identified and monitoring programme and mitigation measures (Turf Management Plan) have been proposed of the measures are implemented properly, the likelihood of uncontrolled leakage of fertilizers and pesticides giving rise to land contamination is low, based on the proven records of the existing two golf courses.