中華電力
CLP Power

ExxonMobil

Capco 青山發電有限公司
Castle Peak Power Co. Ltd.

Emissions Control Project at Castle Peak Power Station "B" Units
Environmental Impact Assessment

EIA Report

June 2006

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FINAL REPORT

CAPCO

Emissions Control Project at Castle Peak Power Station "B" Units Environmental Impact Assessment
EIA Report

June 2006

Reference 0024405

For and on behalf of Environmental Resources Management	
Approved by:	Dr Andrew P Jackson
Signed:	
Position:	Managing Director
Date:	21 June 2006

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ANNEXES

1 INTRODUCTION

1.1 BACKGROUND

In support of the Government of the Hong Kong Special Administrative Region (HKSARG)'s regional air quality improvement initiative, the Castle Peak Power Company Limited (CAPCO), a joint venture between CLP Power Hong Kong Limited (CLP Power) and Exxon Mobil Energy Limited (EMEL), proposes to install additional emissions control facilities on their Castle Peak Power Station "B" Units (CPB) to further reduce air emissions from the operations of these units.

CPB units use pulverised coal as the primary fuel. All CPB units were commissioned during 1986 to 1990 with a unit size of 677 MW (gross).

It is CAPCO's objective to responsibly manage the environmental impacts of their operations and to meet HKSARG's environmental license requirements while providing reliable electricity supply. Since its full commissioning, CPB has been retrofitted with low nitrogen oxide (NO_x) burners for the boilers, flue gas conditioning systems, and upgrades to the electrostatic precipitators (ESPs) in addition to boiler optimisation improvements in recent years for improved particulates and NO_x control. As a result of these measures and together with the introduction of natural gas in the mid 1990s and increased utilisation of ultra low sulphur coal, emissions of NO_x, sulphur dioxide (SO_2) and particulates from all CAPCO facilities have already been reduced by 77%, 44% and 70% respectively over the 1990 to 2005 period when the total electricity demand has grown by about 80%.

Based on the CPB emissions control project description included in CAPCO and CLP Power's 2005 Financial Plan which was accepted by HKSAR Government, the following additional emissions control facilities are currently proposed for implementation at CPB:

- Selective Catalytic Reduction (SCR) for NO_x reduction; and
- Limestone Flue Gas Desulphurisation (LS FGD) for SO_2 reduction.

While there are several other emission control technologies available for NO_x reduction, final NO_x control facility will be subject to design optimisation. For the purpose of this EIA Study, SCR has been selected as the most conservative process with respect to environmental impact. This is due to the fact that the SCR system encompasses the facilities and elements associated with the other available NO_x reduction technologies.

A power station is a designated project (DP) under Category D (Energy Supply), Item D.1 (Public Utility Electricity Power Plant) of Schedule 2, Part I under the *Environmental Impact Assessment Ordinance* (*EIAO*)(Cap 499). As

Castle Peak Power Station (CPPS) has been in operation before the *EIAO* came into force, it is exempted under *Section 9(2)* of the *EIAO*.

As indicated in *Section 1.3* of *EIA Study Brief No. ESB 134/2005* (the *Study Brief*) issued for the above-mentioned Emissions Control Project (the Project), the Project is a Material Change, as defined under *Section 9* (*4*) of the *EIAO*, as a result of the changes introduced by the SCR and the LS FGD operations to the types and quantities of wastes, emissions and effluents. The Project also includes the following elements which would qualify as DPs in their own right under *Schedule 2* of the *EIAO*:

- demolition of the CPB 4,600-tonne Fuel Oil Day Tank (FODT) [Item 16 (Decommissioning of a store for oil with a storage capacity exceeding 200 tonnes) of Schedule 2, Part II];
- construction and operation of urea storage facility, dissolvers, urea solution storage tanks and urea-to-ammonia reactors for SCR operations [Category K (Industrial Activities), Item K.6 (A chemical plant with a storage capacity of more than 500 tonnes and in which substances are processed or produced) of Schedule 2, Part I]; and
- construction and operation of gypsum storage and handling facilities for FGD operations [Category G (Waste Storage, Transfer and Disposal Facilities), Item G.6 (A waste disposal facility for gypsum) of Schedule 2, Part I].

1.2 SITE LOCATION AND SITE HISTORY

The Castle Peak Power Station (CPPS) is located at Tap Shek Kok in Tuen Mun, New Territories, Hong Kong. The site was established mainly by reclamation with rock excavated from the adjacent hillside with a total area of approximately 62 ha. Castle Peak 'B' units (CPB) (each of 677MW) occupy the southern portion of the site, and were commissioned during the period from 1986 to 1990. The Project will be located within the existing CPPS and will only occupy a small portion of the total site area of CPPS.

1.3 OBJECTIVES OF THE STUDY

This EIA Study is conducted in accordance with the *Study Brief*. The objectives of the EIA Study, as stated in the *Study Brief*, are:

- to describe the Project and associated works together with the requirements for carrying out the Project;
- to identify and describe elements of community and environment likely to be affected by the Project and/or likely to cause adverse impacts to the Project, including natural and man-made environment and the associated environmental constraints;

- to provide information on the consideration of alternatives to avoid and minimize potential environmental impacts to ecologically sensitive areas and other sensitive uses; to compare the environmental benefits and drawbacks of each of different options; to provide reasons for selecting the preferred option(s) and to describe the part environmental factors played in the selection of preferred option(s);

- to identify and quantify emission sources and determine the significance of impacts on sensitive receivers and potential affected uses;

- to identify and quantify any potential landscape and visual impacts and to propose measures to mitigate these impacts;

- to identify and quantify any potential losses or damage to flora, fauna and natural habitats and to propose measures to mitigate these impacts;

- to propose the provision of mitigation measures so as to minimise pollution, environmental disturbance and nuisance during construction and operation of the Project;

- to investigate the feasibility, practicability, effectiveness and implications of the proposed mitigation measures;

- to identify, predict and evaluate the residual environmental impacts (ie after practicable mitigation) and the cumulative effects expected to arise during the construction and operation phases of the Project in relation to the sensitive receivers and potential affected uses;

- to identify, assess and specify methods, measures and standards, to be included in the detailed design, construction and operation of the Project which are necessary to mitigate these environmental impacts and cumulative effects and reduce them to acceptable levels;

- to investigate the extent of the secondary environmental impacts that may arise from the proposed mitigation measures and to identify constraints associated with the mitigation measures recommended in the EIA study, as well as the provision of any necessary modification; and

- to design and specify environmental monitoring and audit requirements to ensure the effective implementation of the recommended environmental protection and pollution control measures.

The Project has no impact on cultural heritage, agriculture and fisheries, and therefore these aspects are not assessed in the EIA Study.

1.4 APPROACH TO THE STUDY

The assessments in this EIA Study are conducted using well-proven and internationally accepted methods based on the worst-case conditions associated with the construction and operation of the Project.

1.5 *STRUCTURE OF THE REPORT*

The remainder of this EIA Report is organised as follows:

- *Section 2* presents a description of the Project and the considerations given to alternatives in the process of choosing the preferred option;
- *Section 3* presents the air quality assessment for the Project;
- *Section 4* presents the noise assessment for the Project;
- *Section 5* presents the water quality assessment for the Project;
- *Section 6* discusses the waste management issues associated with the Project;
- *Section 7* presents the land contamination assessment undertaken for the Project;
- *Section 8* discusses the ecological assessment for the Project;
- *Section 9* provides a visual illustration for the Project;
- *Section 10* outlines the requirements for environmental monitoring and audit during the construction and operation of the Project and presents an environmental mitigation implementation schedule; and
- *Section 11* concludes the report with a summary of the environmental outcomes associated with the construction and operation of the Project.

2 CONSIDERATION OF ALTERNATIVES

2.1 NEED FOR THE PROJECT

As stated in EPD's Progress Report on *Improving the Air Quality in Hong Kong* released in November 2005 (1) , the HKSARG and the Guangdong Provincial Government have reached a consensus to reduce, on a best endeavour basis, the emission of four major air pollutants, namely sulphur dioxide (SO_2), nitrogen oxides (NO_x), respirable suspended particulates (RSP) and volatile organic compounds (VOC).

The Project is proposed by CAPCO in response to the HKSARG's emissions reduction initiative with regard to SO_2 and NO_x emissions. Some further reduction in particulate emissions is also anticipated as a result of SO_2 emission control in addition to existing high efficiency ESP.

2.2 SCENARIO WITH OR WITHOUT PROJECT

The Project is proposed and accepted in the 2005 Financial Plan as an additional measure to ongoing efforts in improving the environmental performance of CAPCO generation plant. The Project is expected to deliver significant emissions reduction thus contributing to emissions reduction initiative undertaken by the HKSARG and the Pearl River Delta region. Without the Project, CAPCO's efforts in contributing to emissions reduction initiatives will undoubtedly be undermined.

2.3 CONSIDERATION OF DIFFERENT TECHNOLOGIES AND EMISSION CONTROL OPTIONS

2.3.1 Introduction

There are many different technologies available for the control of NO_x and SO_2. The choice of control technologies and their associated equipment would result in different installation, process material supply and the management of any wastes and/or saleable by-products.

The following sub-sections provide a review of available emission control technology options for the Project, discuss their technological maturity and environmental performance in order to explain the rationale for the base technology selection, LS-FGD and SCR.

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(1) http://www.epd.gov.hk/epd/english/environmentinhk/air/prob_solutions/files /Brief_Progress_Report_Nov2005.pdf

2.3.2 *Review of the available NO_x emission control technologies*

Overview of NO_x Emission Control Technologies

The control of NO_x emissions from large new thermal power stations has become an important consideration in the design and operation of such plant. A number of control technologies have been developed to meet the emerging emission control requirements. Retrofit NO_x control for operating plant varies from combustion control technologies to post-combustion flue gas denitrification (de-NO_x).

CPB has already implemented combustion control technologies to control its NO_x emissions by retrofitting with low NO_x burners (LNBs). This has helped reduce the NO_x production from the boilers. The enhancement technology options available for consideration include:

- Advanced Low NO_x Burners (ALNBs)
- Low NO_x Burners (LNBs) or ALNBs with Over Fire Air
- Gas Reburn or Amine Enhanced Fuel Lean Gas Reburn (AEFLGR)
- Selective Non-catalytic Reduction (SNCR)
- Selective Catalytic Reduction (SCR)

Advanced Low NO_x Burners (ALNBs)

CPB is equipped with LNBs of an early design, an incremental improvements could be made by installing ALNBs either as part of the normal routine maintenance regime of the station or as part of a specific NO_x reduction strategy. This technology can be used in combination with any of the other available NO_x reduction technologies.

LNBs / ALNBs with Over Fire Air

NO_x emissions could be further reduced by adding either an Over Fire Air (OFA) or “reburning” technology to the existing LNBs or ALNBs. Over fire air and boosted over fire air are in-furnace NO_x control techniques that stage combustion in the entire furnace. Typically a portion of the total combustion air is diverted from the main wind box and is injected into the furnace at a level above the top burner row. The intent is to operate the burner zone at a lower stoichiometry than the upper furnace. Staging combustion in the furnace reduces NO_x in two ways. Firstly, a reducing zone is formed which is not conducive to fuel NO_x conversion. Secondly, furnace staging delays combustion which results in a longer flame and causes heat absorption to occur over a large area of the furnace. The temperature of the air/fuel/combustion gas mixture is thus reduced, lowering thermal NO_x production. OFA systems provide up to 30% NO_x reduction at slightly increased auxiliary power consumption and increased carbon content in ash. Higher carbon in ash content can be managed.

Gas Reburn or Amine Enhanced Fuel Lean Gas Reburn (AEFLGR)

Reburning is sometimes considered a potentially effective method of reducing NO_x emissions levels using secondary natural gas through the inherent staging effect of the reducing and over fire air zones. The reburning process divides the furnace into three combustion zones. The main supply of the fuel is burnt under stoichiometry conditions in the lower furnace. Above the main burners a second fuel such as natural gas is injected often using high pressure recirculated flue gas as a carrier to ensure adequate mixing. The balance of the combustion air is introduced above both combustion zones in order to complete the combustion process within the furnace. This remaining air is introduced through openings in the upper furnace wall to the manner typical of over fire air. NO_x reduction typically is 35-45% from an uncontrolled base. The Gas Reburn system requires additional usage of a supplementary fuel such as natural gas.

AEFLGR is a combination of natural gas reburn and SNCR with urea as the reagent. The method features minimal use of natural gas at approximately 7% of the heat input. The effectiveness may approach 50%, but the technology may not be sufficiently tested in large coal-fired plants.

Selective Non-Catalytic Reduction (SNCR)

NO_x emissions in the flue gas are converted into elemental nitrogen and water by injecting a nitrogen-based chemical reagent, most commonly urea (NH_2CONH_2) or ammonia (NH_3; either anhydrous or aqueous). The chemical reactions, in a simplified form, are as follows.

$$2NO + NH_2CONH_2 + 1/2\ O_2 \rightarrow 2N_2 + CO_2 + 2H_2O$$

$$NO_x + NH_3 + O_2 + H_2O + (H_2) \rightarrow N_2 + H_2O$$

Because the highest NO_x reduction is achieved at temperatures between 870 and 1,200°C, the reagent is introduced at the top and back-pass of the boiler. Multiple injection locations may be required, especially in case of cycling units; different injection locations are used as the unit operates at a reduced load.

SNCR is a proven technology applied in some installations worldwide. This technology has generally been applied to units of around 350MW and less, however application has extended to larger generating units of the size similar to CPB. The typical removal efficiency is 30-40%. In the case of SNCR the ammonia slip may be a more important issue than for SCR but can be managed.

Selective Catalytic Reduction (SCR)

SCR is similar to SNCR in that it uses ammonia injection in the flue gas to convert NO_x emissions to elemental nitrogen and water. The key difference between SCR and SNCR is the presence in SCR systems of a catalyst, which accelerates the chemical reactions. The catalyst is needed because SCR systems operate at much lower temperatures when compared with SNCR system. Typical temperatures for SCR are 340 to 380°C, compared with 870 to 1,200°C for SNCR. Different types of SCR catalyst are available in the market. The catalyst active surface is typically metal, ceramic or fibre reinforced. The catalysts are usually made of heavy metal oxides, consisting of the base material TiO_2 and active components vanadium, tungsten, molybdenum, copper and chromium. In most cases, V_2O_5 is used with a small amount of WO_3 and SiO_2. As these catalysts are not chemically modified in the process, their service life is generally very long. Rejuvenation of catalysts is only required after 4 to 6 years of use. The rejuvenation process usually involves the removal of solid particles on the catalysts by vacuum cleaner, washing of the catalysts in acid baths and drying of the washed catalysts. The solid particles removed generally consist of ash particles and therefore can be disposed of in a similar manner. The wash water generated will be separately treated to the required standards by neutralisation before discharge and is not expected to affect the existing wastewater effluents of CPB. Relevant requirements under the *Water Pollution Control Ordinance* (*WPCO*) and *Waste Disposal Ordinance* (*WDO*) should be met for the treatment and disposal of waste and wastewater arising from the catalyst rejuvenation process.

The SCR process is a post-combustion NO_x control technology that removes the NO_x from the flue gas exiting the boiler. When the flue gas passes upstream of the SCR catalyst reactor, the NO_x in the flue gas reacts with the ammonia gas (a reagent) and is reduced to N_2 and water vapour. No solid or liquid by-products will be generated from this process.

The ammonia gas will be generated from an urea to ammonia conversion system to be installed at the CPB, thus avoid bulk anhydrous ammonia storage on site. Up to 40,000 tonnes of urea will be used per year. When urea reacts with water under a heated environment, it hydrolyses to ammonia, carbon dioxide and water. There are also other urea to ammonia conversion technologies available, e.g. thermal decomposition. No solid or liquid wastes will be generated from the conversion process.

A limited amount of solid waste, in the form of spent catalyst, will be generated from the SCR process. Common industry practice is to recycle spent catalysts with original supplier(s) or to rejuvenate them on-site. If the spent catalyst cannot be recycled by the overseas suppliers or has reached a depleted stage, it can be disposed of at the Chemical Waste Treatment Centre (CWTC) or at the SENT Landfill after stabilisation if required. With proper recycling and disposal management of spent catalysts, potential environmental impacts of spent catalysts on the existing and future waste management facilities in Hong Kong will be minimal.

The typical NO_x removal efficiency of SCR is 80%. When compared with SNCR, there would be a slight increase in auxiliary power consumption while ammonia slip can be more easily controlled within acceptable limit because of the presence of catalysts.

Summary of the Option Evaluation for NO_x Emission Control Technologies

Several NO_x emission control technologies have been reviewed and some of the NO_x reduction technology integrating the existing combustion technologies with added modifications. The elements of such reduction technologies are combined, taking into account characteristics of the particular power plant and its fuel. ALNBs and LNBs / ALNBs with OFA can reduce the NO_x emissions by 30%, they can also be used in combination with SNCR and SCR. Combining technologies together may result in the use of less ammonia reagent and less catalyst. *Table 2.1* summarises the main features of the control technologies discussed above, final NO_x control facility will be subject to design optimisation.

Table 2.1 Summary of Considered NO_x Control Technology Options

Control Technology	**Typical NO_x Reduction Efficiency**	**Environmental Considerations**	**Other Comments**
Advanced Low NO_x Burners (ALNBs)	20%		
Low NO_x Burners (LNBs) or ALNBs with Over Fire Air (OFA)	30-50% reduction in addition to present LNBs	Increased auxiliary power consumption and increased carbon content in ash (thus reduce the re-use potential of ash) but can be managed	
Gas Reburn or Amine Enhanced Fuel Lean Gas Reburn (AEFLGR)	Up to 50%		AEFLGR may not been sufficiently tested in large coal-fired plants
Selective Non-Catalytic Reduction (SNCR)	30-40%	Ammonia slip that can be managed to avoid adverse effects on the quality of ash and hence its re-use potential	More experience in 350MW, application now extended to larger generating units
Selective Catalytic Reduction (SCR)	80%	Ammonia slip that can be managed to avoid adverse effects on the quality of ash and hence its re-use potential Proper management of spent catalyst required	A smaller SCR with OFA may also achieve up to 80% NO_x reduction efficiency.

The summary in *Table 2.1* indicates that none of the NO_x control measures considered would present environmental considerations that prohibit their implementation for CPB. Each of the technologies would be capable of providing air quality improvement in terms of NO_x emissions, either individually or in combination.

For the purpose of this EIA Study, the environmental considerations of different NO_x control options were considered and the most conservative process is selected for detailed assessment with respect to environmental impacts. Advanced Low-NO_x burners do not present any new issues. Low-NO_x burners are currently installed at the CPB units. With respect to overfire air, this is a process that involves adding an additional source of air available for combustion into the furnace, again no new environmental considerations are involved. Both SNCR and SCR will involve a reagent which will produce an ammonia slip of a few parts per million (ppm), the SNCR will have a slightly higher slip. However these low levels of ammonia slip are not environmentally significant. The SCR brings with it an additional environmental consideration of catalyst which the SNCR process does not involve. The Gas Reburn option does not bring any new consideration. All of the above does not affect the flue gas dispersion parameters used in the air quality modelling. As a result of the above consideration, SCR has been selected as the most conservative process with respect to environmental impact.

2.3.3 Review of the Available SO_2 Emission Control Technologies

Overview of SO_2 Emission Control Technologies

Flue gas desulphurisation (FGD) represents the most extensively used method for limiting SO_2 emissions from large-scale fossil fuel combustion. These methods remove SO_2 from the flue gases in the furnace or, most frequently, in a processing unit downstream from the boiler. Many widely used FGD systems can achieve a high level of SO_2 removal efficiencies. Typical SO_2 control technologies considered for CPB Emission Control Project include:

- Dry Type Flue Gas Desulphurisation
- Limestone Forced Oxidation Flue Gas Desulphurisation
- Seawater Flue Gas Desulphurisation

Dry Type Flue Gas Desulphurisation

There are three major types of dry sulphur dioxide removal technologies: Dry Circulating Scrubber (DCS), Spray Dryer Absorber (SDA) and dry sorbent injection.

In dry scrubbers, a calcium hydroxide slurry (quicklime mixed with water) is introduced into a spray dryer tower. The slurry is atomized and injected (close to saturation) into the flue gases, where droplets react with SO_2 as they evaporate in the vessel. The resulting dry by-product is collected in the bottom of the spray dryer and in the particulate removal equipment (ESP or bagfilter).

SO_2 may also be removed by injecting a sorbent (lime, limestone, or dolomite) into the combustion gases.

The sorbent decomposes into lime, which reacts in suspension with SO_2 to form calcium sulphate ($CaSO_4$). The calcium sulphate, unreacted sorbent, and fly ash are removed at the particulate control device (either an electrostatic precipitator or bagfilter) downstream from the boiler. Sorbent injection, however, affects the properties of the particulates (higher resistivity and different size and morphology than derived from pulverized coal without SO_2 control), which in turn adversely affects the performance of the electrostatic precipitator (ESP).

Dry FGD systems have up to 70-90% SO_2 removal efficiency, but their disadvantages are the use of reagents that are less cost effective and the large amounts of waste by-products which are of little or no commercial value and have to be disposed in a landfill site.

Limestone Forced Oxidation Flue Gas Desulphurisation (LSFO FGD)

LSFO FGD is by far the most commonly used FGD technology for large power boilers (1). In typical wet scrubbers the flue gas enters a large vessel (spray tower, absorber, bubbler, etc), where it is sprayed or mixed with limestone slurry. The calcium in the slurry reacts with the SO_2 to form calcium sulphite or calcium sulphate. A portion of the slurry from the reaction tank is pumped into the thickener, where the solids settle before going to a filter for final dewatering to about 50 percent solids.

Limestone with forced oxidation (LSFO) is a variation of the traditional wet scrubber in that it utilizes limestone instead of lime. In the LSFO process, the flue gas is passed through absorbers that contain a slurry of ground limestone in water. The sulphur dioxide is removed by reacting with the limestone (calcium carbonate) to form calcium sulphite. The slurry is then aerated to oxidise the calcium sulphite initially formed and is nearly fully oxidized to form gypsum (calcium sulphate). The resulting gypsum slurry is then treated, resulting in dewatered gypsum and a small quantity of liquid effluent. The resulting effluent may have a small chemical oxygen demand and/or reduced dissolved oxygen concentrations.

The treated effluent from the Limestone FGD process is likely to have the following characteristics:

- Increased concentrations of sulphate ions;
- Small amount of suspended ash particles, which are likely to contain some trace amount of metals content; and
- Chemical oxygen demand (COD).

The effluent will be treated to comply with the discharge standards stipulated in the *Technical Memorandum on Standards for Effluents Discharged Into Drainage And Sewerage Systems, Inland And Coastal Waters* issued under the *Water Pollution Control Ordinance*. It will then be added to the cooling water flows and discharged via the existing sub-marine cooling water outfall of CPB, resulting in a small increase in the total flows from the outfall. It should be

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(1) According to *Integrated Pollution Prevention and Control (IPPC) - Reference Document on Best Available Technique for Large Combustion Plants* published by the European Commission in 2005, wet limestone FGD is the most widely used of all the FGD systems and accounts for about 80% of all the installed FGD capacity.

noted that there would be no effect on the temperature of the cooling water or on the quantities of residual chlorine in the discharge.

By-products (up to 240,000 tpa of commercial grade gypsum and 17,000 tpa of lower grade gypsum) and sludge arising from FGD wastewater treatment (about 180 tpd at 30% dry solids) will be generated from the operation of the Limestone FGD system. Gypsum is a material that can be used for a number of applications (such as plasterboard and cement production). According to a market survey commissioned by CLP Power (as CAPCO operator), there is a large demand of gypsum in Pearl River Delta (PRD) and East-Asia region. Taking into account the anticipated growth in population growth and GDP in the region, it is anticipated that all the commercial and lower grade gypsum would be recycled through the regional market (the total gypsum generation rate is only a few percentage of the existing consumption of gypsum for plasterboard and cement production in the PRD and East-Asia region). A number of plasterboard and cement manufactures in the region have expressed interest in engaging in a long term arrangement to take all the gypsum to be generated by the FGD operations.

Typical SO_2 removal efficiency of the LSFO FGD system is 90%. Approximately 1 to 2 percent of the unit's generating capacity is consumed to meet the power requirements of the scrubber. LSFO FGD may also help reduce particulates emission to some extent.

Sea Water Flue Gas Desulphurisation (SWFGD)

SWFGD system reduces SO_2 emissions by reacting seawater with the flue gas. Seawater (reagent) contains natural alkalinity due to dissolved calcium and magnesium bicarbonate will react with the acidic components of the flue gas to form soluble compounds that become part of the effluent.

For the SW FGD option a portion of the existing cooling water is diverted, typically 25% of the total flow, to the absorber. In the absorber, the sulphur dioxide is stripped from the flue gas, reacting with the seawater to form sulphite ions. The effluent from the absorber is mixed with more seawater to reduce acidity (ie raise the pH level) and vigorously aerated to oxidise the sulphite ions, producing sulphate ions. Depending upon the effectiveness of the aeration process the final effluent may have a small chemical oxygen demand and/or reduced dissolved oxygen concentrations. The flue gas will contain small quantities of ash, which are likely to be captured by the seawater in the FGD system. The ash is likely to contain some trace amount of metals content, the quantities of which depend upon the constituents of the original coal fuel.

The final effluent from the SW FGD process is likely to have the following characteristics:

- Increased temperature;
- Increased concentrations of sulphate ions;

- Decreased pH;
- Suspended ash particles, which are likely to be contaminated with trace amount of metals content;
- Chemical oxygen demand (COD); and
- Decreased dissolved oxygen.

The final effluent is then returned to the main cooling water stream and discharged via the CPB outfall. It should be noted that the SW FGD process will typically not result in either increased cooling water flows or a change in the residual chlorine concentrations at the discharge point.

Typical SO_2 removal efficiency of SW FGD is 80%. Particulate emission is also expected to be reduced. No solid waste is generated, but one of the major drawbacks is that additional sulphate, chlorine and heavy metals would discharge back into the sea. This has limited the worldwide application of this technology.

Summary of the Option Evaluation for SO_2 Emission Control Technologies

LSFO FGD can achieve typically 90% reduction of SO_2 emissions and SW FGD would reduce SO_2 emissions by about 80%. Both could achieve a higher level of SO_2 reduction than the Dry Type FGD systems. They also offer the environmental benefit over Dry Type FGD regarding the issue of waste / byproduct management. Dry Type FGD could result in large amounts of waste by-product, which may have no commercial value and has to be disposed in a landfill site.

The potential water quality impacts from the LSFO FGD option were considered to be much less than those from the SW FGD option, which is to be expected given the very small treated effluent discharge from the LSFO FGD system. The SW FGD system reduces the sulphur dioxide (SO_2) emissions by reacting seawater with the flue gas. Some of the fly ash and trace elements entering the SW FGD system will also be removed by the seawater and ultimately end up in the discharge water, which is undesirable. The long-term marine water quality impacts throughout the operating life of the SW FGD are considered to outweigh the transient localised impacts from the construction of additional berthing facility required for the LSFO FGD option.

On the other hand, LSFO FGD's by-product gypsum can be commercially recycled as construction materials. As there are large demand for gypsum market in the PRD and East Asia region, gypsum would be commercially recycled through the regional market or through a buy-back agreement with the limestone supplier. However, provision for a temporary buffer storage within CAPCO facilities will be required to allow for operational contingencies.

Table 2.2 summarises the main features of control technologies discussed above.

Table 2.2 Summary of Considered SO_2 Control Options

Control Technology	**Typical Efficiency**	**Environmental Considerations**	**Other Comments**
Dry Flue Gas Desulphurisation (FGD) Systems	70-90%	Solid waste that cannot be reused	
Limestone Forced Oxidation Flue Gas Desulphurisation (LSFO FGD)	90%	Solid by-product (gypsum) can be recycled with commercial outlets. Sludge from wastewater treatment can be disposed of locally.	Preferred
Sea Water Flue Gas Desulphurisation (SW FGD)	80%	Contaminated effluent with elevated sulphate, chlorine and heavy metals discharged into the sea throughout the operating life of the system and uncertainties with regard to potential bioaccumulation Limited operational experience for large coal-fired plants	

2.3.4 Selection of Emissions Control Option

Following the review of different control options and consideration of their environmental impacts, the SCR and LSFO FGD were selected as the package of emission control options for the purpose of the EIA Study. The choice was based on the expected environmental benefits of each option, potential adverse environmental impacts and technological feasibility.

The environmental impacts of these options and the reasons for selecting these measures have been discussed and summarised in *Tables 2.1* and *2.2*.

- SCR has been selected as the most conservative process with respect to environmental impact. This is due to the fact that the SCR system encompasses the facilities and elements associated with the other available NO_x reduction technologies

- Limestone FGD was selected due to its technological maturity, and the overall lower environmental side effects when compared to other FGD technologies.

The preliminary general arrangements of the proposed facilities are shown in *Figure 2.1*.

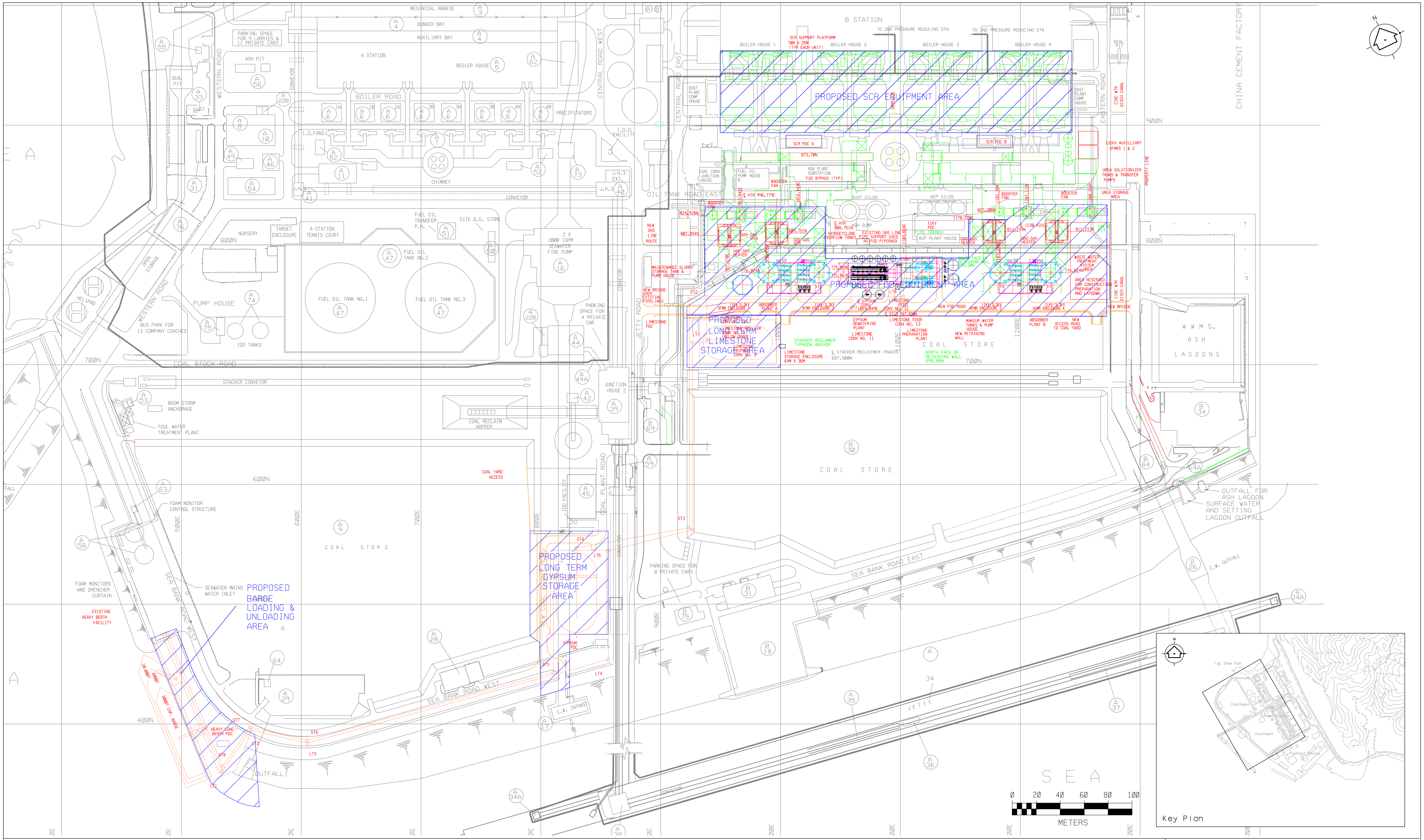

FIGURE 2.1

Overview of Project Site Preliminary General Arrangement

USTN FILE: 0024405_1b.dgn

DATE: 08/05/2006

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2.4 CONSIDERATION OF ALTERNATIVE CONSTRUCTION METHODS AND SEQUENCE OF WORK

The total capacity of the four existing power generation units at CPB represents about one-third of all electricity supplied by CAPCO and CLP Power for use in Hong Kong. Given the complexity and scale of the Project, both the engineering design and construction are being carefully planned to ensure the facilities are phased in smoothly while maintaining a reliable electricity supply. The Project will involve retrofitting the existing units with additional equipment for emissions control. Special considerations have to be given to site constraints such as ground footprint limitations, extensive relocation of existing facilities and common systems, customisation of emissions control equipment to meet specific site requirements and plant conditions while maintaining a reliable power supply.

The scheme described in *Section 2.5* takes into account of many constructability issues associated with this complex retrofitting project.

2.5 DESCRIPTION OF THE SELECTED SCHEME

The currently envisaged construction and operational activities associated with the Project are presented below.

2.5.1 Construction Phase

Demolition and Relocation of Certain Existing Facilities

While the existing generating units will remain in their current locations, some of their auxiliary and common facilities to the south of the generating units at CPB may be demolished or relocated to provide space for the FGD, SCR and related facilities. It must be emphasized that the extent of demolition / relocation works depends primarily on the layout and design of the new emissions control facilities which will be finalised during the design engineering phase. The following paragraphs aim to provide a description of the current scheme of these demolition / relocation works.

Demolition of CPB Fuel Oil Day Tank

The Fuel Oil Day Tank (FODT), which has a capacity of 4,680 t, with the associated stairs, piping, instrumentation, junction boxes, heat tracing, cables, etc, located southwest of the CPB generating units will be demolished. The works will involve cutting the fuel oil piping, moving the fuel oil equipment, and demolishing the fuel oil tank and retaining wall.

The existing 1 m thick reinforced concrete foundation under the tank will be left in place. The eight existing 2 m diameter caissons drilled into the bedrock will also remain in place. The portion of the concrete slab between the tank support foundation and the retaining wall will be backfilled with compacted granular. The oil interceptor serving the FODT bund areas will also be removed.

Demolition of Dangerous Goods Store

The Dangerous Goods (DG) Store to the south of the FOPH will be demolished. The ground floor slab and the existing concrete pavement will remain in place. If caissons or concrete piers are required in the area to support the future emissions control equipment, portions of the pavement will be demolished.

Re-routing of Underground Pipeworks

Several sections of the underground pipeworks of the following systems will be re-routed aboveground:

- sea water flushing;
- town water domestic;
- town water maintenance; and
- sea water fire main.

The underground trench will be backfilled with soil after re-routing of the pipeworks.

Relocation of CO_2 Storage Tank

The existing 2,626-litre CO_2 storage tank, fill connection and vaporisers will be relocated from their existing locations to the area north of the chemical waste building in an area presently occupied as a scaffolding laydown area. The concrete slab supporting the existing CO_2 Tank will remain in place.

Relocation of the LPG Storage Tanks

The existing two LPG tanks of 4,600 litres capacity each and the associated equipment will be removed and relocated to the existing foundation and piers east of Eastern Road. The adjacent vapour room and switch room will be demolished but the concrete slab on grade will remain in place.

Relocation of the Intermediate Pressure Reduction Station

The Intermediate Pressure Reduction Station (IPRS) of the gas transmission system will be relocated to provide space for the installation of the emissions control equipment. The concrete slab floor and objects protruding aboveground will be demolished and backfilled.

Installation of the New Emissions Control Equipment and Facilities

New facilities to be installed for the Project will include the SCR and FGD equipment, reagent and by-product handling and storage facilities associated with the SCR and FGD operations. An additional berthing facility for the loading and unloading of reagents and by-products will also be required. These are described in the following sections.

Installation of SCR and FGD Facilities

The SCR and FGD facilities will be retrofitted to the CPB generating units. The exact footprint of these facilities will be finalised upon design optimisation.

Provision of Reagent and By-product Handling and Storage Facilities

The major reagent and by-product handling facilities for FGD operations will include limestone storage facilities, limestone slurry tanks, gypsum dewatering and storage facilities, and handling and storage facilities for lower grade gypsum. SCR systems will require urea as the ammonia supply reagent, urea storage facilities, dissolvers, urea solution storage tanks and urea-to-ammonia reactors will be required.

Provision of Additional Berthing Facility

The SCR systems could require about 40,000 tonnes per annum (tpa) of urea, while the FGD systems could consume about 150,000 tpa of limestone and generate about 257,000 tpa of gypsum as by-product. The quantities of reagents required and by-product produced will be finalized during the design engineering phase. It is anticipated that additional berthing facility will be needed for the loading and unloading of process reagents and by-product.

The provision of additional berthing is by extending the existing Heavy Load Berth to form a multi-purpose wharf, providing a straight quay with the potential to accommodate ships with a wide range of loaded draft requirements. It is anticipated that the extension work will require some small-scale dredging for the foundations of the deck and for providing sufficient turning basin for the different marine vessel loaded draft requirements. The estimated quantity of the dredged sediment is 80,700 m^3. *Figure 2.2* shows the existing hydrographical profile (i.e. seabed level) in the vicinity of the additional berthing facility. Based on the loaded draught requirement of the vessels to be accommodated, a minimum depth of -8.2 mPD will be required. The area expected to require dredging for the additional berthing facility has been determined taking into account the loaded draught requirements, the existing hydrographical profile and the safety requirements for the berthing manoeuvres and the dredging area is shown in *Figure 2.3*.

The preliminary design of the additional berthing facility, with the envisage pile design and layout, is presented in *Figure 2.4*.

2.5.2 *Operational Phase*

The schematics of the emissions control systems have been presented in *Figure 2.5*. The FGD wastewater treatment system (or known as the chloride purge treatment system) is used to treat effluent from LS FGD processes. No effluent is anticipated from the operation of the NO_x control system.

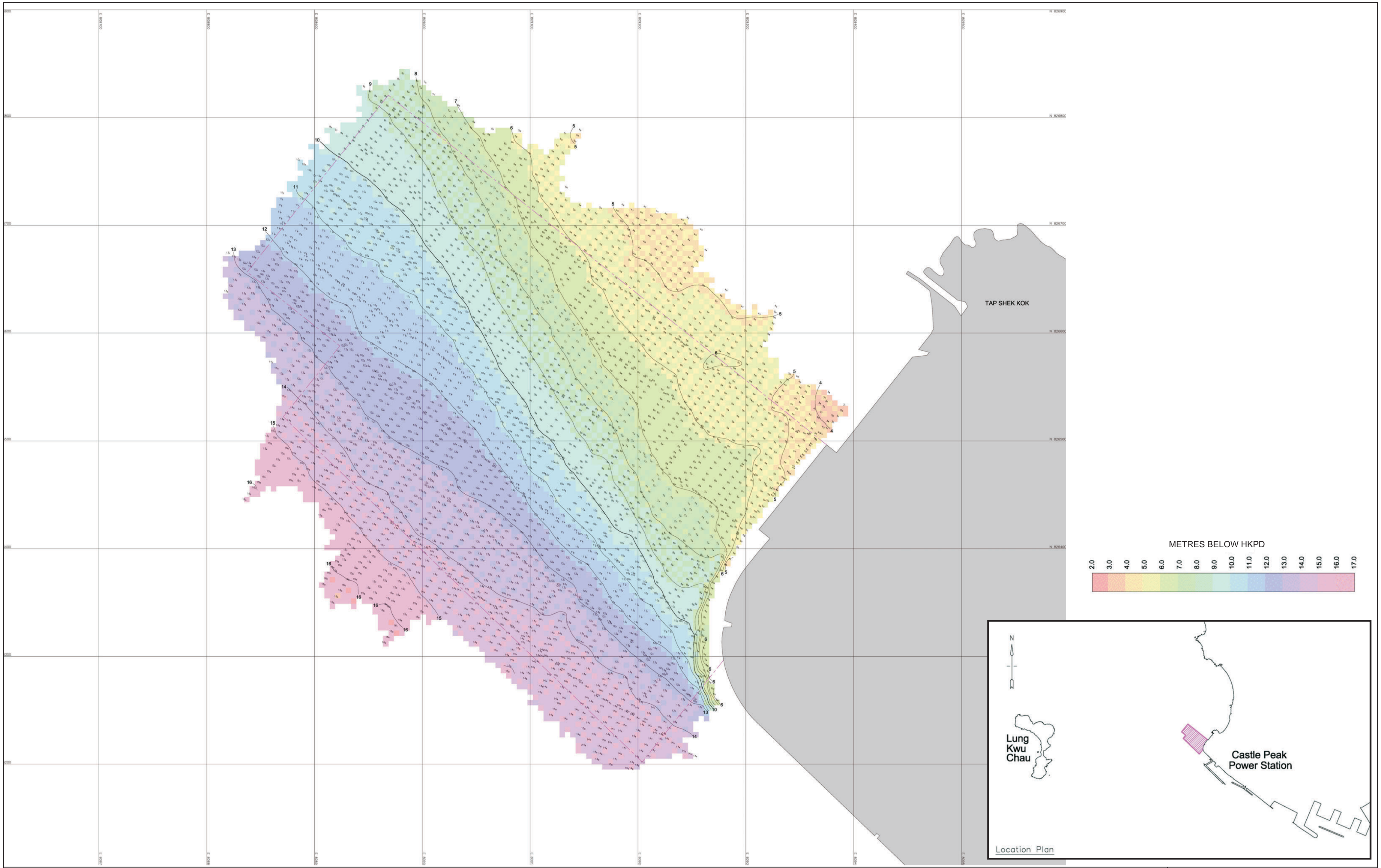

Figure 2.2

Seabed Level at the Dredging Area

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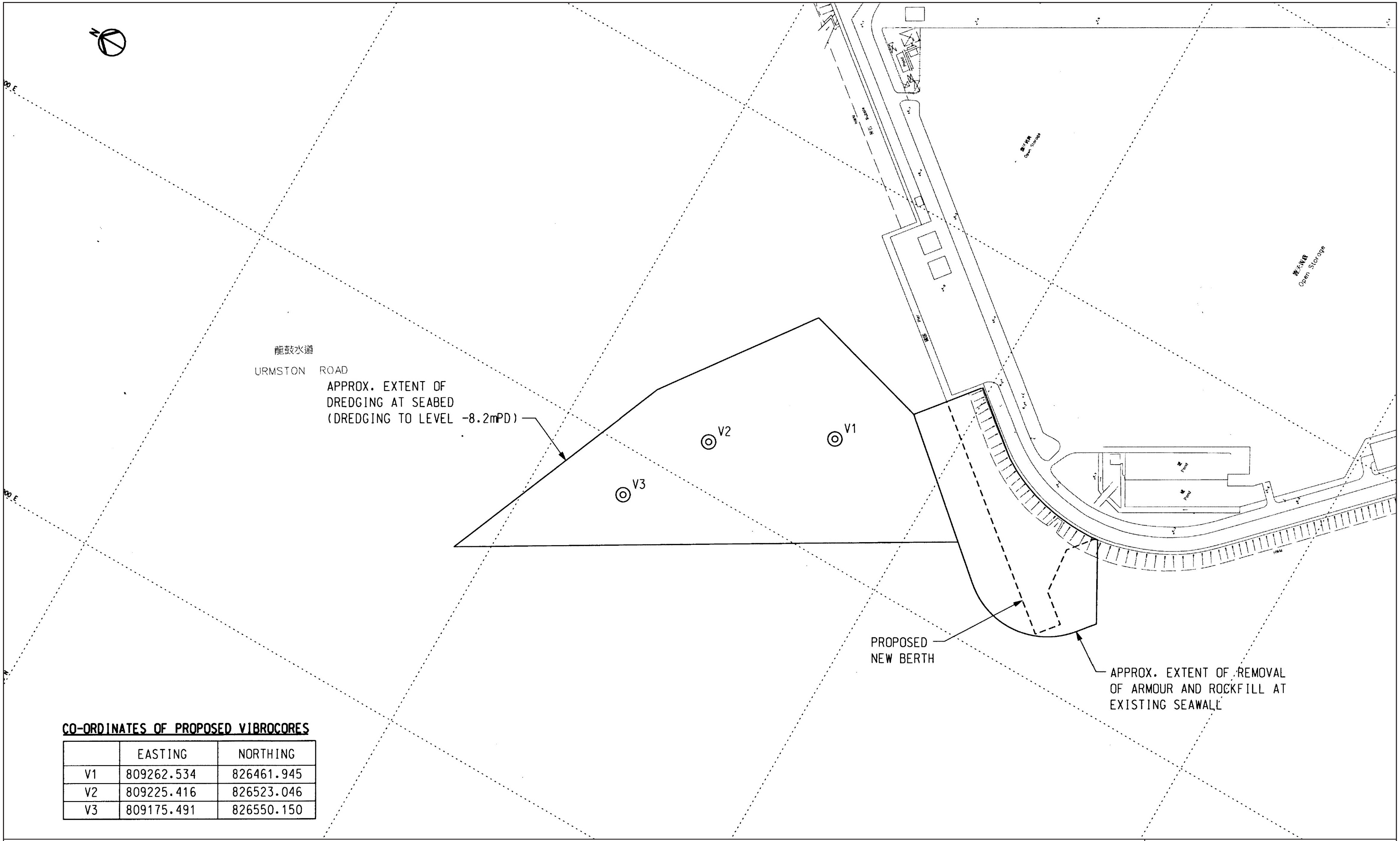

CO-ORDINATES OF PROPOSED VIBROCORES

	EASTING	NORTHING
V1	809262.534	826461.945
V2	809225.416	826523.046
V3	809175.491	826550.150

Figure 2.3

The Proposed Additional Berthing Facility and Dredging Area

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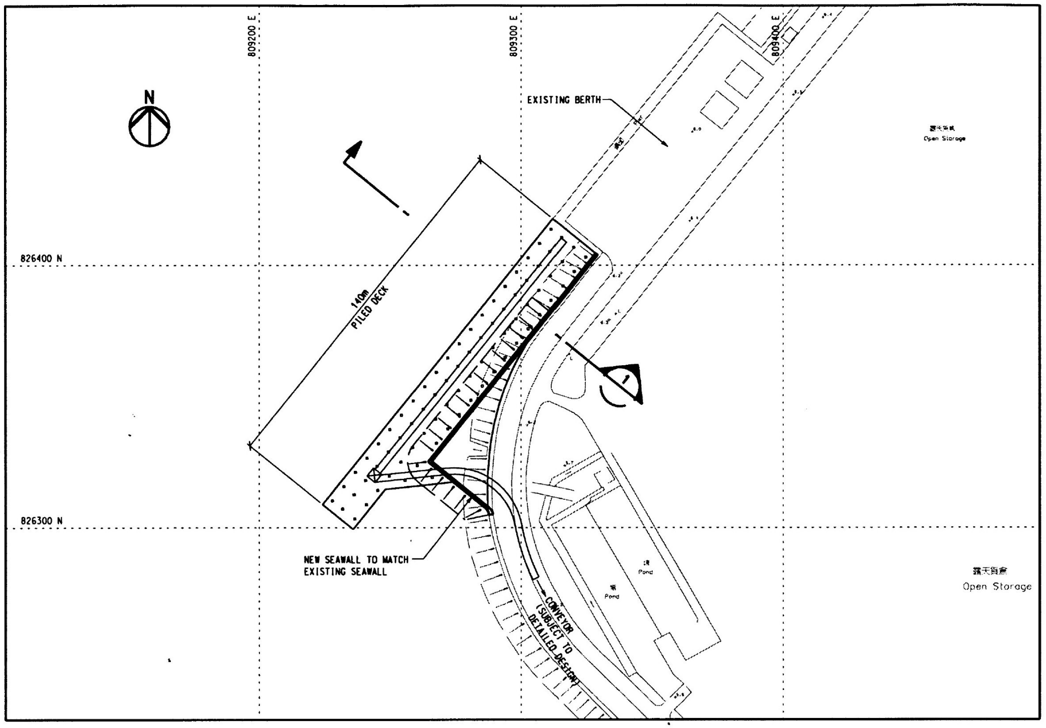

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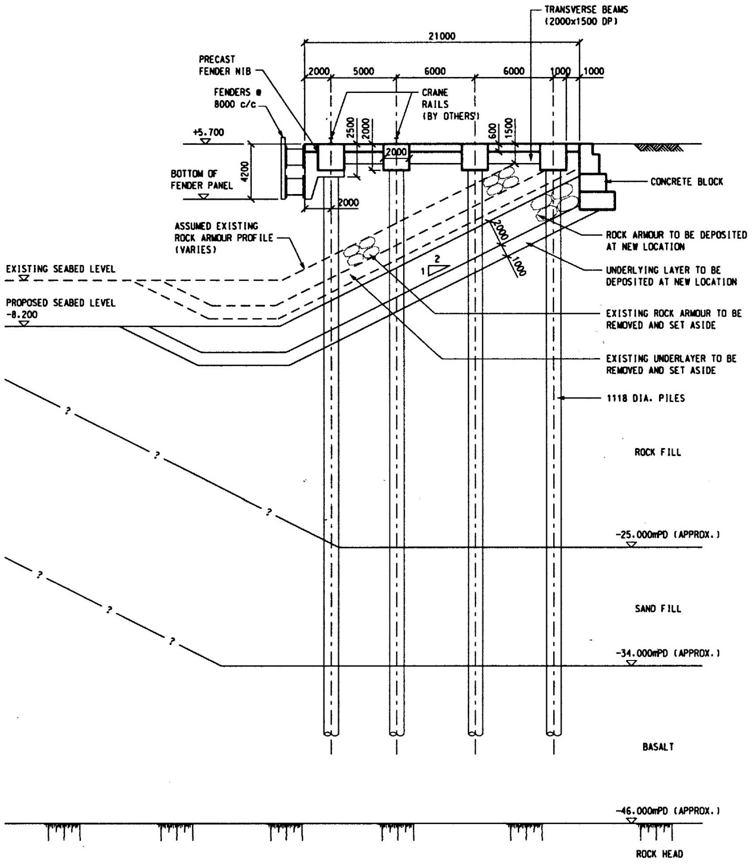

SECTION ①
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Figure 2.4

Preliminary Layout and Location Plan of the Proposed Additional Berthing Facility

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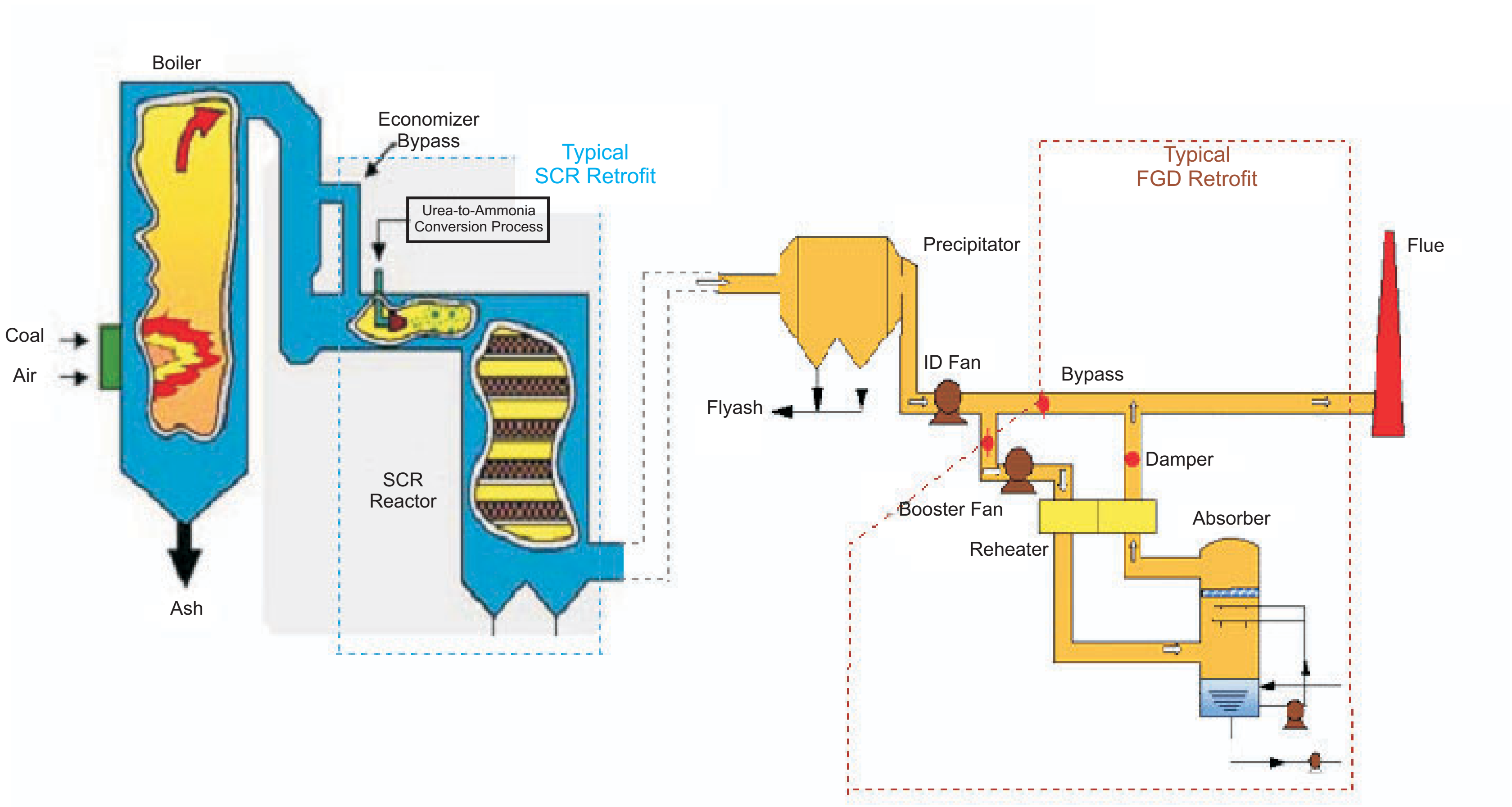

Figure 2.5

Typical SCR and FGD Retrofit for a Coal-fired Power Station

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Environmental Resources Management

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2.5.3 *Proposed Project Programme*

Subject to timely agreement of a long-term environmental policy and the successor regulatory regime with the HKSARG, the currently envisaged project milestones are as follows:

Key Stage of the Project	**Indicative Date**
Finalisation of other major permitting requirements	2006
Completion of front-end engineering design	1st half of 2007
Commencement of relocation of existing facilities	1st half of 2007
Award of major contracts	2007
Dredging works	2nd Quarter of 2007
Commencement of retrofit site work	End 2007
Start-up of the retrofitted units	End 2009 to 2011

3 AIR QUALITY ASSESSMENT

3.1 INTRODUCTION

This section presents the air quality impact assessment for the Project during the construction and operation phases. Air Sensitive Receivers (ASRs) and the potential sources of impacts have been identified and assessed. Mitigation measures are recommended, where necessary.

3.2 LEGISLATIVE REQUIREMENT AND EVALUATION CRITERIA

The principal legislation for the management of air quality in Hong Kong is the *Air Pollution Control Ordinance* (*APCO*) (Cap. 311). Under the *APCO*, the *Hong Kong Air Quality Objectives* (AQOs), as summarised in *Table 3.1*, stipulate the statutory limits for air pollutants and the maximum allowable numbers of exceedances over specific periods.

Table 3.1 Hong Kong Air Quality Objectives ($\mu g\ m^{-3}$) (a)

Air Pollutant	**Averaging Time**			
	1 Hour (b)	**24 Hour (c)**	**3 Months (d)**	**1 Year (d)**
Total Suspended Particulates (TSP)	-	260	-	80
Respirable Suspended Particulates (RSP) (e)	-	180	-	55
Sulphur Dioxide (SO_2)	800	350	-	80
Nitrogen Dioxide (NO_2)	300	150	-	80
Carbon Monoxide (CO)	30,000	-	-	-
Photochemical Oxidants (as ozone (O_3)) (f)	240	-	-	-
Lead (Pb)	-	-	1.5	-

Notes:

(a) Measured at 298K (25°C) and 101.325 kPa (one atmosphere)
(b) Not to be exceeded more than three times per year
(c) Not to be exceeded more than once per year
(d) Arithmetic means
(e) Suspended airborne particulates with a nominal aerodynamic diameter of 10 micrometres or smaller
(f) Photochemical oxidants are determined by measurement of ozone only

In addition, the *Technical Memorandum on Environmental Impact Assessment Ordinance* (*EIAO-TM*) also stipulates an hourly TSP criterion of 500 $\mu g\ m^{-3}$ for construction dust impacts.

3.3 BASELINE CONDITIONS AND AIR SENSITIVE RECEIVERS

3.3.1 Existing Conditions

The Emission Control Project is to be located at the existing Castle Peak Power Station. The existing air quality in the area is influenced by the emissions from a number of industrial establishments in the nearby area and in the Pearl River Delta region, including the existing Castle Peak Power Station.

One of the nearest EPD Air Quality Monitoring Stations (AQMS) is located in Tung Chung, about 10 km from the site. The annual average concentrations of major air pollutants measured at the Tung Chung AQMS in 2005 are presented in *Table 3.2*.

Table 3.2 *Annual Average Pollutant Concentrations in the Study Area*

Pollutant	**Annual Average Concentration (μg m^{-3})[(a)]**
Total Suspended Particulates (TSP)	65
Respirable Suspended Particulates (RSP)	57
Sulphur Dioxide (SO_2)	21
Nitrogen Dioxide (NO_2)	46

Note:

(a) Tung Chung AQMS, 2005

3.3.2 *Air Sensitive Receivers (ASRs)*

The Air Sensitive Receivers identified in the Study Area are listed in *Table 3.3* and their locations shown in *Figure A.2* of *Annex A*. ASRs are representative of residential and commercial areas at various distances from the project site, as required by the *Study Brief.*

The receptor heights were chosen at 1.5 m for all locations, and at selected locations at an additional level depending on the properties of each ASR (20 m or 30 m for low-rise buildings, 100 to 150 m for high-rises). It is believed that these assessment levels are adequate to capture the plume properties under a range of different wind speeds, both for the low-rise structures and also for the high-rise ASRs, considering the size of the plume and the distance to the ASRs.

Table 3.3 *Air Sensitive Receivers*

Label	**Location**	**Approximate distance (km)**	**Height above ground (m)**
A1	Lung Kwu Tan (Lung Tsai Village)	1.3	1.5
A2	Lung Kwu Tan (Pak Long Village)	1.8	1.5
A3	Lung Kwu Sheung Tan (village house)	3.3	1.5
A4	Ha Pak Nai (village house)	6.2	1.5
A5	Sheung Pak Nai (village house)	8.7	1.5
A6a	Hung Shui Kiu, Aster Court	10.3	1.5
A6b	Hung Shui Kiu, Aster Court	10.3	30
A7a	Lam Tei, Botania Villa	8.4	1.5
A7b	Lam Tei, Botania Villa	8.4	30
A8a	Tuen Mun North	6.1	1.5
A8b	Tuen Mun North	6.1	120
A9a	Tuen Mun Centre	5.6	1.5
A9b	Tuen Mun Centre	5.6	120
A10a	Tuen Mun South, Butterfly Estate	4.3	1.5
A10b	Tuen Mun South, Butterfly Estate	4.3	110
A11a	So Kwun Wat, Aegean Coast	7.3	1.5
A11b	So Kwun Wat, Aegean Coast	7.3	100
A12a	Tai Lam Chung (Tai Lam Correctional Institution)	10.4	1.5
A12b	Tai Lam Chung (Tai Lam Correctional Institution)	10.4	15

Label	Location	Approximate distance (km)	Height above ground (m)
A13	River Trade Golf	3.0	1.5
A14a	Tung Wah Group of Hospital Youth Holiday Camp at Siu Lang Shui	1.8	1.5
A14b	Tung Wah Group of Hospital Youth Holiday Camp at Siu Lang Shui	1.8	20
A15a	Proposed Eco Park at Tuen Mun Area 38	1.0	1.5
A15b	Proposed Eco Park at Tuen Mun Area 38	1.0	30
A16	Siu Ho Wan (village house)	10.3	1.5
A17	Tai Ho Wan (village house)	10.0	1.5
A18a	Tung Chung (residential building along coast)	9.2	1.5
A18b	Tung Chung (residential building along coast)	9.2	150
A19a	HK International Airport (hotel, offices)	6.4	1.5
A19b	HK International Airport (hotel, offices)	6.4	30
A20	Sha Lo Wan (village house)	9.2	1.5
A21a	Tin Shui Wai, Tin Chung Court (or Tin Shing Court)	11.9	1.5
A21b	Tin Shui Wai, Tin Chung Court (or Tin Shing Court)	11.9	110
A22	So Kwun Wat, So Kwun Wat Tsuen	8.6	1.5
A23a	Tuen Mun South, Siu Lun Court	5.7	1.5
A23b	Tuen Mun South, Siu Lun Court	5.7	110

Most of the near-field ASRs are village houses or low-rise structures with representative receptor heights at 1.5 m. The ASR closest to the project site is the proposed Eco Park at Tuen Mun Area 38 (A15a / A15b) which is located about 950 m to the east. The distance to the closest existing ASRs, the village houses of Lung Tsai and Pak Long (A1 and A2) is well over 1 km. Other industrial facilities adjacent to the CPPS are low-rise structures unlikely to be affected by the tall CPB stack and therefore they have not been selected as ASRs. In addition, they have been represented by other ASRs (A15a / b and A14a / b).

3.4 CONSTRUCTION PHASE AIR QUALITY IMPACT ASSESSMENT

3.4.1 The Project Construction, Demolition and Site Formation Activities and their Potential Air Quality Impacts

The following construction / demolition works are the subject of this assessment:

- Demolition of existing facilities at CPB, including: the 4,680 tonne Fuel Oil Day Tank and Dangerous Goods (DG) Store;

- Relocation or re-routing of existing facilities, including: 2,626 litre Carbon Dioxide (CO_2) Storage Tank, two 4,600 litre Liquefied Petroleum Gas (LPG) Storage Tanks, and Intermediate Pressure Reduction Station;

- Installation of new emission control equipment and facilities (SCR and FGD) and associated site formation works;

- Provision of Reagent and By-Product Handling and Storage Facilities, including: limestone silos, limestone slurry tanks, gypsum dewatering and storage facilities for the LS-FGD operations and the urea storage silos, urea dissolving tanks, urea solution storage tanks and urea-to-ammonia reactors for the SCR operations;

- Provision of additional berthing facility for loading and unloading of the process reagents, including up to 40,000 tonnes per year of urea, up to 150,000 tonnes per year of limestone and up to 257,000 tonnes per year of gypsum as by-products.

It is expected, that due to the limited scale of the construction and demolition works and the remoteness of ASRs, gaseous and particulate emissions (of CO, SO_2, NO_x and RSP) from the construction machinery and vehicles are of secondary importance and do not have the potential to cause any exceedances of Air Quality Objectives listed in *Table 3.1*.

Dust nuisance is therefore the remaining concern during the construction, demolition and site formation works and, in accordance with the *Study Brief*, constitutes the main subject of this assessment.

The Construction Dust generation potential of different construction activities are discussed below.

Demolition and Relocation Works

Most of the demolition and relocation works concerns steel/concrete structures with most of the caissons and concrete foundations remaining intact. The principal potential sources of construction dust will include:

- Demolition of concrete structures in the Dangerous Goods Store, Fuel Oil Day Tank, and LPG switch room & vaporiser room, and LPG Tank areas (about 1,300 m^3 in total)

- Underground excavation (soil/concrete) for the new piping locations (about 800 m^3 in total)

- Backfilling with soil the trenches following relocation of the piping.

Construction and Installation of the FGD and SCR Equipment

The superstructures and equipment installed will mainly be of prefabricated steel construction, so the dust generation potential of the construction works is low.

Site Formation

Site formation activities with the potential for dust generation will be very limited. The main area of such works will be the northern coal yard, where some filling is anticipated.

Provision of Additional Berthing Facility

These will involve the handling of wet materials, and therefore their potential for construction dust generation is low.

3.4.2 Conclusion

Due to relatively small scale of the dust generating activities during the construction phase of the Project and the distance from the ASRs (the closest sensitive receiver is approximately 1 km away from the project site), no adverse dust impact is anticipated. Although dust emissions and gaseous emissions are not expected to affect the nearby ASRs during the construction phase, the dust control measures stipulated in the *Air Pollution Control (Construction Dust) Regulation* should be implemented to comply with the *Regulation*.

3.5 OPERATIONAL PHASE ASSESSMENT

3.5.1 Emission Reductions under the CPB Emission Control Project

The Emission Control Project is a project aimed to achieve a significant reduction in emissions from the Castle Peak Power Station.

The following reduction efficiencies are used as the basic assumptions for the operational air quality assessment:

- SO_2 emission reduction by up to 90%; and
- NO_x emission reduction by up to 80%.

Some reduction in particulate emissions is also anticipated as a result of FGD operation, details of which will be assessed during the design optimisation.

3.5.2 Other Potential Sources of Impact

Increased Marine Traffic

To achieve the significant reductions in the SO_2 and NO_x emissions from CPB, the project will create a slight increase in the marine traffic, due to the need for limestone and gypsum transportation. It is anticipated that marine vessels, in the size range of 1,000 DWT to 10,000 DWT, will arrive at a rate of about one per week, with 2 days berthing time for loading / unloading activities. This will constitute only an insignificant fraction of the existing marine traffic emissions in Urmston Road. In the context of the overall reductions in the SO_2 and NO_x emissions due to the Project, the effects of a relatively small increase in the marine emissions are considered insignificant.

Ammonia Slip

The operation of the SCR and SNCR systems may result in a phenomenon known as “ammonia slip”, i.e. excess, unreacted ammonia making its way to the flue gas. For typical SCR and SNCR systems in a coal-fired power station, the ammonia slip is kept at a range of few parts per million, the potential ammonia emissions from the Project would be negligible. It should be noted that ammonia required for the SCR and SNCR NO_x reduction is generated from urea on a supply-on-demand basis. There will not be any bulk ammonia storage on-site. The design of the SCR and SNCR facilities will allow for the ammonia slip in the flue gas to be closely monitored and in case of sign of deterioration, adequate control and measures will be implemented. Immediate control measures include adjustment to the injection rate of ammonia. Other longer-term actions include the addition or replacement of SCR catalyst.

Potential Dust Impact from Limestone Storage and Handling

The unloader of limestone at the berthing facility will be of low dust emission potential, consisting of dust control measures like telescoping chute. Conveyor belts will be covered; transfer towers and storage of limestone will be enclosed and provided with dust collection system. The potential dust impact from the limestone handling operation is therefore expected to be negligible.

3.5.3 Scope and Objectives of the Operational Phase Assessment

The Study Brief stipulates that "The Applicant may carry out a comparative study to demonstrate if the stack emission impacts of the "B" Units before and after the Project will lead to lower air quality impacts at the Air Sensitive Receivers (ASRs) by using either a simple screening tool such as ISCST3 Gaussian model or a more sophisticated tool, such as wind tunnel test, if necessary". The following sub-sections summarise the methodology and results of such comparative assessment, using a Wind Tunnel testing methodology. More details on this comparative wind tunnel study are provided in *Annex A*.

It should be noted that, as described in *Section 3.5.6*, the comparative study demonstrated that the Project will result in an improvement of air quality at all locations; therefore, a quantitative assessment of cumulative air quality impacts under *Section 3.4.1.5* of the *Study Brief* is not necessary.

3.5.4 Wind Tunnel Test Methodology

General

The spatially and temporally variable meteorological and atmospheric dispersion conditions associated with complex terrain pose several challenges to assessing the dispersion of airborne pollutants in a coastal, mountainous region such as the Study Area. Physical scale wind tunnel modelling accounts for building wake and complex terrain effects, and is one of the most accurate methods for the simulation of these near-field influences for neutrally stable atmospheric conditions.

In general, wind tunnel air quality studies involve placing a physical model of the emission sources and surrounding terrain in a wind tunnel, emitting a passive tracer from the sources and measuring its concentrations at a number of receivers inside the wind tunnel for different wind speeds and directions.

The Present Study

Wind tunnel tests for this study were conducted by Rowan Williams Davies & Irwin Inc. (RWDI) of Guelph, Ontario, Canada, using a 1:2000 scale physical model of the site including the existing plant and all surrounding terrain. The setup of the physical model in the wind tunnel is shown in *Figure 3.1*.

The wind tunnel simulated the winds approaching the Study Area, the exhaust discharged from the source being tested and the dispersion of the exhaust in the atmosphere.

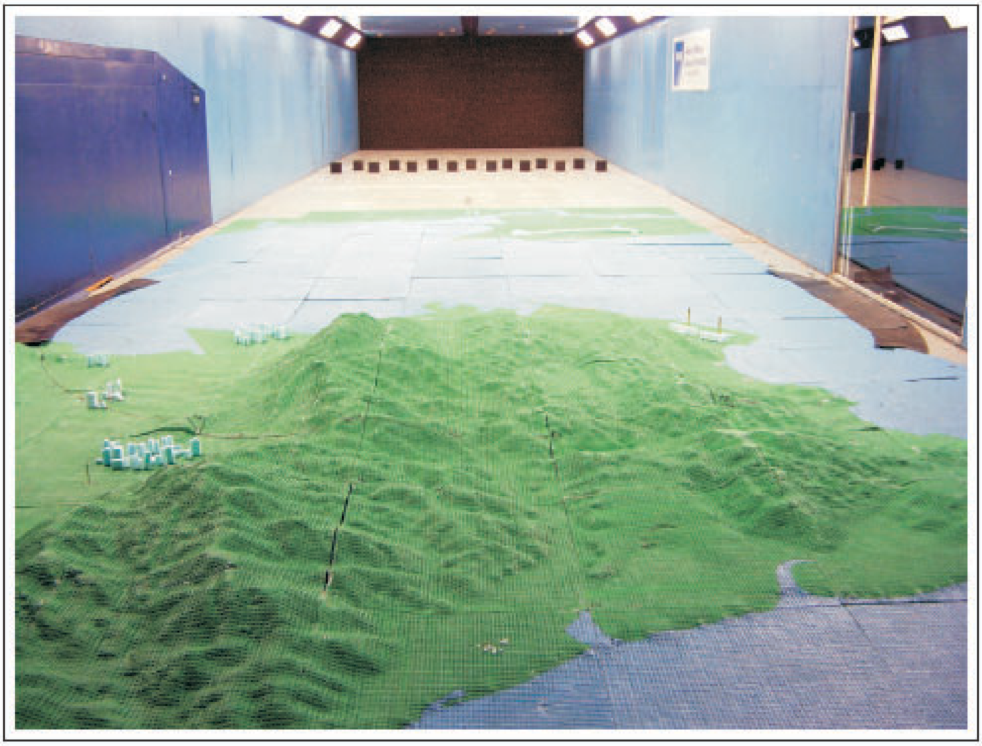
3.5.5 Results: Air Quality Improvements under Worst-Case Conditions

The estimated relative decreases in concentrations of SO_2 and NO_x after the retrofit for the worst-case meteorological conditions (ie those for which the highest concentration ratios were measured) have been presented for each receptor in *Table A.4* of *Annex A*.

The results shown in *Table A.4* of *Annex A* represent the resultant reduction of SO_2 and NO_x concentrations, hence air quality improvements at the ASRs, under the worst-case conditions measured in the wind tunnel for each of the two scenarios tested. The results demonstrate that the percentage reductions in the measured SO_2 and NO_x concentrations at the ASRs are very similar to the corresponding reductions of SO_2 and NO_x emissions from the CPB units after retrofit. The slight changes in the percentage reduction of the measured concentrations can be explained by the changes in the plume characteristics (i.e. a lower exit velocity and a lower efflux temperature after implementation of the retrofit programme) and the effects of the complex terrain on the exhaust dispersion.

In conclusion, the effects of changes in dispersion characteristics (due to changes in flue gas physical properties) on the pollutant concentrations at ASRs after the retrofit are much lower in magnitude when compared with those of the expected emission reductions of SO_2 and NO_x. The combined effects of the emission reductions and the changes in physical characteristics of the plume result in air quality improvements at all the identified ASRs ranging from 86% to 91% for SO_2, 72% to 83% for NO_x.

It should be noted that the above NO_x and SO_2 reductions in predicted worst-case concentrations are related to the Castle Peak Station “B” emissions only and do not include cumulative effects. While the assessment of cumulative impacts is not the focus of this EIA Study, it is anticipated that (with all other emissions assumed constant) the Project will result in an improvement in SO_2 and NO_x levels in the vicinity of the Castle Peak Power Station. The magnitude of such improvements will of course be lower for sensitive receivers located further away from the CPPS.



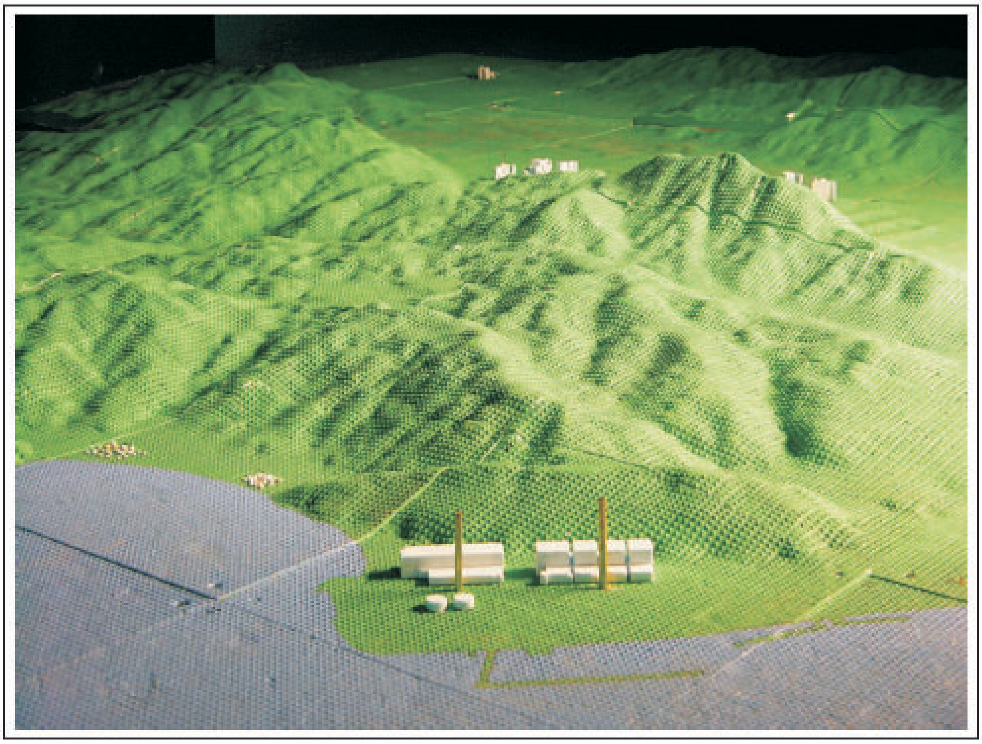


Figure 3.1

Physical Model Inside the Wind Tunnel

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Based on the current licence limit for particulate emissions (125 mg Nm^{-3}) and the likely achievable particulate emissions level after FGD retrofit (50 mg Nm^{-3}), the potential reduction in particulate emissions would be around 60%. Assuming this 60% reduction rate in particulate emissions, it can be concluded based on the concentration ratios measured in wind tunnel (see *Annex A*) that the particulate concentrations will decrease at all ASRs and that, depending on location, these concentration decreases will range from 44% to 66%. Further studies will be needed with FGD manufacturers during design to confirm if additional particulate emissions reduction through FGD is feasible.

3.5.6 Conclusion

A comparative air quality assessment was conducted for the existing CPB units. Scale model testing was performed in RWDI's Boundary Layer Wind Tunnel to simulate the behaviour of the exhaust plume before and after installation of the proposed emission control equipment.

Each configuration was tested for a wide range of wind speeds and directions, as required to measure the plume impacts at the receptor locations. The results of the wind tunnel study are presented in *Table A.4 of Annex A* as percentage changes measured at each receptor location by comparing the pre-retrofit concentrations against the corresponding reductions in the pollutant concentrations after the retrofit.

The following is a summary of the major findings:

- The measured percentage reduction in SO_2, NO_x and particulates concentrations at the receptor locations before and after implementation of the retrofit programme are similar in magnitude to the proposed emission reductions at source. The effects of changes in flue gas characteristics on the dispersion of emissions were minor and insignificant when compared to the corresponding reductions in SO_2, NO_x and particulates emissions from CPB after retrofit.

- This comparative study demonstrated that the worst case predicted SO_2, NO_x and particulates concentrations at all the identified ASRs will have an improvement in air quality after the retrofit as required in *Section 3.4.1.2* of the *Study Brief*.

3.6 MITIGATION MEASURES

3.6.1 Construction Phase

The following dust control measures stipulated in the *Air Pollution Control (Construction Dust) Regulation* are recommended.

- The area at which demolition work takes place should be sprayed with water prior to, during and immediately after the demolition activities so as to maintain the entire surface wet;

- Dust screens or sheeting should be provided to enclose the structure to be demolished to a height of at least 1 m higher than the highest level of the structure;

- Any dusty materials should be wetted with water to avoid any fugitive dust emission;

- All temporary stockpiles should be wetted or covered by tarpaulin sheet to prevent fugitive emissions;

- All the dusty areas and roads should be wetted with water;

- All the dusty materials transported by lorries or barges should be covered entirely by impervious sheet to avoid any leakage; and

- The falling height of fill materials should be controlled.

3.6.2 Operational Phase

Since the project will significantly reduce SO_2 and NO_x emissions and further reduce particulate emissions from the Castle Peak Station "B" units, and the potential impacts of ammonia slip and dust from limestone handling will be dealt with at the design and equipment procurement stage, no further mitigation measures are required.

3.7 ENVIRONMENTAL MONITORING AND AUDIT

Due to the relatively small scale of the demolition and construction works and the remoteness of the Air Sensitive Receivers, no EM&A is required for the Construction Phase.

Since the Project will achieve reductions in SO_2, NO_x and particulates emissions, no additional EM&A activities are required for the Operational Phase, other than those already required by the Specified Process Licenses for the operation of the Castle Peak Power Station.

3.8 SUMMARY AND CONCLUSION

3.8.1 Construction Phase

Dust from demolition, site formation and construction activities is the key concern during the construction of the Project.

Demolition of concrete structures in the Dangerous Goods Store, Fuel Oil Day Tank, and LPG storage compound (about 1300 m^3 in total), underground excavation (soil / concrete) for the new piping locations (about 800 m^3 in total), filling with soil of the existing trenches of the piping to be relocated, limited foundation works at the FGD, SCR and reagent and by-product handling and storage facilities locations, as well as limited site filling works in the northern coal yard area are the major construction / demolition works of the Project with dust-generating potential. Due to the relatively small scale of these works, the remoteness of Air Sensitive Receivers (the closest ASR is at approximately 1 km away) and with the implementation of the dust control measures stipulated in the *Air Pollution Control (Construction Dust) Regulation*, no adverse air quality impact is envisaged from the construction of the Project.

3.8.2 Operational Phase

A comparative wind tunnel modelling study demonstrated that the operation of the Project will result a significant reduction in SO_2, NO_x and particulates concentrations at the receptor locations, similar in magnitude to the proposed emission reductions at the source after the implementation of the retrofit programme.

4 NOISE

4.1 INTRODUCTION

This Section presents the potential noise impacts associated with the demolition of oil tanks, retrofitting of the Castle Peak Power Station “B” Units (CPB) with emissions control facilities and the operation of the CPB.

4.2 RELEVANT LEGISLATION AND GUIDELINES

4.2.1 Construction Noise

The principal legislation relating to the control of construction noise is the *Noise Control Ordinance (Cap. 400)* (*NCO*). A number of technical memoranda (TMs) have been issued under the NCO to stipulate control approaches and criteria and those which may be relevant to the demolition works and retrofitting of CBP include the following:

- *Technical Memorandum on Noise from Percussive Piling (PP-TM);* and
- *Technical Memorandum on Noise from Construction Work other than Percussive Piling* (*GW-TM*).

Apart from the above, the *Environmental Impact Assessment Ordinance* (*EIAO*) *(Cap. 499)* also provides means to assess construction noise impacts. The *Technical Memorandum on Environmental Impact Assessment Process* (*EIAO-TM*), issued under the *EIAO*, provides guidelines and noise criteria for evaluating construction noise impacts.

Percussive Piling

Under the *PP-TM*, percussive piling is prohibited at any time on Sundays and public holidays and during the weekday evening and night-time hours (1900-0700 hours, Monday through Saturday). A Construction Noise Permit (CNP) is required for such works during weekday daytime hours (0700-1900 hours, Monday through Saturday).

General Construction Works

Under the *EIAO*, noise impact arising from general construction works during normal working hours (i.e. 0700 to 1900 hours on any day not being a Sunday or public holiday) at the openable windows of buildings is to be assessed in accordance with the noise criteria as given in the *EIAO-TM*. The *EIAO-TM* noise standards are presented in *Table 4.1*.

Table 4.1 ***EIAO-TM Daytime Construction Noise Standard ($L_{eq, 30\ min}$ dB(A))***

Use	**Noise Standard**
Domestic Premises	75
Educational Institutions (normal periods)	70
Educational Institutions (during examination periods)	65

When assessing a CNP application for the use of Powered Mechanical Equipment (PME) during restricted hours, the Noise Control Authority will compare the ANLs, as promulgated in *GW-TM*, and the CNLs (after accounting for factors such as barrier effects and reflections) associated with the proposed PME operations. The ANLs are related to the noise sensitivity of the area in question and different Area Sensitivity Ratings have been established to reflect the background characteristics of different areas. The relevant ANLs are shown in *Table 4.2*.

The *Noise Control Authority* will consider a well-justified Construction Noise Permit (CNP) application, once filed, for construction works within restricted hours as guided by the relevant Technical Memorandum issued under the *NCO*. The *Noise Control Authority* will take into account adjoining land uses and any previous complaints against construction activities at the site before making a decision in granting a CNP. Nothing in this EIA Report shall bind the *Noise Control Authority* in making his decision. The *Noise Control Authority* may include any conditions in a CNP that it considers appropriate. Failure to comply with any such conditions may lead to cancellation of the CNP and prosecution action under the NCO.

Table 4.2 ***Acceptable Noise Levels (ANL, $L_{eq, 5\ min}$ dB(A))***

Time period	**Area Sensitivity Rating**		
	A	B	C
All days during the evening (1900-2300 hours) and general holidays (including Sundays) during the day and evening (0700-2300 hours)	60	65	70
All days during the night-time (2300-0700 hours)	45	50	55

4.2.2 *Operational Noise*

Fixed plant noise is controlled under *Section 13* of the *NCO* and the predictions will be undertaken in accordance with the *Technical Memorandum on Noise from Places other than Domestic Premises, Public Places or Construction Sites* (*IND-TM*). The criteria noise limits are set out in the *EIAO-TM* as follows:

- the total fixed source noise level at the facade of the nearest NSR is at least 5 dB(A) lower than the appropriate ANL (as shown in *Table 4.3*) as specified in the *IND-TM*; or

- where the prevailing noise level in the area is 5 dB(A) or more below the appropriate ANL, the total fixed source noise level must not exceed this noise level. Future check of prevailing noise levels will be made during baseline noise measurement prior to construction of the Project.

The criteria noise limits stipulated in the *IND-TM* are dependent on the Area Sensitivity Rating (ASR) of the NSRs, as shown in *Table 4.3.*

Table 4.3 ANLs to be used as Operation Noise Criteria

Time Period	**$L_{Aeq\ 30min}$ (dB(A))**		
	ASR "A"	**ASR "B"**	**ASR "C"**
Daytime 0700-1900	60	65	70
Evening 1900-2300	60	65	70
Night-time 2300-0700	50	55	60

As the site is located in a rural area and no influencing factors affect the NSRs which are located at more than 1 km away from the site, an ASR "A" has been assumed for the NSR located in the vicinity of the proposed site. Baseline noise measurement has been conducted to investigate the prevailing noise levels at Castle Peak and to establish the noise limit for the assessment of the operational noise impact. Detail of the noise measurement will be further discussed in *Section 4.3.3.*

The Area Sensitive Rating assumed in this Report is for indicative assessment only given that there are currently no influencing factors assumed in the vicinity of the NSRs. It should be noted that fixed noise sources are controlled under Section 13 of the *NCO*. At the time of investigation, the *Noise Control Authority* shall determine noise impact from concerned fixed noise sources on the basis of prevailing legislation and practices being in force, and taking account of contemporary conditions / situations of adjoining land uses. Nothing in this Report shall bind the *Noise Control Authority* in the context of law enforcement against all the fixed noise sources being assessment.

4.3 BASELINE ENVIRONMENTAL CONDITIONS AND NOISE SENSITIVE RECEIVERS

4.3.1 Baseline Environmental Conditions

The site will be located within the existing site of the Castle Peak Power Station (*Figure 4.1*). The background noise environment is dominated by the fixed plant noise from the operation of the existing Castle Peak Power Station and the adjoining Green Island Cement Plant, and road traffic noise from Lung Mun Road.

4.3.2 Noise Sensitive Receivers

The nearest NSR is identified as the village house at Sha Po Kong (N1) which is located at approximately 1.1 km away from the site. A planned noise sensitive development is identified as the Holiday Camp (PN1) located at approximately 1.2 km to the east of the site. The locations of the NSRs are shown in *Figure 4.1* and presented in *Table 4.4.*

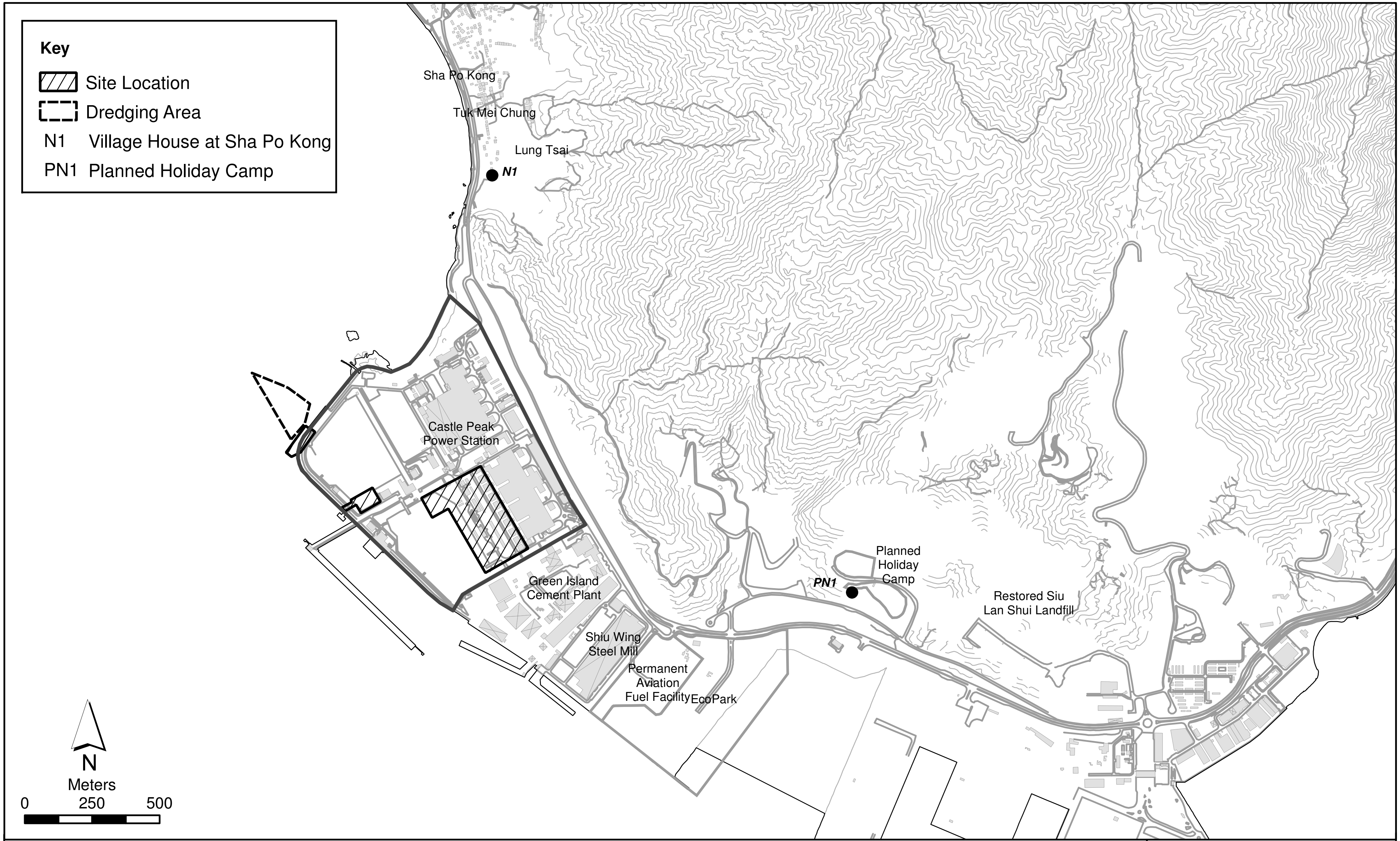

Figure 4.1

Location of Noise Sensitive Receivers

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Table 4.4 Identified Noise Sensitive Receivers

NSR	Location	Type of Uses
N1	Village house at Sha Po Kong	Residential (3-Storey)
PN1	Planned Holiday Camp at Siu Lang Shui	Temporary housing

4.3.3 Baseline Noise Measurement

To investigate the prevailing noise levels at the NSRs in Castle Peak, a continuous 24-hour free-field noise measurement was made from 15 to 16 March 2006 at the 1st floor level of village house at Sha Po Kong (*Figure 4.2*). The noise measurement was conducted using 01 dB Solo Sound Level Meter (Type 1) and was calibrated using B&K Sound Level Calibrator Type 4231 with a calibration signal of 94.0 dB(A) at 1kHz. The measurement was logged at $L_{Aeq, 1s}$ intervals using fast time weighting. The measurement was conducted with reference to the calibration and measurement procedures as stated in the *IND-TM*.

The measurement results are summarised in *Table 4.5* and a timeline chart showing the prevailing noise levels is presented in *Annex B-1*. Since the measurement is a free field measurement, an appropriate facade correction of 3dB(A) has been applied to the noise measurement results.

Table 4.5 Measured Prevailing Free-field Noise Level (with Facade Correction)

Period	**$L_{Aeq, 30min}$ dB(A)**		
	Minimum	Average	Maximum
0700 – 2300 hours	56	66	75
2300 – 0700 hours	48	54	65

With the inclusion of facade correction, the measured prevailing noise level will be higher than the (ANL-5) criterion, and therefore the (ANL – 5) criterion, i.e. 45 dB(A) $L_{Aeq, 30min}$ for night-time period will be considered as the stipulated noise limit for the assessment of operational noise impact.

4.4 CONSTRUCTION NOISE ASSESSMENT

4.4.1 Potential Sources of Impact

Potential impacts to the NSR during the construction phase of the CPB will mainly arise from PME operating at construction work sites. The major construction work will include the following key activities:

- Demolition of some existing facilities;
- Relocation of some existing facilities;
- Installation of new emissions control equipment and associated facilities; and
- Extension of the existing heavy load berth.

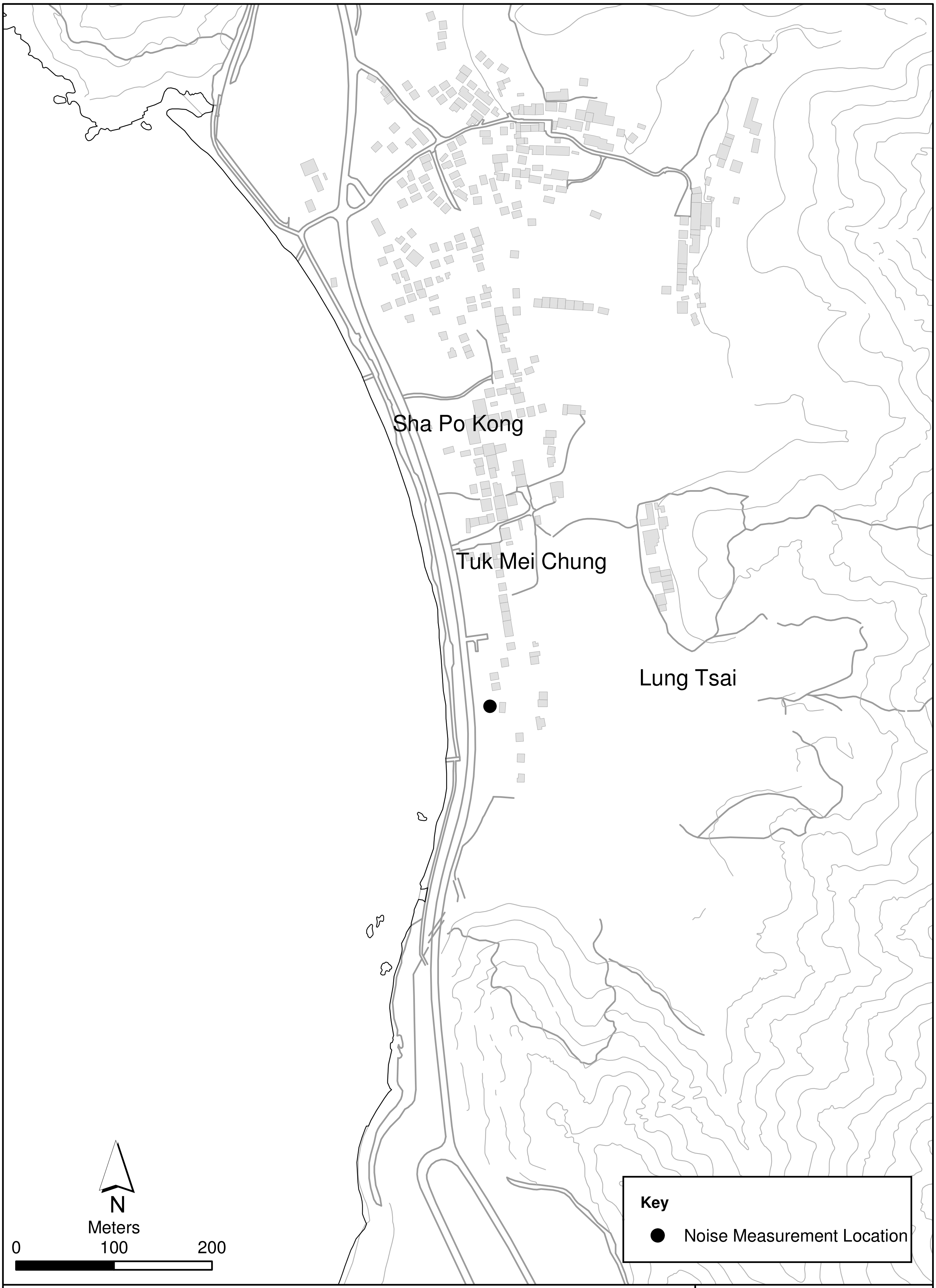

FIGURE 4.2

Location of Prevailing Noise Measurement

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The construction noise from PME controlled under *GW-TM* is assessed in this EIA. For the extension of the heavy load berth, percussive piling is assumed. In accordance with the *PP-TM*, a CNP is required for all percussive piling works. For this season, a CNP application for the piling works of the berth extension will need to be submitted to the *Noise Control Authority* and the issue of a CNP will be governed by the procedures laid down in the *PP-TM* when such an application is made. The assessment of the percussive piling noise impact associated with the construction of the berth extension is therefore not included in this EIA.

Some of the construction works will be carried out simultaneously according to planned project programme. It is anticipated that the normal working hours of the contractor will be between 0700 and 1900 hours from Monday to Saturday (except public holidays). Given the site constraints and scale of the concurrent construction activities, there will be limited plant items to be operating at the site. Construction noise assessment will be undertaken based on construction programme and plant inventories summarized in *Annexes B-2 and B-3* respectively.

4.4.2 Assessment Methodology

The methodology for the noise impact assessment is in accordance with the procedures outlined in the *GW-TM*, which is issued under the *NCO* and the *EIAO-TM, and* is summarized as follows:

- Identifying the likely type, sequence and duration of principal noisy construction activities required for the implementation of the project;
- Identifying a list of plant likely to be required for each construction activity;
- Calculating the maximum total sound power level (SWL) for each construction activity using the plant list and SWL data given for each plant in the technical memorandum;
- Identifying representative NSRs as defined by the *EIAO-TM* based on existing and committed land uses in the Study Area that may be affected by the worksite;
- As a conservative approach, calculating the distance attenuation to NSR from the boundary of nearest worksite; and
- Predicting construction noise levels at NSRs in the absence of any mitigation measures.

Due to the large separation distance between the construction site and the NSR (approximately 1 km), in accordance with ISO 9613-2 (1), the noise will be reduced due to energy lost through atmospheric absorption during

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(1) ISO9613-2 Acoustics - Attenuation of Sound during Propagation Outdoors - Part 2 : General Method of Calculation

transmission. As a conservative approach to the assessment, the atmospheric absorption during transmission has been omitted in the assessment. In addition, it was assumed that all the construction plant will be operated simultaneously for each activity.

The assessment has taken into account the distance attenuation, barrier correction, and facade correction of +3 dB(A).

4.4.3 Evaluation of Impacts

The unmitigated construction noise levels at the NSR N1 (Village house at Sha Po Kong) and PN1 (Planned Holiday Camp) have been predicted and are presented in *Annex B-4*. The predicted construction noise levels at N1 and PN1 are in the range of 43 - 51 dB(A), which are below the daytime construction noise criterion of 75 dB(A) throughout the construction period and utilized the conservative set of assumptions in the analysis.

Given that the predicted construction noise levels are well within the stipulated noise criterion, mitigation measures are not required to alleviate the noise impacts.

The normal working hours of the contractor will be between 0700 and 1900 hours from Monday to Saturday (except public holidays). Should evening and night works between 1900 and 0700 hours or on public holidays (including Sunday) be required, the contractor should submit a CNP application and will be assessed by the *Noise Control Authority*. Conditions stipulated in CNPs should be strictly followed.

4.5 OPERATIONAL NOISE ASSESSMENT

4.5.1 Potential Sources of Impact

Noise associated with the operational phase of the CPB would arise from the plant at the CPB. The dominant noise sources are mainly from the machinery including the following equipment:

- Flue Gas Desulphurisation (FGD) absorbers and associated duct works;
- Various kind of fans and pumps;
- Gas-gas heater;
- Wastewater treatment plant; and
- Loader/unloader of process reagents and by-products.

To minimise the noise impact to the environment, most of the noise sources associated with the retrofit project will be housed within individual enclosures or claddings. In addition, Project Proponent has advised that the maximum allowable measured free-field sound pressure level (SPL) of 85 - 90 dB(A) at 1 m will be included in the tender specification (*Annex B-5*). With such guarantee included in the FGD Supply Contract, the noise emission from the equipment should comply with the tender specification.

As a conservative approach, it was assumed that all equipment will be operated on a 24-hour basis.

4.5.2 *Assessment Methodology*

The methodology for the noise impact assessment is in accordance with the procedures outlined in the *IND-TM*, which is issued under the *NCO* and the *EIAO-TM*. The methodology for the fixed plant noise assessment is presented below:

- Identifying types of equipment and the number of equipment;
- Assuming area sources with specified maximum SPL for each emission group;
- Identifying representative NSRs as defined by the *EIAO-TM* based on existing and committed landuses in the Study Area that may be affected by the worksite;
- Calculating the distance attenuation to the NSRs from the nearest noise sources; and
- Presenting the results in terms of $L_{Aeq\,(30min)}$ dB, as specified in the TM.

Due to the large separation distance between the construction site and the NSR (approximately 1 km), in accordance with ISO 9613-2 (1), the noise will be reduced due to energy lost through atmospheric absorption during transmission. As a conservative approach to the assessment, the atmospheric absorption during transmission has been omitted in the assessment.

The assessment has taken into account the distance attenuation, barrier correction and facade correction of +3 dB(A).

4.5.3 *Evaluation of Impacts*

Based on the maximum specified sound pressure levels for new equipment at the CPB, the NSR N1 and PN1 will be subject to noise level up to 35 dB(A), which comply with the night-time (ANL-5) noise criterion (*Annex B-6*).

The suppliers should guarantee the specified SPL by providing certificate of measurement and verify the SPL during testing and commissioning in accordance with international standard procedures. If necessary, the suppliers should apply attenuation measures to achieve the guaranteed noise levels during the detailed design stage.

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(1) ISO9613-2 Acoustics - Attenuation of Sound during Propagation Outdoors - Part 2 : General Method of Calculation

4.6 MITIGATION MEASURES

4.6.1 Construction Phase

The predicted noise levels are within the stipulated noise criterion as a result of the considerable separation distance plus topography and existing building structures at CPB located between the NSR and the Project. Mitigation measures are not required.

4.6.2 Operational Phase

The predicted noise levels are below the daytime and night-time criteria as a result of the considerable separation distance plus topography and existing building structures at CPB located between the NSR and the Project. Mitigation measures are not required.

4.7 ENVIRONMENTAL MONITORING AND AUDIT

4.7.1 Construction Phase

Given the compliance with the stipulated noise criterion, noise monitoring is not required during the construction phase.

4.7.2 Operational Phase

Given the compliance with the stipulated noise criterion, noise monitoring is not required during the operational phase.

4.8 SUMMARY AND CONCLUSION

No noise sensitive receivers will be affected by the construction activities to be undertaken at the site. Predicted construction noise levels at the NSR, range from 43 – 51 dB(A), are within the stipulated noise criteria. In view of the insignificant construction noise impact, mitigation measures are not required during the construction phase.

Due to the large separation distance (approximately 1 km) and the use of enclosure/cladding plus topography and existing building structures at CPB located between the NSR and the Project, the predicted operational noise levels are up to 35 dB(A), which are within the daytime and night-time noise criteria. Further mitigation measures are therefore not required during the operational phase.

In view of the anticipated insignificant noise impact in both construction and operational phases, noise monitoring is therefore considered not necessary.

5 WATER QUALITY ASSESSMENT

5.1 INTRODUCTION

This section presents an assessment of the potential water quality impacts associated with the construction and operation of the Project and identifies any mitigation measures that may be required.

5.2 LEGISLATIVE REQUIREMENTS AND EVALUATIVE CRITERIA

The following relevant pieces of legislation and associated guidance are applicable to the evaluation of marine water quality impacts.

- *Water Pollution Control Ordinance* (*WPCO*) (*Cap 358*);
- *Technical Memorandum for Effluents Discharged into Drainage and Sewerage Systems Inland and Coastal Waters*; and
- *Environmental Impact Assessment Ordinance* (*Cap. 499, S.16*), *Technical Memorandum on Environmental Impact Assessment Process* (*EIAO TM*), *Annexes 6* and *14*.

Apart from the above statutory requirements, the *Practice Note for Professional Persons: Construction Site Drainage* (*ProPECC PN 1/94*), issued by ProPECC in 1994, also provides useful guidelines on the management of construction site drainage and prevention of water pollution associated with construction activities.

In addition, the Water Supplies Department (WSD) have also established a set of water quality criteria for abstracted seawater.

5.2.1 Water Pollution Control Ordinance (Cap 358)

The *WPCO* is the legislation for the control of water pollution and water quality in Hong Kong. Under the *WPCO*, Hong Kong waters are divided into 10 Water Control Zones (WCZs). Each WCZ has a designated set of statutory Water Quality Objectives (WQOs). The WQOs set limits for different parameters that should be achieved in order to maintain the water quality within the WCZs. The potential effluents from the construction and operation of the Project will be discharged into the North Western WCZ and may be transported into the adjoining Deep Bay WCZ by the strong tidal currents in the vicinity of the discharges. The boundaries for the WCZs are shown on *Figure 5.1*. The WQOs for the marine waters of the North Western and Deep Bay WCZs, which are presented in *Table 5.1*, are applicable as evaluation criteria for assessing compliance of any effluents from the construction and operation of the Project.

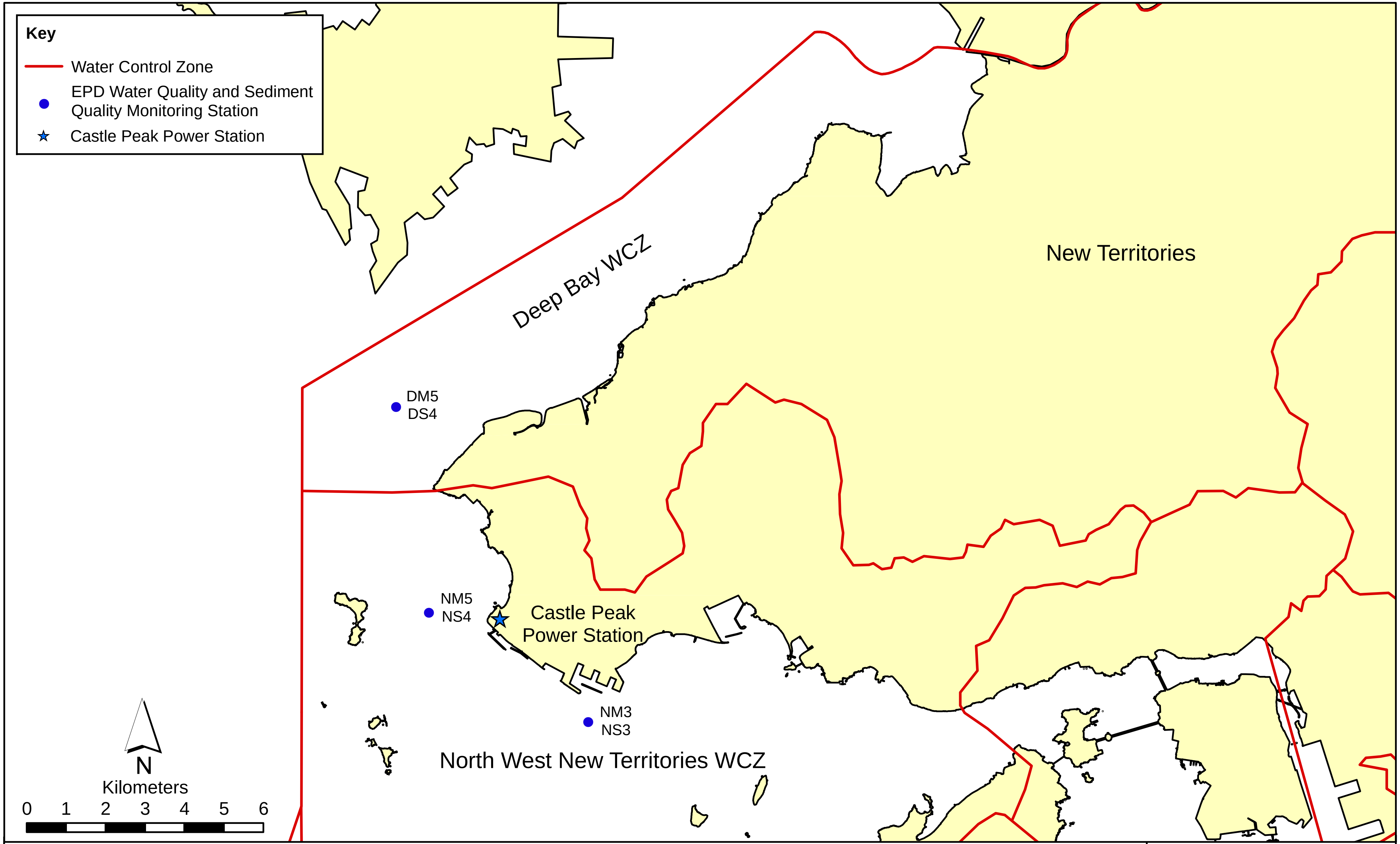

Figure 5.1

Locations of Water Control Zones and
Routine EPD Water Quality and Sediment Quality Monitoring Stations

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Table 5.1 ***Water Quality Objectives for the North Western and Deep Bay Water Control Zones***

Water Quality Objective	**North Western WCZ**	**Deep Bay WCZ**
A. AESTHETIC APPEARANCE		
a) Waste discharges shall cause no objectionable odours or discolouration of the water.	Whole zone	Whole zone
b) Tarry residues, floating wood, articles made of glass, plastic, rubber or of any other substances should be absent.	Whole zone	Whole zone
c) Mineral oil should not be visible on the surface. Surfactants should not give rise to a lasting foam.	Whole zone	Whole zone
d) There should be no recognisable sewage-derived debris.	Whole zone	Whole zone
e) Floating, submerged and semi-submerged objects of a size likely to interfere with the free movement of vessels, or cause damage to vessels, should be absent.	Whole zone	Whole zone
f) Waste discharges shall not cause the water to contain substances which settle to form objectionable deposits.	Whole zone	Whole zone
B. BACTERIA		
a) The level of *Escherichia coli* should not exceed 610 per 100 mL, calculated as the geometric mean of all samples collected in one calendar year.	Secondary Contact Recreation Subzone	Secondary Contact Recreation Subzone and Mariculture Subzone
b) The level of *Escherichia coli* should not exceed 180 per 100 mL, calculated as the geometric mean of all samples collected from March to October inclusive in one calendar year. Samples should be taken at least 3 times in a calendar month at intervals of between 3 and 14 days.	Bathing Beach Subzone	Yung Long Bathing Beach Subzone
D. DISSOLVED OXYGEN		
a) Waste discharges shall not cause the level of dissolved oxygen to fall below 4 mg per litre for 90% of the sampling occasions during the year; values should be taken at 1 metre below surface.	-	Inner Marine Subzone excepting Mariculture Subzone
b) Waste discharges shall not cause the level of dissolved oxygen to fall below 4 mg per litre for 90% of the sampling occasions during the year; values should be calculated as water column average. In addition, the concentration of dissolved oxygen should not be less than 2 mg per litre within 2 metres of the seabed for 90% of the sampling occasions during the year.	Marine Waters (water column average specified as arithmetic mean of at least 3 measurements at 1 metre below surface, mid-depth and 1 metre above seabed)	Outer Marine Subzone excepting Mariculture Subzone (water column average specified as arithmetic mean of at least 2 measurements at 1 metre below surface and 1 metre above seabed)
c) The dissolved oxygen level should not be less than 5 mg per litre for 90% of the		Mariculture Subzone

Water Quality Objective	North Western WCZ	Deep Bay WCZ
sampling occasions during the year; values should be taken at 1 metre below surface.		
E. pH		
a) The pH of the water should be within the range of 6.5 - 8.5 units. In addition, waste discharges shall not cause the natural pH range to be extended by more than 0.2 units.	Marine waters excepting Bathing Beach Subzones.	Marine waters excepting Yung Long Bathing Beach Subzone
b) The pH of the water should be within the range of 6.0 - 9.0 units for 95% of samples. In addition, waste discharges shall not cause the natural pH range to be extended by more than 0.5 units.	Bathing Beach Subzones.	Yung Long Bathing Beach Subzone
F. TEMPERATURE		
Waste discharges shall not cause the natural daily temperature range to change by more than 2.0 °C.	Whole zone	Whole zone
G. SALINITY		
Waste discharges shall not cause the natural ambient salinity level to change by more than 10%.	Whole zone	Whole zone
H. SUSPENDED SOLIDS		
a) Waste discharges shall neither cause the natural ambient level to be raised by 30% nor give rise to accumulation of suspended solids which may adversely affect aquatic communities.	Marine waters	Marine waters
I. AMMONIA		
The un-ionized ammoniacal nitrogen level should not be more than 0.021 mg per litre, calculated as the annual average (arithmetic mean).	Whole zone	Whole zone
J. NUTRIENTS		
a) Nutrients shall not be present in quantities sufficient to cause excessive or nuisance growth of algae or other aquatic plants.	Marine waters	Inner and Outer marine Subzones
b) Without limiting the generality of objective (a) above, the level of inorganic nitrogen should not exceed 0.3 mg per litre, expressed as annual water column average (arithmetic mean of at least 3 measurements at 1m below surface, mid-depth and 1m above seabed).	Castle Peak Bay Subzone	-
c) Without limiting the generality of objective (a) above, the level of inorganic nitrogen should not exceed 0.7 mg per litre, expressed as annual mean.	-	Inner Marine Subzone
d) Without limiting the generality of objective (a) above, the level of inorganic nitrogen should not exceed 0.5 mg per litre, expressed as annual water column average.	Marine waters excepting Castle Peak Bay Subzone (water column average specified as arithmetic mean of at least 3 measurements at 1m below surface, mid-	Outer Marine Subzone (water column average specified as arithmetic mean of at least 2 measurements at 1 metre below surface and 1 metre above seabed)

Water Quality Objective	North Western WCZ	Deep Bay WCZ
	depth and 1m above seabed)	
M. TOXINS		
a) Waste discharges shall not cause the toxins in water to attain such levels as to produce significant toxic, carcinogenic, mutagenic or teratogenic effects in humans, fish or any other aquatic organisms, with due regard to biologically cumulative effects in food chains and to interactions of toxic substances with each other.	Whole zone	Whole zone
b) Waste discharges shall not cause a risk to any beneficial uses of the aquatic environment.	Whole zone	Whole zone
N. PHENOLS		
Phenols shall not be present in such quantities as to produce a specific odour, or in concentration greater than 0.05 mg per litre as C_6H_5OH.	Bathing Beach Subzones	Yung Long Bathing Beach Subzone
O. TURBIDITY		
Waste discharges shall not reduce light transmission substantially from the normal level.	Bathing Beach Subzones	Yung Long Bathing Beach Subzone

5.2.2 *Technical Memorandum for Effluent Discharges*

All discharges from the Castle Peak Power Station (CPPS), including those from the proposed emission control facilities, are required to comply with the *Technical Memorandum on Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters* (TM) issued under *Section 21* of the *WPCO*. The TM defines discharge limits for different types of receiving waters. Under the TM, effluents discharged into the drainage and sewerage systems, inshore and coastal waters of the WCZs are subject to pollutant concentration standards for particular discharge volumes. Any new discharges within a WCZ are subject to licence conditions and the TM acts as a guideline for setting discharge standards for inclusion in the licence.

For the discharges from the CPPS it is appropriate to make reference to *Table 10b Standards for Effluents Discharged into the Marine Waters of Southern, Mirs Bay, Junk Bay, North Western, Eastern Buffer and Western Buffer Water Control Zones*. Existing *WPCO* discharge licences have been issued for a number of wastewater discharges from the existing CPPS, including the cooling water systems, oil separators and sewage treatment plant.

5.2.3 *Technical Memorandum on the Environmental Impact Assessment Process*

Annexes 6 and *14* of the *EIAO-TM* provide general guidelines and criteria to be used in assessing water quality issues.

The *EIAO-TM* recognises that it may not be possible to achieve compliance with the WQOs in the vicinity of a wastewater discharge. In this area, where the initial dilution of pollutants takes place, there may be greater water quality impacts than would be allowed by the WQOs. Such an area may be termed a 'mixing zone' and within this area exceedance of the WQOs is generally allowed. The criteria for acceptance of a 'mixing zone' are that it must not impair the integrity of the water body as a whole and must not damage the ecosystem or impact marine sensitive receivers.

5.2.4 Water Supplies Department (WSD) Water Quality Criteria for Seawater Intakes

The Water Supplies Department (WSD) has a set of standards for the quality of abstracted seawater (*Table 5.2*). Water quality at the WSD sea water intakes has been assessed against these standards, in addition to the WQOs.

Table 5.2 WSD Water Quality Criteria for Abstracted Seawater

Parameter	**Criterion**
Colour (HU)	< 20
Turbidity (NTU)	< 10
Threshold Odour No.	< 100
Ammoniacal Nitrogen (mg L^{-1})	< 1
Suspended Solids (mg L^{-1})	< 10 (20 is the upper threshold)
Dissolved Oxygen (mg L^{-1})	> 2
5-day Biochemical Oxygen Demand (mg L^{-1})	< 10
Synthetic Detergents (mg L^{-1})	< 5
E. coli (cfu 100mL^{-1})	< 20,000

5.2.5 Sediment Quality

Dredged sediments destined for marine disposal are classified according to a set of regulatory guidelines (*Management of Dredged / Excavated Sediment, ETWBTC No. 34/2002*) issued by the Environment, Transport and Works Bureau (ETWB) in August 2002. These guidelines comprise a set of sediment quality criteria, which include organic pollutants and other substances. The requirements for the marine disposal of sediment are specified in the *ETWBTC No. 34/2002*. Marine disposal of dredged materials is controlled under the *Dumping at Sea Ordinance 1995*.

5.2.6 Definition of Assessment Criteria

Water Quality

The quantitative criteria for assessment of compliance with the WQOs for abstracted water has been derived through a review of EPD routine water quality monitoring data for the period 1996 - 2005 from station NM5, the closest to the FGD discharge point. These criteria are summarised in *Table 5.3*.

Table 5.3 Summary of the Assessment Criteria for Water Quality Derived from the Water Quality Objectives (WQO)

Parameter	**Depth (a)**	**Unit**	**Water Quality Objective (WQO)**	**Ambient Level (b) (c) (d)**			**Allowable Effect**		
				Annual	**Dry**	**Wet**	**Annual**	**Dry**	**Wet**
Dissolved Oxygen (e)	S	mg L^{-1}	> 4 mg L^{-1} (f) > 5 mg L^{-1} (g)	6.2	6.7	5.8	-2.2 -1.2	-2.7 -1.7	-1.8 -0.8
	M	mg L^{-1}	-	5.8	6.7	5.1	N/A	N/A	N/A
	B	mg L^{-1}	> 2 mg L^{-1} (h)	5.5	6.7	4.5	-3.5	-4.7	-2.5
	DA	mg L^{-1}	> 4 mg L^{-1} (h)	5.8	6.7	5.1	-1.8	-2.7	-1.1
Temperature	S	°C	± 2 °C	N/A	N/A	N/A	± 2 °C	± 2 °C	± 2 °C
	M	°C	± 2 °C	N/A	N/A	N/A	± 2 °C	± 2 °C	± 2 °C
	B	°C	± 2 °C	N/A	N/A	N/A	± 2 °C	± 2 °C	± 2 °C
	DA	°C	± 2 °C	N/A	N/A	N/A	± 2 °C	± 2 °C	± 2 °C
Salinity	S	o/oo	10% variation	23.9	30.2	19.2	2.4	3.0	1.9
	M	o/oo	10% variation	28.6	31.4	26.5	2.9	3.1	2.6
	B	o/oo	10% variation	30.4	31.7	29.5	3.0	3.2	2.9
	DA	o/oo	10% variation	27.6	31.1	25.1	2.8	3.1	2.5
Suspended Solids	S	mg L^{-1}	30% increase	13.9	16.7	12.0	4.2	5.0	3.6
	M	mg L^{-1}	30% increase	16.0	20.7	14.0	4.8	6.2	4.2
	B	mg L^{-1}	30% increase	51.0	49.2	51.0	15.3	14.8	15.3
	DA	mg L^{-1}	30% increase	23.4	27.6	21.4	7.0	8.3	6.4
pH	S	-	6.5 – 8.5 units	8.0	8.0	8.0	± 5	± 5	± 5
	M	-	6.5 – 8.5 units	8.0	8.1	8.0	± 5	± 4	± 5
	B	-	6.5 – 8.5 units	8.0	8.1	8.0	± 5	± 4	± 5
	DA	-	6.5 – 8.5 units	8.0	8.1	8.0	± 5	± 4	± 5

Notes:

(a) Depth: S = Surface, M = Middle, B = Bottom, DA = Depth average

(b) The ambient level is derived from the routine EPD monitoring data in 1996-2005 for Station NM5.

(c) The ambient level is the arithmetic mean value, with exception for SS.

(d) The ambient level for SS is the 90th percentile values for the difference depth layers and depth-average.

(e) No surface and middle DO WQO criteria have been specified for the North Western WCZ.

(f) The WQO for Inner Marine Subzone excepting Mariculture Subzone of the Deep Bay WCZ

(g) The WQO for Mariculture Subzone of the Deep Bay WCZ

(h) The WQO for the North Western WCZ and the Outer Marine Subzone excepting Mariculture Subzone of the Deep Bay WCZ

In addition to the above, it is noted that the flushing water intake is one of the identified sensitive receivers. The WSD maintains a set of water quality standards for abstracted seawater. There are specified standards for dissolved oxygen (DO), which is that the DO should be greater than 2 mg L^{-1}, and suspended solids (SS), which states that the SS should be less than 10 mg L^{-1}. Other criteria, such as those for ammonia and *E. coli*, will not be affected by the discharges from the potential FGD systems, with regard to the characteristics of the treated effluent from the Limestone FGD process (*Section 5.7.1*).

As EPD routine monitoring station NM3 is the closest station to the WSD intake, it is considered appropriate to use this data to characterise the background concentrations at the intake point. Furthermore, as the WSD intake is located close to the water surface it is also appropriate to consider the surface layer monitoring data. Analysis of the EPD routine monitoring has determined that the minimum recorded DO concentration in the surface layer was 3.7 mg L^{-1}, whilst the maximum value for SS in the surface layer was 16.0 mg L^{-1}. As the lowest allowable DO concentration at the intake is 2.0 mg L^{-1}, the effluent discharges should not, therefore, cause DO to be reduced by more than **1.7 mg L^{-1}** at the intake. It should note that the intake criterion for SS has in the past been exceeded and hence the mean value in the surface layer, i.e., 6.4 mg L^{-1}, was taken to give the allowable SS increase of **13.6 mg L^{-1}** at the intake.

Both Black Point Power Station and Castle Peak Power Station intakes have specific requirements for intake water quality. The applicable criteria for temperature and SS for the Black Point Power Station and Castle Peak Power Station seawater intakes are between 17°C and 32°C and between 30 mg L^{-1} and 764 mg L^{-1}, respectively. These values have, therefore, been taken as the assessment criteria for the power station intakes.

The annual ambient SS level in the vicinity of the Black Point Power Station, based on the EPD monitoring data at station DM5, is 28.9 mg L^{-1} (37.6 mg L^{-1} for the dry season and 22.8 mg L^{-1} for the wet season). Hence the allowable SS elevation at the Black Point Power Station intake is **726.4 mg L^{-1}** and **741.2 mg L^{-1}** for the dry and wet seasons respectively.

The annual ambient SS level in the vicinity of the Castle Peak Power Station, based on the EPD monitoring data at station NM5, is 22.2 mg L^{-1} (22.0 mg L^{-1} for the dry season and 23.0 mg L^{-1} for the wet season). Hence the allowable SS elevation at the Black Point Power Station intake is **742 mg L^{-1}** and **741 mg L^{-1}** for the dry and wet seasons respectively.

There are no specific water quality criteria for seawater intakes at Tuen Mun Area 38, Shiu Wing Steel Mill as well as the Eco Park, and therefore the suspended solids WQO stipulated under WPCO was referenced for the purpose of this assessment only.

Sediment Deposition

Possible indirect impact on the artificial reefs (ARs) may arise due to deposited sediments. Two AR sites, both at a distance of more than 4 km away from the works area, are identified. In Hong Kong, there is no consented criterion for artificial reefs and therefore reference has been made to previous approved EIAs in which impacts with regard to sediment deposition to hard coral communities were assessed. Hard or hermatypic corals are susceptible to increased rates of deposition, with the sensitivities of the species to sedimentation being determined largely by the particle-trapping properties of the colony and the ability of individual polyps to reject settled materials. Horizontal platelike colonies and massive growth forms present large stable surfaces for the interception and retention of settling solids while vertical plates and upright branching forms are less likely to retain sediments. Tall polyps and convex colonies are also less susceptible to sediment accumulation than other growth forms. It is also acknowledged that sensitivities to sediment loads can also vary markedly between species within the same genus (1).

Information presented by Pastorok and Bilyard (1985) (2) has been regarded as the primary reference when discussing the effects of sedimentation on corals. Pastorok and Bilyard have suggested the following criteria:

• 10 - 100 g m^{-2} day^{-1}	slight to moderate impacts
• 100 - 500 g m^{-2} day^{-1}	moderate to severe impacts
• > 500 g m^{-2} day^{-1}	severe to catastrophic impacts

Fringing and inshore reefal environments, however, are known to experience sedimentation events in exceedance of the 500 g m^{-2} day^{-1} criterion and support flourishing coral communities (3).

Pastorok & Bilyard's criteria for the assessment of impacts to coral communities have been adopted previously under the *EIAO* in Hong Kong (4). For example, a recent EIA examining the potential impacts to coral communities in the Tolo Channel as a result of the installation of a submarine natural gas pipeline employed a criterion of 100 g m^{-2} day^{-1} as the allowable rate of deposition. Such a criterion has also been utilised in coral monitoring

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(1) Hawker DW & Connell DW (1992). Standards and Criteria for Pollution Control in Coral Reef Areas. Chapter 7 of Pollution in Tropical Aquatic Systems. Connell DW & Hawker DW ed. CRC Press.

(2) Pastorok RA and Bilyard GR (1985). Effects of sewage pollution on coral-reef communities. Marine Ecology Progress Series 21: 175-189.

(3) Ayling AA and Ayling AK (1987). Is silt run-off affecting corals communities on the Cape Tribulation Fringing Reefs? In; Fringing Reef Workshop, GMRMPA Workshop series 9: 83-86. Ed CL Baldwyn.

(4) ERM-Hong Kong, Limited (2003) The Proposed Submarine Gas Pipelines from Cheng Tou Jiao Liquefied Natural Gas Receiving Terminal, Shenzhen to Tai Po Gas Production Plant, Hong Kong – EIA Study. For The Hong Kong China Gas Company.

EM&A programmes around the Po Toi Islands and has been deemed to be sufficiently protective (1) (2) .

Similarly, an *EIAO* approved study of dredging and reclamation works associated with the construction of the Hong Kong International Theme Park determined that a criterion of 200 g m^{-2} day^{-1} would be sufficient on the basis that ambient concentrations of suspended sediments and subsequent deposition are considerably higher in the Western waters when compared to the Eastern waters of Hong Kong (3).

Based on the above, it is proposed that Pastorok & Bilyard's criteria should also be employed for this EIA. As the Project is located in the Western waters of Hong Kong, it is appropriate to adopt an assessment criterion of 200 g m^{-2} day^{-1} for the reasons provided above. Such a limit would allow works to proceed according to the precautionary principle without adding a level of unnecessary conservatism.

Sulphate Ions

There are no criteria for the assessment of the potential impacts due to the discharge of sulphate ions. In order to assess the potential magnitude of the effects from the discharges of sulphate reference will be made to typical ambient concentrations of sulphate. Typically, at 35 ppt salinity seawater has a concentration of sulphate ions of 2,715 mg L^{-1} (4). In accordance with the EPD monitoring data at stations NM3 and NM5, average salinity concentrations are approximately 28.3 ppt, which would equate to a typical concentration of sulphate of **2,195 mg L^{-1}**. The potential increases in sulphate concentration due to the FGD systems may be compared to this value to determine the relative magnitude and provide an indication of whether the increases are above normal conditions.

Dissolved Metals and Organic Compounds

There are no quantitative standards for dissolved metals in the marine waters of Hong Kong. It is thus proposed to make reference to the relevant UK water quality standards (5). This standard has been adopted in the previous approved EIAs, i.e., *EIA for Decommissioning of Cheoy Lee Shipyard at Penny's*

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(1) Hyder (1997). Sand Dredging and Backfilling of Borrow Pits at the Potential Eastern Waters Marine Borrow Area, EIA Report, CED, 1997.

(2) ERM-Hong Kong, Limited (2001). Focused Cumulative Water Quality Impact Assessment of Sand Dredging at the West Po Toi Marine Borrow Area Final Report.

(3) ERM-Hong Kong, Limited (2002) EIA Construction of an International Theme Park in Penny's Bay of North Lantau and it's Essential Associated Infrastructres. CEDD, 2002.

(4) Chester, R (1990). Marine Geochemistry, Unwin Hyman Ltd.

(5) Her Majesty's Inspectorate of Pollution (HMIP) (1994). Environmental Economic and BPEO Assessment Principals for Integrated Pollution Control.

Bay (1), *EIA for Disposal of Contaminated Mud in the East Sha Chau Marine Borrow Pit* (2) and *EIA for Wanchai Development Phase II* (3).

As standards provide total concentrations of the pollutants, while the water quality modelling only provides quantification of the potential increases in the receiving marine waters, it is necessary to quantify the ambient concentrations. Reference is made to water quality monitoring data collected in the period 1997 to 2000 as part of the monitoring works at the East Sha Chau CMP IVa and IVb (4). The difference between the standards and the monitoring data will show the allowable increases due to a small amount of effluent from the FGD operations (0.02% of total discharge). The standards for metals concentration, the measured ambient concentrations and the allowable increases due to the FGD discharges are summarised in *Table 5.4*.

Table 5.4 ***Summary of Assessment Criteria for Dissolved Metals and the Allowable Increases due to the Effluent Discharges from the FGD Operations***

Parameter	**Assessment Criterion ($\mu g\ L^{-1}$)**	**Ambient Concentration [a] ($\mu g\ L^{-1}$)**	**Allowable Increase ($\mu g\ L^{-1}$)**
Arsenic	25.0	1.8	23.2
Cadmium	2.5	0.1	2.4
Chromium	15.0	0.5	14.5
Copper	5.0	0.9	4.1
Lead	25.0	0.5	24.5
Mercury	0.3	0.1	0.2
Nickel	30.0	1.4	28.6
Silver	2.3	0.5	1.8
Zinc	40.0	6.2	33.8
Total PCBs	0.03 [b]	-	-
Total PAHs	3.0 [b]	-	-
TBT	0.1 [b]	-	-
Alpha-BHC	0.0049 [c]	-	-
Beta BHC	0.017 [c]	-	-
Gamma BHC	0.16 [b]	-	-
Delta-BHC	- [d]	-	-
Heptachlor	0.053 [b]	-	-
Aldrin	1.3 [b]	-	-
Heptachlor epoxide	0.053 [b]	-	-
Alpha Endosulfan	0.034 [b]	-	-
p, p'-DDT	0.13 [b]	-	-
p, p'-DDD	0.00031 [c]	-	-
p, p'-DDE	0.00022 [c]	-	-
Endosulfan sulfate	89 [c]	-	-

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(1) Maunsell (2002). EIA for Decommissioning of Cheoy Lee Shipyard at Penny's Bay. For Civil Engineering Department, Hong Kong SAR Government.

(2) ERM – Hong Kong (1997). EIA for Disposal of Contaminated Mud in the East Sha Chau Marine Borrow Pit. For Civil Engineering Department, Hong Kong SAR Government.

(3) Maunsell (2001). EIA for Wanchai Development Phase II - Comprehensive Feasibility Study. For Territory Development Department, Hong Kong SAR Government.

(4) ERM-Hong Kong (2003). Detailed Site Selection Study for a Proposed Contaminated Mud Disposal Facility within the Airport East/East of Sha Chau (Agreement No. CE 12/2002 (EP)) – Environmental Monitoring Data Review. For the Civil Engineering Department, Hong Kong SAR Government.

Parameter	Assessment Criterion ($\mu g\ L^{-1}$)	Ambient Concentration [a] ($\mu g\ L^{-1}$)	Allowable Increase ($\mu g\ L^{-1}$)

Notes:

(a) The ambient concentrations were obtained from the monitoring works at the East Sha Chau CMP IVa and IVb (1997-2000).

(b) The water quality criteria were derived from the USEPA water quality criteria. The Criteria Maximum Concentration (CMC) is an estimate of the highest concentration of a material in surface water to which an aquatic community can be exposed briefly without resulting in an unacceptable effect. CMC is used as the criterion of the respective compounds in this study.

(c) No saltwater criteria for this chlorinated pesticide were defined by USEPA. The water quality criterion to protect human health for the consumption of aquatic organisms is provided for reference.

(d) No water quality criteria for delta-BHC were defined by USEPA.

There are no existing legislative standards or guidelines for the contaminants total PCBs, total PAHs and TBT and hence reference has been made to the USEPA water quality criteria (1), Australian water quality guidelines (2), and international literature (3) respectively. The assessment criteria for total PCBs, total PAHs and TBT are 0.03 $\mu g\ L^{-1}$, 3.0 $\mu g\ L^{-1}$ and 0.1 $\mu g\ L^{-1}$ respectively as shown in *Table 5.4*.

Similarly, there are no legislative standards or guidelines in Hong Kong for chlorinated pesticides and the assessment criteria are in accordance with the USEPA water quality criteria.

5.3 BASELINE CONDITIONS AND WATER SENSITIVE RECEIVERS

5.3.1 Hydrodynamics

The wastewater discharges from the CPPS are located on the northern edge of the Urmston Road, which is the main channel for the Pearl River Estuary flows entering and exiting the north western marine waters of Hong Kong. The tidal currents within the Urmston Road are to the north and west on the flood tide and to the south and east on the ebb tide. Tidal currents in the Urmston Road are high, with peak values greater than 1 m s^{-1}.

In the wet season the high freshwater outflows from the Pearl River Estuary result in strong salinity stratification, with lowered salinity in the surface waters compared to the remainder of the water column. In the summer months, temperature stratification may also occur, with the temperatures in the surface waters being increased. In the dry season the reduced freshwater flows mean that the marine waters are well mixed, with limited stratification.

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(1) United States Environmental Protection Agency (2006). National Recommended Water Quality Criteria.

(2) Australian and New Zealand Environment and Conservation Council (1992). Australian Water Quality Guidelines for Fresh and Marine Waters.

(3) Salazar, M.H. and Salazar, S.M. (1996). "Mussels as Bioindicators: Effects of TBT on Survival, Bioaccumulation, and Growth under Natural Conditions" in Organotin, edited by M.A. Champ and P.F. Seligman. Chapman & Hall, London.

5.3.2 Water Quality

Effluents from the CPPS are discharged within the North Western WCZ and would be expected to primarily affect the marine waters of the Urmston Road. There are three EPD routine water quality monitoring stations, i.e. NM3, NM5 and DM5, located in the vicinity of the CPPS that would provide suitable data to characterise the ambient quality of the marine waters that may be affected by the effluents from the CPPS. The locations of these monitoring stations are shown in *Figure 5.1* and a summary of water quality data for these stations is presented in *Table 5.5*.

Water quality has been determined through a review of the EPD routine water quality monitoring data collected in 1996 - 2005, the most recently available data.

Table 5.5 EPD Routine Marine Water Quality Monitoring Data in the Vicinity of the Castle Peak Power Station (1996-2005)

Water Quality Parameter	Station DM5	Station NM3	Station NM5
Temperature (°C)	23.7	23.4	23.5
	(14.4 - 31.1)	(15.6 - 29.7)	(15.5 - 30.3)
Salinity (ppt)	26.5	29.1	27.7
	(1.4 - 34.3)	(7.4 - 33.9)	(4.1 - 33.6)
pH	8.0	8.0	8.0
	(6.2 - 8.7)	(6.3 - 8.4)	(7.3 - 8.7)
Dissolved Oxygen (mg L^{-1})	5.9	5.8	5.8
	(2.6 - 10.0)	(2.2 - 8.8)	(2.3 - 9.2)
Dissolved Oxygen, Bottom (mg L^{-1})	5.7	5.6	5.5
	(2.6 - 10.0)	(2.2 - 8.6)	(2.3 - 8.8)
5-day Biochemical Oxygen Demand (mg L^{-1})	0.9	0.7	0.8
	(0.1 - 4.9)	(0.1 - 2.6)	(0.1 - 4.1)
Suspended Solids (mg L^{-1})	13.3	10.0	13.0
	(1.1 - 130.0)	(1.2 - 71.0)	(1.6 - 210.0)
Total Inorganic Nitrogen (mg L^{-1})	0.67	0.43	0.56
	(0.14 - 2.46)	(0.02 - 1.75)	(0.03 - 2.30)
Unionised Ammonia (mg L^{-1})	0.007	0.005	0.006
	(0.000 - 0.067)	(0.000 - 0.025)	(0.000 - 0.027)
Chlorophyll-*a* (μg L^{-1})	2.3	2.4	2.6
	(0.2 - 49.0)	(0.2 - 25.0)	(0.2 - 28.0)
E. coli (cfu $100mL^{-1}$)	400	510	520
	(4 - 41,000)	(1 - 180,000)	(4 - 28,000)

Notes:

(a) Data presented are depth-averaged, except as specified.

(b) Data presented are arithmetic mean except for *E. coli*, which are geometric mean values.

(c) Data enclosed in brackets indicate the ranges.

(d) Shaded cells indicate non-compliance with the WQOs.

The water quality in the vicinity of the CPPS is influenced by both the outflow from the Pearl River Estuary and local effluent discharges, including those from the sewage treatment works (STW) at Pillar Point and Northwest New Territories (San Wai STW). Localised effects may also be caused by the outflows from Deep Bay, in the marine waters to the north, and from the Tuen Mun Nullah, to the east of the CPPS.

Throughout the period of 1996 - 2005, there were non-compliances with the WQOs for total inorganic nitrogen at all Stations NM3, NM5 and DM5. The exceedances are most likely as a result of discharges from the Pearl River Estuary and there may also be a contribution from the outflows from the inner part of Deep Bay, which typically experiences high nutrient concentrations.

There are two non-gazetted bathing beaches along the coast to the north-west of the Castle Peak Power Station, named Lung Kwu Lower and Lung Kwu Upper. To the east there are several gazetted bathing beaches including Butterfly, Castle Peak, Kadoorie, Cafeteria New & Old, Golden, Angler's, Gemini, Ho Mei Wan, Casam, Lido and Ting Kau. In 2004 (1), Lung Kwu Upper beach and the Tuen Mun beaches were rated as 'Fair', while Lung Kwu Lower was rated as 'Poor'.

5.3.3 Water Quality in Marine Parks

AFCD commenced a routine water quality monitoring programme in 1999 to collect baseline water quality data from existing Marine Parks / Marine Reserves in Hong Kong. The water quality monitoring results for the Sha Chau and Lung Kwu Chau Marine Park (1999 – 2005) are presented in *Table 5.6*.

It is apparent from the data that the mean values of suspended sediment range between stations from 9.7 to 37.2 mg L^{-1}.

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(1) EPD (2005). Beach Water Quality Report in 2004.

Table 5.6 Summary of Water Quality in the Sha Chau & Lung Kwu Chau Marine Park

Water Quality Parameter	**Sha Chau and Lung Kwu Chau Marine Park**			
	N Lung Kwu Chau	**N Sha Chau**	**Pak Chau**	**SE Sha Chau**
	(1999 – 2005)	**(1999 – 2000)**	**(1999 – 2005)**	**(1999 – 2000)**
Temperature (°C)	24.1	24.3	24.1	24.3
Salinity (ppt)	24.7	23.9	25.1	25.1
pH	7.9	8.1	7.9	8.1
Dissolved Oxygen (mg L^{-1})	6.2	5.8	6.2	5.8
Suspended Solids (mg L^{-1})	20.3	9.7	37.2	10.0
Secchi Depth (m)	1.1	0.8	1.2	0.7
BOD (mg L^{-1})	0.2	0.2	0.2	0.2
Ammonia Nitrogen (µg L^{-1})	0.050	0.029	0.071	0.030
Unionized Ammonia (µg L^{-1})	0.29	0.34	0.29	0.33
Nitrite Nitrogen (µg L^{-1})	1.50	3.77	1.38	3.68
Nitrate Nitrogen (µg L^{-1})	1.38	0.54	1.31	0.56
Total Inorganic Nitrogen (µg L^{-1})	2.26	3.98	2.37	3.81
Total Kjeldahl Nitrogen (mg L^{-1})	5.18	14.82	5.13	16.21
Total Nitrogen (mg L^{-1})	0.27	0.06	0.13	0.05
Orthophosphate Phosphorus (µg L^{-1})	0.74	0.10	0.65	0.09
Total Phosphorus (mg L^{-1})	1.02	1.16	1.02	1.10
Silica (mg L^{-1})	2.59	2.59	2.09	2.78
Chlorophyll-*a* (µg L^{-1})	1.90	1.07	1.81	1.09
Phaeo-pigment (µg L^{-1})	343	54	201	58
E. coli (CFU / 100 mL)	1298	117	1070	114
Faecal Coliforms (CFU / 100 mL)	24.1	24.3	24.1	24.3

Notes:

(a) Data from AFCD (2005). *Marine Park Water Quality Report* (Web site: www.afcd.gov.hk)

(b) Data presented are depth averaged, except as specified.

(c) Data presented are annual arithmetic mean except for *E. coli*, which are geometric means and dissolved oxygen, which are 10th percentiles.

5.3.4 Sediment Quality

EPD Sediment Quality Monitoring

EPD collects sediment quality data as part of the marine water quality monitoring programme. There are three relevant monitoring stations in the vicinity of the additional berthing facility, i.e., Stations NS3 and NS4 in the Northwestern WCZ and Station DS4 in the Deep Bay WCZ. The locations of these stations are shown in *Figure 5.1*.

Data for these stations have been obtained from the EPD are presented in *Table 5.7*. The data represent the range of values collected in 1996-2005. As with the water quality data, this dataset provides Hong Kong's most comprehensive long term sediment quality monitoring data and provides an indication of temporal and spatial change in marine sediment quality in Hong Kong.

The values for metals, PAHs and PCBs may also be compared to the relevant sediment quality criteria specified in the *Environment Transport & Works Bureau Technical Circular No 34/2002 Management of Dredged/Excavated Sediment (ETWBTC 34/2002)*.

A comparison of the data with the sediment quality criteria (i.e., Lower Chemical Exceedance Level (LCEL) and Upper Chemical Exceedance Level (UCEL)) shows that the levels of arsenic for Station DS4 have exceeded the LCEL and they are classified as Category M.

Table 5.7 Summary of EPD Sediment Quality Monitoring Data Collected in 1996 - 2005

Parameter	**Deep Bay WCZ**	**North Western WCZ**		**Sediment Quality Criteria**	
	DS4	**NS3**	**NS4**	**LCEL**	**UCEL**
COD (mg kg^{-1})	14,540 (8,800 - 20,000)	15,320 (8,400 - 19,000)	13,635 (6,700 - 19,000)	-	-
Total Carbon (% w / w)	0.6 (0.3 - 1.3)	0.6 (0.4 - 0.8)	0.6 (0.3 - 0.8)	-	-
Ammonical Nitrogen (mg kg^{-1})	6.3 (0.0 - 36.0)	6.7 (0.1 - 23.0)	14.2 (0.2 - 39.0)	-	-
TKN (mg kg^{-1})	285 (110 - 820)	308 (120 - 440)	275 (160 - 530)	-	-
Total Phosphorous (mg kg^{-1})	165 (77 - 270)	178 (86 - 250)	145 (92 - 220)	-	-
Total Sulphide (mg kg^{-1})	15 (<0.1 - 76)	23 (<0.1 - 94)	23 (<0.1 - 77)	-	-
Arsenic (mg kg^{-1})	14.4 (7.6 - 19.0)	11.7 (6.3 - 14.0)	12.0 (9.1 - 18.0)	12	42
Cadmium (mg kg^{-1})	<0.1 (<0.1 - 0.2)	<0.1 (<0.1 - 0.3)	<0.1 (<0.1 - 0.2)	1.5	4
Chromium (mg kg^{-1})	32 (14 - 50)	34 (16 - 48)	28 (20 - 44)	80	160

Parameter	Deep Bay WCZ	North Western WCZ		Sediment Quality Criteria	
	DS4	NS3	NS4	LCEL	UCEL
Copper (mg kg^{-1})	26 (6 - 64)	34 (17 - 48)	23 (17 - 42)	65	110
Lead (mg kg^{-1})	40 (18 - 68)	39 (20 - 54)	39 (29 - 47)	75	110
Mercury (mg kg^{-1})	0.1 (<0.05 - 0.2)	0.1 (<0.05 - 0.2)	0.1 (<0.05 - 0.2)	0.5	1
Nickel (mg kg^{-1})	19 (7 - 31)	20 (10 - 31)	18 (13 - 30)	40	40
Silver (mg kg^{-1})	0.4 (<0.2 - <1.0)	0.4 (0.2 - <1.0)	0.4 (<0.2 - <0.5)	1	2
Zinc (mg kg^{-1})	96 (36 - 180)	95 (48 - 120)	96 (67 - 110)	200	270
Total PCBs (μg kg^{-1})	18 (18 - 18)	18 (18 - 18)	18 (18 - 18)	23	180
Low Molecular Wt PAHs (μg kg^{-1})	91 (90 - 94)	92 (90 - 95)	92 (90 - 99)	550	3,160
High Molecular Wt PAHs (μg kg^{-1})	61 (16 - 254)	80 (31 - 296)	59 (21 - 139)	1,700	9,600

Notes:

(a) Data presented are arithmetic mean.

(b) Data enclosed in brackets indicate the ranges.

(c) The shaded cell indicates exceedance of LCEL.

(d) Low Molecular Wt PAHs include acenaphthene, acenaphthylene, anthracene, fluorine and phenanthrene.

(e) High Molecular Wt PAHs include benzo[a]anthracene, benzo[a]pyrene, chrysene, dibenzo[a,h]anthracene, fluoranthene, pyrene, benzo[b]fluoranthene, benzo[k]fluoranthene, indeno[1,2,3-c,d]pyrene and benzo[g,h,I]perylene.

Sediment Quality Tests for Proposed Dredging Area

In addition to the background data presented above, a marine sediment sampling survey and elutriation tests were conducted within the proposed dredging areas. The purpose of elutriate testing was to investigate the leaching potential for the sediment-bonded pollutants being released into the ambient marine water (in the immediate vicinity of dredging) during dredging activities for the Project.

Vibrocore samples were collected at three locations, V1, V2 and V3, and were taken down to the proposed dredging depth (*Figure 2.3*). Sampling locations were chosen so that they are representative of the dredging area. The contaminants tested included all of the contaminants stated in *Table 1 - Analytical Methodology* in *Appendix B* of *ETWBTC No 34/2002* plus PCBs and 12 Chlorinated Pesticides.

The results of the sediment quality tests are presented in detail in the *Waste Management Section* (*Table 6.4* of *Section 6*) and the results indicate that all measured contaminant levels of the samples are below the Lower Chemical

Exceedance Level (LCEL) as defined in *ETWBTC No 34/2002*. Hence, the sediment is likely to be uncontaminated but further sampling and testing in accordance with the detailed requirements of *ETWBTC No. 34/2002* will be required for the actual allocation of sediment disposal site and the application for a dumping permit under the *Dumping at Sea Ordinance (Cap 466)* prior to the commencement of the dredging activities.

The results of the elutriation test are presented in the following section and in *Annex C1*. The details of the elutriation tests are provided in *Annex D*.

The sediment samples were also analysed for particle size distribution. The majority of the sediment in the samples was found to be silt and clay.

5.3.5 Water Sensitive Receivers

The sensitive receivers that may be affected by the effluent discharges associated with the construction and operation of the Project are primarily located along the coastline of the north-west New Territories, with the exception of the marine waters around the Sha Chau and Lung Kwu Chau Marine Park. Sensitive receivers have been identified under the broad categories of gazetted bathing beaches, non-gazetted bathing beaches, water intakes and areas of ecological value. The identified sensitive receivers in each of these categories are as follows, the locations of which are shown in *Figure 5.2*:

- **Gazetted Bathing Beaches**: Butterfly Beach and the Tuen Mun Beaches (Castle Peak, Kadoorie, Cafeteria New & Old, Golden, Angler's, Gemini, Ho Mei Wan, Casam, Lido and Ting Kau);

- **Non-Gazetted Bathing Beaches**: Lung Kwu Upper, Lung Kwu Lower and Dragon Beach;

- **Water Intakes**: Shiu Wing Steel Mill, the proposed EcoPark in Tuen Mun Area 38, Castle Peak Power Station Intake, Black Point Power Station Intake, Tuen Mun Area 38 Industries Intake, and Tuen Mun Flushing Water Intake; and

- **Areas of Ecological Value**: Sha Chau and Lung Kwu Chau Marine Park, the Sha Chau and Lung Kwu Chau and Airport Artificial Reefs (ARs).

Water Quality Sensitive Receivers

The Water Quality Objectives (WQOs) presented in *Table 5.1* are considered to be suitable as assessment criteria at the water quality sensitive receivers which include the gazetted bathing beaches, the non-gazetted bathing beaches and water intakes. The assessment criteria has been summarised in *Table 5.3*. Among the seawater intakes, the WSD and power station sea water intakes have been assessed against the specific standards, in addition to the WQOs. The standards for the WSD abstracted seawater are presented in *Table 5.2*.

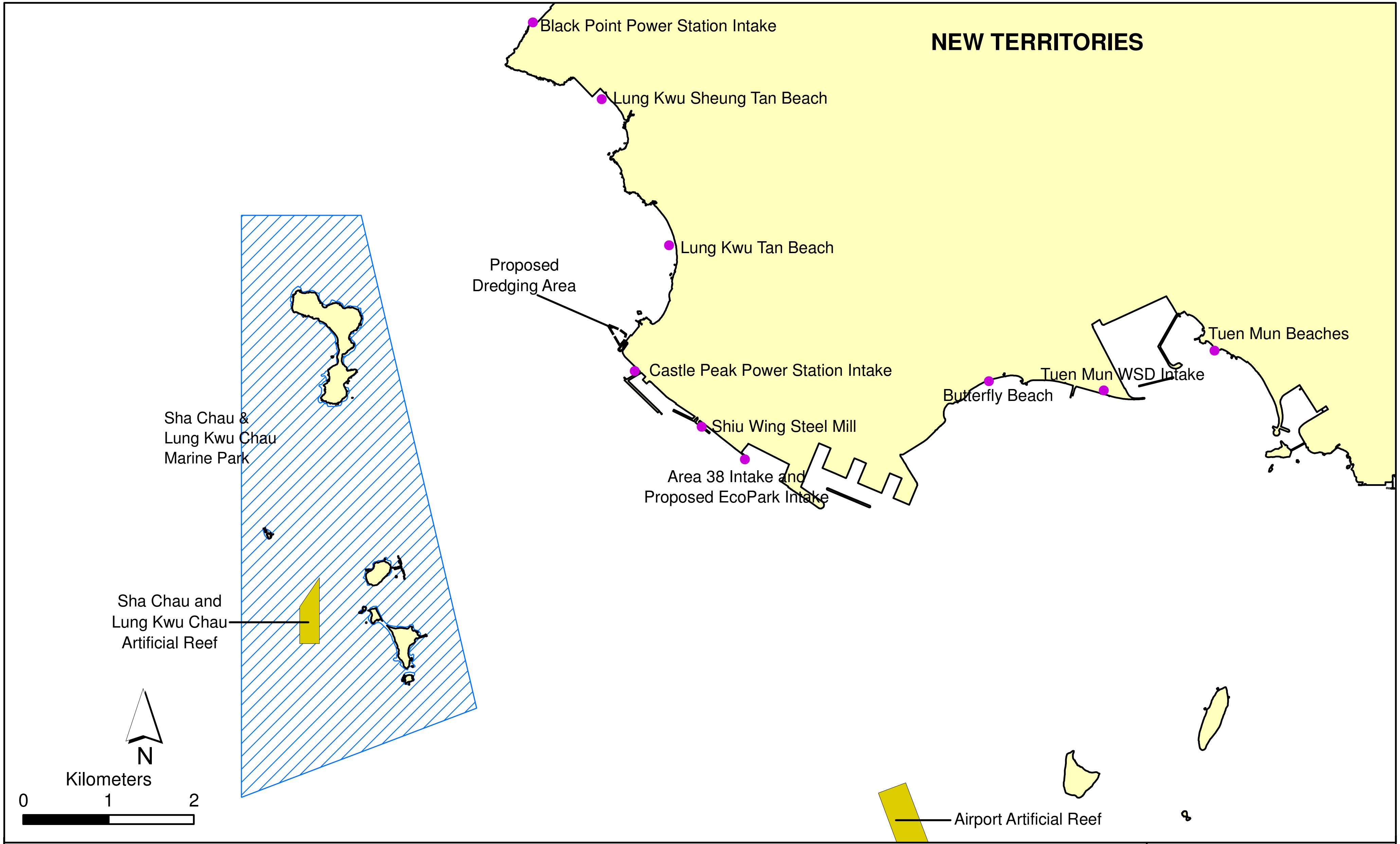

Figure 5.2

Location of Water Quality Sensitive Receivers

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Ecological Sensitive Receivers

The Sha Chau and Lung Kwu Chau AR site and the Airport AR site have been deployed to act as a fisheries resource enhancement tool, to encourage growth and development of a variety of marine organisms, and to provide feeding opportunities for the Indo-Pacific Humpback Dolphin. There is no specific water quality criterion for the AR sites, thus water quality impacts have been assessed with reference to the WQOs criterion for the assessment of impacts to marine life.

5.4 POTENTIAL SOURCES OF IMPACT

Potential sources of impacts to water quality as a result of the project may occur during both the construction and operational phases.

5.4.1 Construction Phase

The major construction activities associated with the proposed project that may cause impacts to water quality involve the following:

- Dredging for the additional berthing facility;
- Construction of the additional berthing facility including the piling works;
- Sewage discharges due to the on-site workforce; and
- Site runoff and pollutants entering the receiving waters and/or water drainage system.

Of the above the main impacts arising from the construction works may relate to disturbances to the seabed and re-suspension of marine sediment. These, in turn, may result in physico-chemical changes to the water column as a result of the release of suspended solids.

5.4.2 Operational Phase

The potential impacts to water quality arising from the operation of the proposed facility have been identified as follows:

- Effluent from the FGD process would likely impact concentrations of sulphate ions; salinity; suspended ash particles and chemical and biochemical oxygen demand.

The treated effluent will be added to the cooling water flows and then discharged via the CPB cooling water outfall, resulting in a small increase (i.e. 0.02 %) in the total flows from the outfall. It should be noted that there would be no effect on the temperature of the cooling water or on the quantities of residual chlorine in the discharge.

5.5 *WATER QUALITY IMPACT ASSESSMENT METHODOLOGY*

The methodology employed to assess the above impacts has been based on the information presented in *Section 2*.

Impacts due to the dispersion of fine sediment in suspension during the construction of the additional berthing facility have been assessed using computational modelling. Mitigation measures were assumed to be absent.

The simulation of operational impacts on water quality has also been performed by means of computational modelling. The models have been used to simulate the effects of discharges on water quality.

Full details of the scenarios examined in the modelling works are presented in the following sections. As discussed previously, the water quality sensitive receivers in the vicinity of the proposed works are presented in *Figure 5.2* and the points at which the modelling data has been analysed are shown in *Figure 5.3* and summarised in *Table 5.8*. These modelling output points are considered representative as any sensitive receivers beyond these points would be expected to have lower impacts.

Table 5.8 Water Quality Modelling Output Points

Type	Description	ID	Evaluation Criteria
Water Quality Sensitive Receivers			
Gazetted Bathing Beach	Butterfly Beach	B3	Water Quality Objectives (WQO)
	Tuen Mun Beaches	B4	Water Quality Objectives (WQO)
Non-Gazetted Bathing Beach	Lung Kwu Sheung Tan Beach	B1	Water Quality Objectives (WQO)
	Lung Kwu Beach	B2	Water Quality Objectives (WQO)
Water Intakes	Black Point Power Station	I1	Water Quality Objectives (WQO) and Power Station Specified Water Quality Criteria
	Castle Peak Power Station	I2	Water Quality Objectives (WQO) and Power Station Specified Water Quality Criteria
	Industrial Intakes and Proposed EcoPark at Area 38	I3	Water Quality Objectives (WQO)
	Tuen Mun WSD	I4	WSD Water Quality Criteria
	Shiu Wing Steel Mill	I5	Water Quality Objectives (WQO)
Marine Ecological Sensitive Receivers			
Marine Park	Sha Chau and Lung Kwu Chau Marine Park	MP1 [a, c] MP2 [a, c] MP3 [a, c]	Water Quality Objectives (WQO)
Other Modelling Output Points for Assessment Purpose			
Marine Water Stations	EPD Monitoring station	DM5 NM3 [b, c] NM5	Water Quality Objectives (WQO)

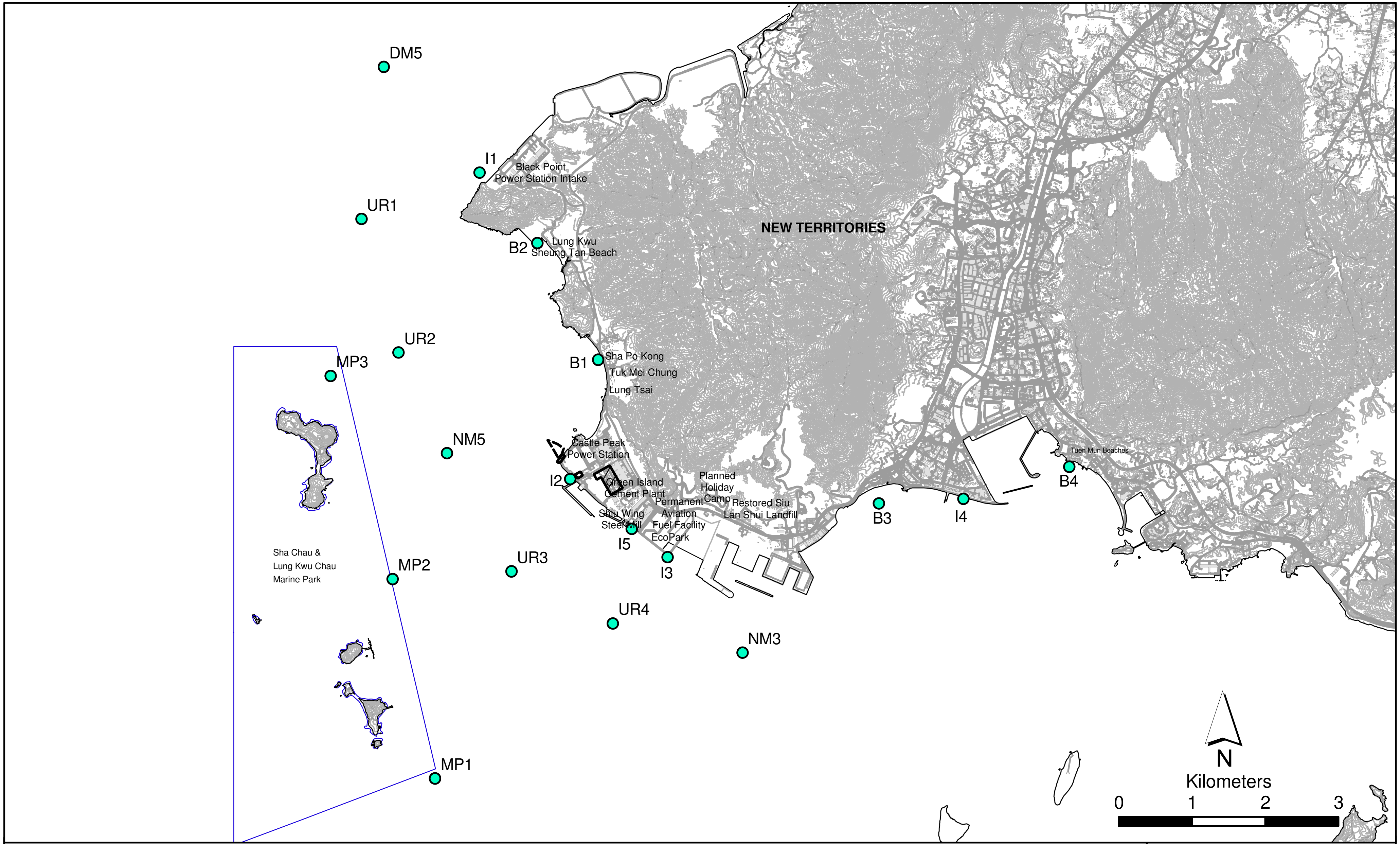

Figure 5.3

Location of Water Quality Modelling Ouput Points

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Type	Description	ID	Evaluation Criteria
	Urmston Road Station	UR1 UR2 UR3 UR4 [b, c]	Water Quality Objectives (WQO)

Notes:

(a) MP1, MP2 and MP3 indicate the boundary of the Sha Chau Marine Park. They are surrogate points for assessing pollutant dispersion trend at the artificial reefs at Sha Chau.

(b) UR4 and NM3 indicate the waters at the Urmston Road which are the closest locations to the Airport. They are surrogate points for assessing pollutant dispersion trend at the artificial reef site at the Airport.

(c) If the results for these modelling points indicate no unacceptable impacts to occur due to the Project, it is assumed that those sensitive receivers beyond the modelling points will not be adversely affected.

5.5.1 *Uncertainties in Assessment Methodology*

Quantitative uncertainties in the hydrodynamic modelling and suspended sediment plumes should be considered when making an evaluation of the modelling predictions. For hydrodynamic modelling these are considered to be negligible for the following reasons:

- The computational grid of the model is sufficiently refined to provide precise simulation results;
- The model has been calibrated and verified in order to provide reliable predictions for the study area; and
- The simulations comprise a sufficient spin up (or initial start up) period of 6 days so that initial conditions do not affect the results.

In carrying out the suspended solids assessment, worst case assumptions have been made in order to provide a conservative assessment of environmental impacts. These assumptions are as follows.

- The assessment is based on the peak dredging rates. In reality, these will only occur for short periods of time;
- The calculations of loss rates of sediment to suspension are based on conservative estimates for the type of plant and method of working.

Such allow a conservative approach to be applied to the water quality modelling and should be considered when drawing conclusions from the assessment.

The following uncertainties, however, have not been covered in the modelling:

- Instantaneous vessel access;
- *Ad hoc* marine traffic; and
- Near-shore scouring of marine sediment.

5.6 *CONSTRUCTION PHASE WATER QUALITY IMPACT ASSESSMENT*

5.6.1 *Modelling Details*

The Western Harbour Model was developed by WL | Delft Hydraulics and applied in this Study. The model has been previously set up to cover the whole of the marine waters of the North West New Territories and was most recently used in the assessment of the potential mud disposal areas at East of Sha Chau and South Brothers (1).

Hydrodynamics

The first phase of the modelling involved setting up a detailed hydrodynamic model of the area around the CPPS.

The spin-up period equals one spring-neap-cycle is approximately 14 days. The time step used in the model is 1.5 min. The computation simulation periods for the model are as follows.

	Dry	**Wet**
Start:	08 February 2007 18:00	25 July 2007 23:00
Stop:	23 February 2007 18:00	09 August 2007 23:00

The flow rate of Pearl River discharges have been assumed as shown below.

	Dry	**Wet**
Humen:	1245 $m^3 s^{-1}$	7442 $m^3 s^{-1}$
Jiaomen:	527 $m^3 s^{-1}$	4732 $m^3 s^{-1}$
Hongqili:	128 $m^3 s^{-1}$	1535 $m^3 s^{-1}$
Hengmen:	136 $m^3 s^{-1}$	2805 $m^3 s^{-1}$
Deep Bay:	2.5 $m^3 s^{-1}$	16 $m^3 s^{-1}$

The existing hydrodynamics data were interpolated onto the refined grid (*Figure 5.4*) used in the Delft-3D-WAQ module to provide necessary input data for the refined grid simulations. The refinement grid improved resolution (less than 75m) at the areas of interest. This methodology has been successfully applied to simulations using the water quality model in previously approved EIAs in Hong Kong. A detailed discussion of the numerical implementation of the interpolation process is presented in *Annex C2.*

Hydrodynamic data have also been obtained using coastline and bathymetry for a time horizon representative of the construction period of the facility (i.e., 2007 onwards) (*Figure 5.5*).

Scenarios

During dredging activities required for the additional berthing facility, a quantity of fine sediment will be lost to suspension which may be transported away from the works area, forming suspended sediment plumes. The

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(1) ERM (2005). Op cit.

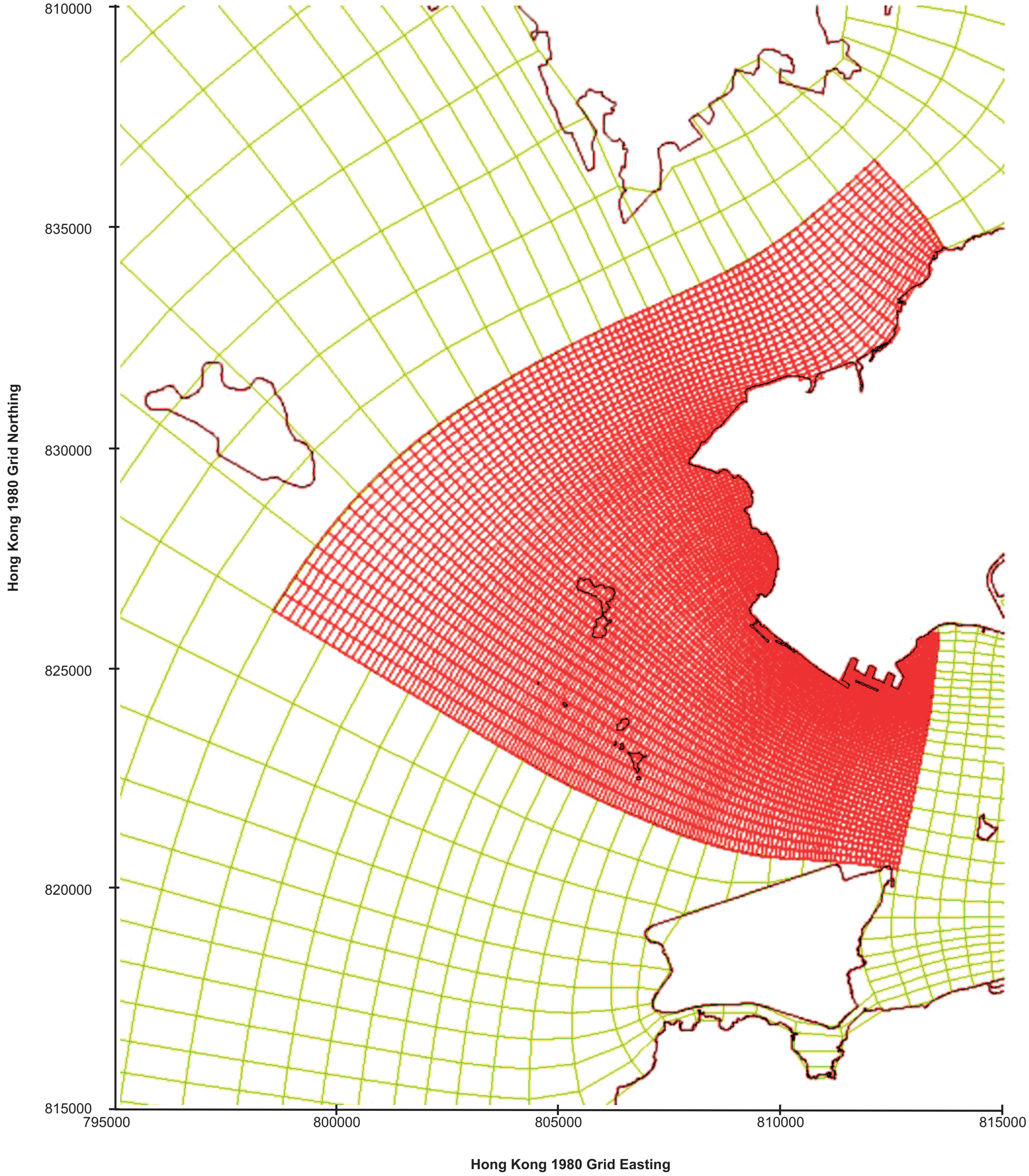

Figure 5.4

Refined Water Quality Model Grid

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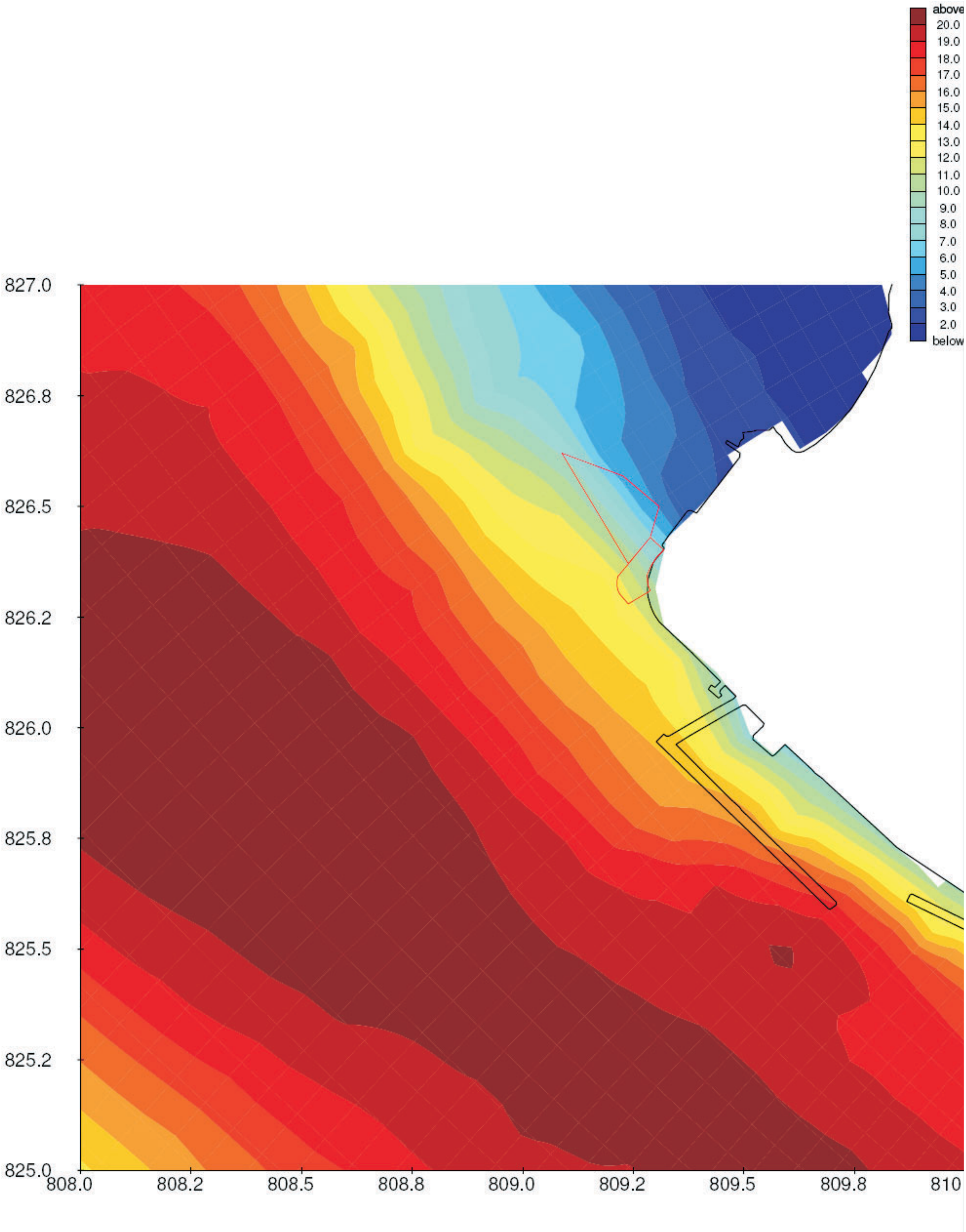

Figure 5.5

Coastlines and Bathymetry during the Construction Phase (The numbers on the two axes Hong Kong 1980 Grid coordinates)

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formation and transport of such sediment plumes have been modelled with the Delft-3D-WAQ module which simulated the process of sediment transport, deposition and erosion for plumes generated during dredging. The basis of the model is the advection-diffusion transport. All sediment particles are transported by the flow (advection) and turbulent mixing (diffusion), and additional processes will be included for modelling various water quality parameters.

As the dredging area is small, the use of a closed grab dredger is considered to be most suitable. The dredger will commence at the utmost southeast of the dredging area moving along the route as indicated in *Figure 5.6*, covering the whole trajectory (approximately 1.5 km) in around 12 days. It was assumed the most conservative case that the sediments would be released during neap tide (taking into account applicable working hours).

The assumptions made with regards to modelling grab dredging operations are detailed in *Table 5.9*.

Table 5.9 Assumptions for the Grab Dredging Operations

Parameter	**Assumption**
Hopper capacity of each vessel	700 m^3
Minimum Grab size	8 m^3 (closed grab)
Total number of dredgers to be deployed on site	1
Estimated quantity of the dredged sediment	80,700 m^3
Typical daily dredging rate	3,500 m^3 day^{-1}
Maximum daily dredging rate	5,200 m^3 day^{-1}
Maximum loss rate	20 kg m^{-3} day^{-1}
Loss rate per second	1.81 kg s^{-1}
Duration of the dredging works	maximum 6 weeks
Working time	16 hours per day, 6 days per week

Although it is acknowledged that a larger grab would result in less sediment being released and, therefore, lower loss rates, it is considered appropriate for the conservative nature of the assessment to assume an 8 m^3 grab will be used. Typical and maximum daily dredging rate is assumed to be 3,500 m^3 day^{-1} and 5,200 m^3 day^{-1}. To consider the most conservative case, a loss rate of 20 kg m^{-3} is assumed, which equates to a sediment release rate of 1.81 kg s^{-1}.

Based on the above information, the detailed hydrodynamic model was used to simulate two scenarios which are defined below. Each of the scenarios was simulated for 15 day spring-neap tidal cycles in the dry and wet seasons.

- **Scenario 1**: Baseline case, corresponding to the current conditions with the existing discharges in the vicinity of the CPPS (including BPPS and CPPS); and

- **Scenario 2**: Additional Berthing Facility Construction case, including the dredging for the additional berthing facility.

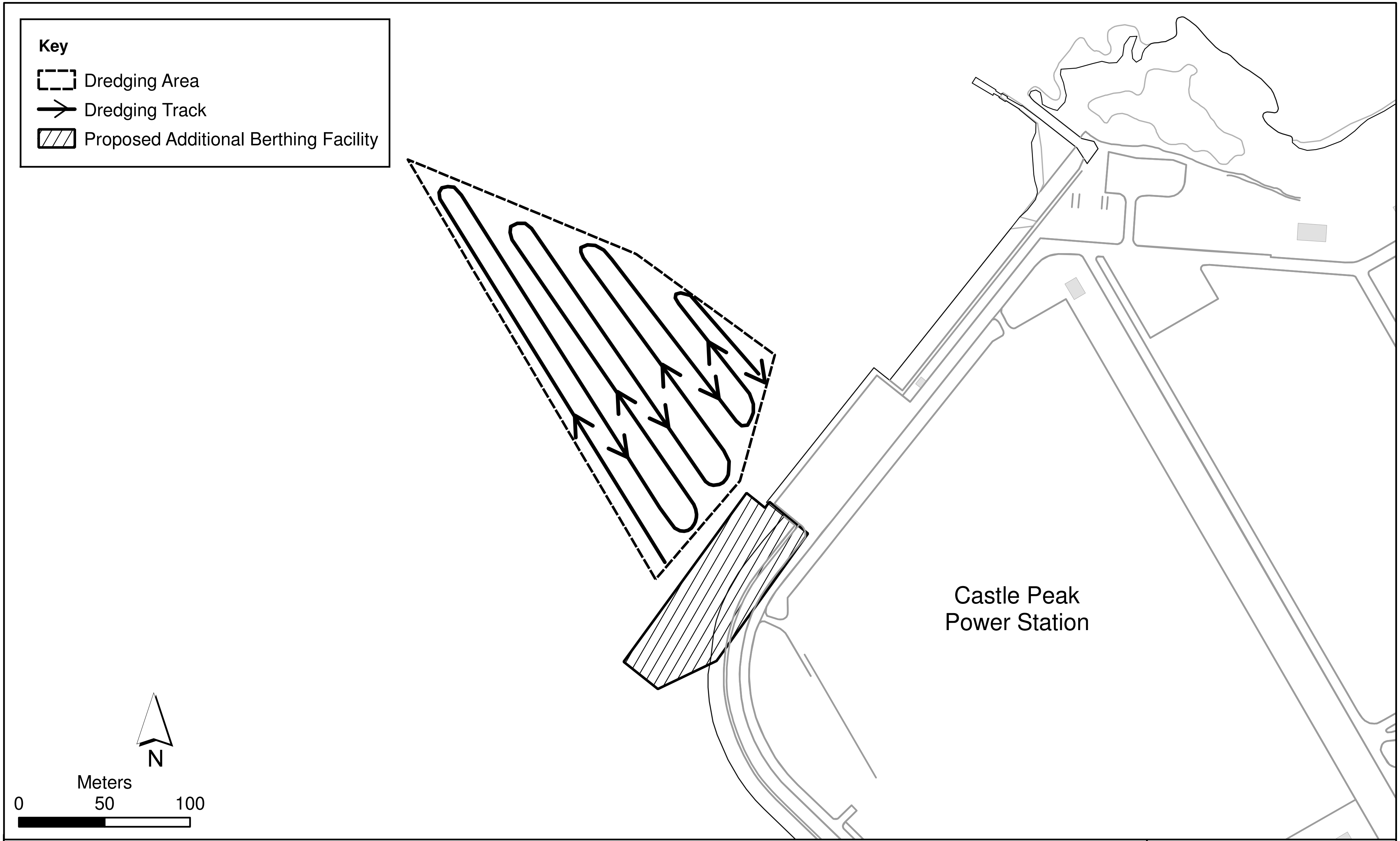

Figure 5.6

Trajectory of Grab Dredger within the Dredging Area during Dredging Operations

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The area proposed to be dredged for the additional berthing facility is presented in *Figure 2.3*. The dredged area covers approximately 30,000 m^2. The final dredging level has been taken to be approximately -8.2 mPD.

5.6.2 Prediction and Evaluation of Impacts

As the results of the hydrodynamic model were used to drive the water quality model, these are not discussed in detail.

Dredging for the Additional Berthing Facility

Suspended Solids

Impacts from the dispersion of fine sediment in suspension from the construction of the additional berthing facility have been simulated using computer modelling. The maximum and mean elevations of depth-averaged SS for each scenario are presented in *Table 5.10.* Results are presented as predicted levels of suspended sediment at each of the sensitive receivers.

Modelling results indicate that SS elevations will be compliant with the WQO for all sensitive receivers in both seasons (*Table 5.10*).

Table 5.10 Predicted SS Elevations above Ambient due to the Grab Dredging Operations

Sensitive Receivers	**Depth**	**Evaluation Criteria (mg L^{-1})**		**Suspended Solids Concentration (mg L^{-1})**			
				Mean		**Max**	
		Dry	**Wet**	**Dry**	**Wet**	**Dry**	**Wet**
B1	Surface	6.6	6.9	0.0	0.1	0.2	1.1
B1	Middle	6.6	6.9	0.1	0.1	0.6	1.3
B1	Bottom	6.6	6.9	0.1	0.1	1.0	1.6
B1	Depth-averaged	6.6	6.9	0.1	0.1	0.6	1.3
B2	Surface	6.6	6.9	0.0	0.0	0.1	0.1
B2	Middle	6.6	6.9	0.0	0.0	0.2	0.1
B2	Bottom	6.6	6.9	0.0	0.0	0.3	0.1
B2	Depth-averaged	6.6	6.9	0.0	0.0	0.2	0.1
B3	Surface	6.6	6.9	0.0	0.0	0.0	0.0
B3	Middle	6.6	6.9	0.0	0.0	0.1	0.0
B3	Bottom	6.6	6.9	0.0	0.0	0.1	0.0
B3	Depth-averaged	6.6	6.9	0.0	0.0	0.1	0.0
B4	Surface	6.6	6.9	0.0	0.0	0.0	0.0
B4	Middle	6.6	6.9	0.0	0.0	0.0	0.0
B4	Bottom	6.6	6.9	0.0	0.0	0.0	0.0
B4	Depth-averaged	6.6	6.9	0.0	0.0	0.0	0.0
I1	Surface	726.4	741.2	0.0	0.0	0.2	0.0
I1	Middle	726.4	741.2	0.0	0.0	0.2	0.0
I1	Bottom	726.4	741.2	0.1	0.0	0.4	0.4
I1	Depth-averaged	726.4	741.2	0.0	0.0	0.2	0.1
I2	Surface	742	741	1.2	0.5	7.7	4.5
I2	Middle	742	741	1.7	1.4	16.4	8.9
I2	Bottom	742	741	1.5	2.6	16.9	12.7
I2	Depth-averaged	742	741	1.5	1.6	11.9	8.2
I3	Surface	6.6	6.9	0.1	0.1	1.1	0.9

Sensitive Receivers	Depth	Evaluation Criteria (mg L^{-1})		Suspended Solids Concentration (mg L^{-1})			
				Mean		Max	
		Dry	Wet	Dry	Wet	Dry	Wet
I3	Middle	6.6	6.9	0.1	0.2	1.1	1.7
I3	Bottom	6.6	6.9	0.1	0.1	1.0	0.5
I3	Depth-averaged	6.6	6.9	0.1	0.1	1.0	0.9
I4	Surface	13.6	13.6	0.0	0.0	0.0	0.0
I4	Middle	13.6	13.6	0.0	0.0	0.1	0.1
I4	Bottom	13.6	13.6	0.0	0.0	0.1	0.1
I4	Depth-averaged	13.6	13.6	0.0	0.0	0.1	0.1
I5	Surface	6.6	6.9	0.1	0.1	1.2	0.9
I5	Middle	6.6	6.9	0.2	0.2	1.7	1.8
I5	Bottom	6.6	6.9	0.1	0.1	1.1	0.6
I5	Depth-averaged	6.6	6.9	0.2	0.2	1.2	1.2
MP1	Surface	28	28	0.0	0.0	0.1	0.0
MP1	Middle	28	28	0.0	0.0	0.1	0.0
MP1	Bottom	28	28	0.0	0.0	0.1	0.1
MP1	Depth-averaged	28	28	0.0	0.0	0.1	0.0
MP2	Surface	28	28	0.0	0.0	0.1	0.0
MP2	Middle	28	28	0.0	0.0	0.1	0.1
MP2	Bottom	28	28	0.0	0.0	0.2	0.1
MP2	Depth-averaged	28	28	0.0	0.0	0.1	0.1
MP3	Surface	28	28	0.0	0.0	0.1	0.0
MP3	Middle	28	28	0.0	0.0	0.1	0.0
MP3	Bottom	28	28	0.1	0.0	0.2	0.2
MP3	Depth-averaged	28	28	0.0	0.0	0.1	0.1
DM5	Surface	6.6	6.9	0.0	0.0	0.1	0.0
DM5	Middle	6.6	6.9	0.0	0.0	0.2	0.0
DM5	Bottom	6.6	6.9	0.1	0.0	0.3	0.3
DM5	Depth-averaged	6.6	6.9	0.0	0.0	0.2	0.1
NM3	Surface	6.6	6.9	0.0	0.0	0.4	0.4
NM3	Middle	6.6	6.9	0.1	0.0	0.3	0.2
NM3	Bottom	6.6	6.9	0.1	0.0	0.2	0.3
NM3	Depth-averaged	6.6	6.9	0.1	0.0	0.2	0.1
NM5	Surface	6.6	6.9	0.0	0.0	0.0	0.0
NM5	Middle	6.6	6.9	0.0	0.0	0.4	0.2
NM5	Bottom	6.6	6.9	0.1	0.0	0.3	0.2
NM5	Depth-averaged	6.6	6.9	0.0	0.0	0.2	0.1
UR1	Surface	6.6	6.9	0.0	0.0	0.1	0.0
UR1	Middle	6.6	6.9	0.0	0.0	0.2	0.1
UR1	Bottom	6.6	6.9	0.1	0.1	0.4	0.3
UR1	Depth-averaged	6.6	6.9	0.0	0.0	0.2	0.1
UR2	Surface	6.6	6.9	0.0	0.0	0.0	0.0
UR2	Middle	6.6	6.9	0.0	0.0	0.2	0.1
UR2	Bottom	6.6	6.9	0.1	0.1	0.4	0.3
UR2	Depth-averaged	6.6	6.9	0.0	0.0	0.2	0.1
UR3	Surface	6.6	6.9	0.0	0.0	0.2	0.5
UR3	Middle	6.6	6.9	0.0	0.0	0.3	0.1
UR3	Bottom	6.6	6.9	0.1	0.0	0.2	0.1
UR3	Depth-averaged	6.6	6.9	0.0	0.0	0.2	0.1
UR4	Surface	6.6	6.9	0.0	0.0	0.3	0.5
UR4	Middle	6.6	6.9	0.1	0.0	0.4	0.1
UR4	Bottom	6.6	6.9	0.1	0.0	0.2	0.2

Sensitive Receivers	Depth	Evaluation Criteria (mg L^{-1})		Suspended Solids Concentration (mg L^{-1})			
				Mean		Max	
		Dry	Wet	Dry	Wet	Dry	Wet
UR4	Depth-averaged	6.6	6.9	0.1	0.0	0.3	0.1

The contour plots of the suspended solids are also presented in *Annex C3*. The maximum depth-averaged SS plots for both seasons suggest that plumes over 10 mg L^{-1} are likely to be confined to the works area and will not reach the closest northward WSR, ie Lung Kwu Tan Beach. Although they will reach the closest southward WSR, ie Castle Peak Power Station Intake A, the 10 mgL^{-1} is predicted to be well below the SS criterion for this intake.

Due to the relatively limited spread of SS and no exceedances of the WQOs or tolerance criterion at sensitive receivers, no unacceptable elevations of SS would be expected to occur.

Sediment Deposition

Contour plots (*Annex C3*) of sediment deposition as a result of dredging operations indicate that the majority of sediment settles either within, or within relatively close proximity, to the CPPS. *Table 5.11* summarises the predicted sediment deposition rate due to the grab dredging operations. The highest sedimentation rate was 110 g m^{-2} d^{-1} during the wet season at I2, i.e. Castle Peak Power Station intake, which is the closest to the working site. For other intakes, the sedimentation rate is predicted to be < 4 g m^{-2} d^{-1}. In consideration of the short duration of the dredging works (approximately 12 days), the sediment deposition is unlikely cause any unacceptable impacts to the intakes.

For those sensitive receivers farther away from the CPPS representing the ARs, i.e. MP1-3, UR4 and NM3, the sedimentation rate is predicted to be < 1 g m^{-2} d^{-1} which is far below 50 g m^{-2} d^{-1} (the criterion used in this Study for the artificial reef). Hence, it is expected that the sediment deposition at those ARs at Sha Chau and the Airport will be minimal. Sediment deposition is, therefore, not expected to affect any nearby submarine utilities or ecological sensitive receivers.

Table 5.11 Predicted Sediment Deposition Rate due to the Grab Dredging Operations

Sensitive Receivers	Sedimentation Rate (g m^{-2} d^{-1})	
	Dry	Wet
B1	4	4
B2	1	0
B3	1	0
B4	0	0
I1	0	0
I2	62	110
I3	2	3
I4	0	0
I5	4	3

Sensitive Receivers	**Sedimentation Rate (g m^{-2} d^{-1})**	
	Dry	**Wet**
MP1	0	0
MP2	0	0
MP3	0	0
DM5	0	0
NM3	0	0
NM5	0	1
UR1	0	1
UR2	0	1
UR3	0	0
UR4	0	0

Dissolved Oxygen Depletion

The degree of oxygen depletion exerted by a sediment plume is a function of the sediment oxygen demand of the sediment, its concentration in the water column and the rate of oxygen replenishment.

The impact of the sediment oxygen demand (SOD) on dissolved oxygen concentrations has been calculated based on the following equation (1):

$$DO_{Dep} = C * SOD * K * 10^{-6}$$

where DO_{Dep} = Dissolved oxygen depletion (mg L^{-1})
C = Suspended solids concentration (mg L^{-1})
SOD = Sediment oxygen demand (mg kg^{-1})
K = Daily oxygen uptake factor (set as 1 (2))

An SOD of 15,000 mg kg^{-1} has been used in a recent approved EIA (3) which made reference to EPD Marine Monitoring data. This value was considered as a suitably representative value for sediments in the North Western Waters. In the same EIA, K was set to be 1, which means instantaneous oxidation of the sediment oxygen demand. This was a more conservative prediction of DO depletion than this study since oxygen depletion is not instantaneous and will depend on tidally averaged suspended sediment concentrations.

It is worth noting that the above equation does not account for re-aeration which would tend to reduce impacts of the SS on the DO concentrations in the water column. The proposed analysis, which is on the conservative side, will not, therefore, underestimate the DO depletion.

The calculated results (*Table 5.12*) showed that the predicted oxygen depletion at the WSRs is less than 0.3 mg L^{-1}, except at I2, i.e. Castle Peak Power Station Intake. By comparing the predicted depletion values with the allowable deduction in DO, the dissolved oxygen at those WSRs is expected to be compliance with the WQOs. The sediment plumes predicted in the model are

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(1) ERM - HK Ltd (1997). EIA for Disposal of Contaminated Mud in the East of Sha Chau Marine Borrow Pit. For Civil Engineering Department of the SAR Government.

(2) Mouchel (2002). EIA for Permanent Aviation Fuel Facility. For Hong Kong Airport Authority.

(3) Mouchel (2002). *Op. Cit.*

thus unlikely to deteriorate dissolved oxygen conditions in the receiving waters. For Castle Peak Power Station Intake, there is no specific DO criterion set for the intake and hence the DO depletion will not affect the intake system.

SS elevations induced by the marine works within the Study Area as a whole will remain compliant with the WQOs. The subsequent effect on dissolved oxygen within the surrounding waters is, therefore, predicted to be minimal and unacceptable impacts to marine ecological resources including the Indo-Pacific Humpback Dolphins are not expected to occur.

Table 5.12 Predicted Dissolved Oxygen Depletion due to Increase in SS Concentrations

Sensitive Receivers	**Depth**	**Allowable Effect (mg L^{-1})**		**Dissolved Oxygen Depletion (mg L^{-1})**			
				Mean		**Max**	
		Dry	**Wet**	**Dry**	**Wet**	**Dry**	**Wet**
B1	Surface	N/A	N/A	0.00	0.01	0.03	0.16
B1	Middle	N/A	N/A	0.01	0.01	0.09	0.20
B1	Bottom	-4.7	-2.5	0.02	0.02	0.15	0.24
B1	Depth-averaged	-2.7	-1.1	0.01	0.02	0.09	0.20
B2	Surface	N/A	N/A	0.00	0.00	0.01	0.01
B2	Middle	N/A	N/A	0.00	0.00	0.03	0.01
B2	Bottom	-4.7	-2.5	0.01	0.00	0.05	0.02
B2	Depth-averaged	-2.7	-1.1	0.00	0.00	0.03	0.01
B3	Surface	N/A	N/A	0.00	0.00	0.01	0.00
B3	Middle	N/A	N/A	0.00	0.00	0.01	0.01
B3	Bottom	-4.7	-2.5	0.00	0.00	0.01	0.00
B3	Depth-averaged	-2.7	-1.1	0.00	0.00	0.01	0.00
B4	Surface	N/A	N/A	0.00	0.00	0.00	0.00
B4	Middle	N/A	N/A	0.00	0.00	0.00	0.00
B4	Bottom	-4.7	-2.5	0.00	0.00	0.00	0.00
B4	Depth-averaged	-2.7	-1.1	0.00	0.00	0.00	0.00
I1	Surface	N/A	N/A	0.00	0.00	0.02	0.00
I1	Middle	N/A	N/A	0.00	0.00	0.03	0.01
I1	Bottom	-4.7	-2.5	0.01	0.00	0.06	0.07
I1	Depth-averaged	-2.7	-1.1	0.01	0.00	0.03	0.02
I2	Surface	N/A	N/A	0.18	0.08	1.15	0.67
I2	Middle	N/A	N/A	0.26	0.21	2.47	1.34
I2	Bottom	-4.7	-2.5	0.22	0.39	2.53	1.91
I2	Depth-averaged	-2.7	-1.1	0.23	0.23	1.79	1.24
I3	Surface	N/A	N/A	0.02	0.01	0.16	0.13
I3	Middle	N/A	N/A	0.02	0.02	0.16	0.25
I3	Bottom	-4.7	-2.5	0.02	0.01	0.14	0.08
I3	Depth-averaged	-2.7	-1.1	0.02	0.02	0.15	0.13
I4	Surface	N/A	N/A	0.00	0.00	0.01	0.00
I4	Middle	N/A	N/A	0.00	0.00	0.01	0.01
I4	Bottom	-4.7	-2.5	0.00	0.00	0.01	0.01
I4	Depth-averaged	-2.7	-1.1	0.00	0.00	0.01	0.01
I5	Surface	N/A	N/A	0.02	0.02	0.19	0.13
I5	Middle	N/A	N/A	0.03	0.03	0.25	0.27
I5	Bottom	-4.7	-2.5	0.02	0.02	0.17	0.10
I5	Depth-averaged	-2.7	-1.1	0.02	0.03	0.19	0.18
MP1	Surface	N/A	N/A	0.00	0.00	0.01	0.00
MP1	Middle	N/A	N/A	0.00	0.00	0.01	0.00

Sensitive Receivers	**Depth**	**Allowable Effect (mg L^{-1})**		**Dissolved Oxygen Depletion (mg L^{-1})**			
				Mean		**Max**	
		Dry	**Wet**	**Dry**	**Wet**	**Dry**	**Wet**
MP1	Bottom	-4.7	-2.5	0.00	0.00	0.02	0.02
MP1	Depth-averaged	-2.7	-1.1	0.00	0.00	0.01	0.00
MP2	Surface	N/A	N/A	0.00	0.00	0.01	0.00
MP2	Middle	N/A	N/A	0.00	0.00	0.01	0.01
MP2	Bottom	-4.7	-2.5	0.00	0.00	0.03	0.02
MP2	Depth-averaged	-2.7	-1.1	0.00	0.00	0.02	0.01
MP3	Surface	N/A	N/A	0.00	0.00	0.01	0.00
MP3	Middle	N/A	N/A	0.00	0.00	0.02	0.01
MP3	Bottom	-4.7	-2.5	0.01	0.00	0.03	0.03
MP3	Depth-averaged	-2.7	-1.1	0.01	0.00	0.02	0.01
DM5	Surface	N/A	N/A	0.00	0.00	0.01	0.00
DM5	Middle	N/A	N/A	0.01	0.00	0.03	0.01
DM5	Bottom	-4.7	-2.5	0.01	0.00	0.05	0.04
DM5	Depth-averaged	-2.7	-1.1	0.01	0.00	0.03	0.02
NM3	Surface	N/A	N/A	0.01	0.00	0.06	0.06
NM3	Middle	N/A	N/A	0.01	0.00	0.05	0.03
NM3	Bottom	-4.7	-2.5	0.01	0.00	0.03	0.04
NM3	Depth-averaged	-2.7	-1.1	0.01	0.00	0.03	0.02
NM5	Surface	N/A	N/A	0.00	0.00	0.01	0.00
NM5	Middle	N/A	N/A	0.01	0.00	0.06	0.03
NM5	Bottom	-4.7	-2.5	0.01	0.01	0.05	0.04
NM5	Depth-averaged	-2.7	-1.1	0.01	0.00	0.03	0.02
UR1	Surface	N/A	N/A	0.00	0.00	0.01	0.00
UR1	Middle	N/A	N/A	0.01	0.00	0.04	0.01
UR1	Bottom	-4.7	-2.5	0.01	0.01	0.05	0.05
UR1	Depth-averaged	-2.7	-1.1	0.01	0.00	0.03	0.02
UR2	Surface	N/A	N/A	0.00	0.00	0.01	0.00
UR2	Middle	N/A	N/A	0.01	0.00	0.04	0.02
UR2	Bottom	-4.7	-2.5	0.01	0.01	0.05	0.04
UR2	Depth-averaged	-2.7	-1.1	0.01	0.00	0.03	0.02
UR3	Surface	N/A	N/A	0.00	0.00	0.04	0.07
UR3	Middle	N/A	N/A	0.01	0.00	0.04	0.01
UR3	Bottom	-4.7	-2.5	0.01	0.00	0.03	0.02
UR3	Depth-averaged	-2.7	-1.1	0.01	0.00	0.03	0.01
UR4	Surface	N/A	N/A	0.01	0.00	0.05	0.08
UR4	Middle	N/A	N/A	0.01	0.00	0.06	0.02
UR4	Bottom	-4.7	-2.5	0.01	0.00	0.03	0.02
UR4	Depth-averaged	-2.7	-1.1	0.01	0.00	0.04	0.02

Note:

(a) The shaded indicates the potential non-compliance with the WQO.

Nutrients

An assessment of nutrient release during dredging has been carried out in relation to the modelling results of the sediment plume due to unmitigated dredging works and the sediment testing results for the dredging area. In the calculation it has assumed that all TIN and unionised ammonia (NH_3-N) concentrations in the sediments are released to the water. This is the most conservative assumption and will likely result in overestimation of the potential impacts.

The calculated TIN concentrations due to the increase in SS by the dredging works are presented in *Table 5.13*. As shown and aforementioned, the existing water quality conditions in the vicinity of the CPPS has already breach the WQO for TIN. It is predicted that the dredging works will cause an increase in TIN by 0.1%. The dredging works are thus not attributed significantly to the non-compliance of WQO.

Ammoniacal Nitrogen (NH_4-N) is the sum of ionised ammoniacal nitrogen and unionised nitrogen. Under normal conditions of Hong Kong waters, more than 90% of the ammoniacal nitrogen would be in the ionised form. For the purpose of assessment, a correction (as a function of temperature, pH, and salinity) has been applied based on the EPD monitoring results for station NM5, i.e. temperature of 23.5 degrees Celsius, salinity of 27.7 ppt and pH of 8. From this it derived that NH_3-N constitutes 5% of ammoniacal nitrogen. The results are presented in *Table 5.14*.

The results show that the increase in NH_3-N concentrations due to the dredging works would be negligible comparing with the ambient concentrations. The total concentrations of NH_3-N at the water quality sensitive receivers are predicted to be well below the WQO criterion of 0.021g L^{-1}.

Thus it is anticipated that the impacts of the SS elevations due to the dredging works on the nutrient levels are minimal and acceptable.

Table 5.13 ***Calculated Total Inorganic Nitrogen Concentrations due to Increase in Suspended Solids***

Sensitive Receivers	**Maximum Depth-averaged SS Concentration (mg L^{-1})**		**Maximum TIN in Sediment (mg kg^{-1})**	**Maximum Increase in TIN (mg L^{-1})**		**Ambient TIN (mg L^{-1})**	**Total TIN (mg L^{-1})**	
	Dry	**Wet**		**Dry**	**Wet**		**Dry**	**Wet**
B1	0.6	1.3	41.2	0.0000240	0.0000552	0.56	0.56	0.56
B2	0.2	0.1	41.2	0.0000092	0.0000033	0.56	0.56	0.56
B3	0.1	0.0	41.2	0.0000032	0.0000012	0.56	0.56	0.56
B4	0.0	0.0	41.2	0.0000002	0.0000008	0.56	0.56	0.56
I1	0.2	0.1	41.2	0.0000089	0.0000054	0.56	0.56	0.56
I2	11.9	8.2	41.2	0.0004906	0.0003396	0.56	0.56	0.56
I3	1.0	0.9	41.2	0.0000399	0.0000368	0.56	0.56	0.56
I4	0.1	0.1	41.2	0.0000025	0.0000024	0.56	0.56	0.56
I5	1.2	1.2	41.2	0.0000513	0.0000488	0.56	0.56	0.56
MP1	0.1	0.0	41.2	0.0000039	0.0000012	0.56	0.56	0.56
MP2	0.1	0.1	41.2	0.0000044	0.0000027	0.56	0.56	0.56
MP3	0.1	0.1	41.2	0.0000050	0.0000022	0.56	0.56	0.56
DM5	0.2	0.1	41.2	0.0000077	0.0000044	0.56	0.56	0.56
NM3	0.2	0.1	41.2	0.0000089	0.0000057	0.56	0.56	0.56
NM5	0.2	0.1	41.2	0.0000083	0.0000045	0.56	0.56	0.56
UR1	0.2	0.1	41.2	0.0000080	0.0000054	0.56	0.56	0.56
UR2	0.2	0.1	41.2	0.0000077	0.0000050	0.56	0.56	0.56
UR3	0.2	0.1	41.2	0.0000075	0.0000033	0.56	0.56	0.56
UR4	0.3	0.1	41.2	0.0000107	0.0000047	0.56	0.56	0.56

Notes:

Sensitive Receivers	**Maximum Depth-averaged SS Concentration (mg L^{-1})**		**Maximum TIN in Sediment (mg kg^{-1})**	**Maximum Increase in TIN (mg L^{-1})**		**Ambient TIN (mg L^{-1})**	**Total TIN (mg L^{-1})**	
	Dry	**Wet**		**Dry**	**Wet**		**Dry**	**Wet**

(a) The TIN concentration in sediment is taken from the maximum concentrations among the three sampling stations.

(b) The ambient concentration level is derived from the EPD monitoring data at NM5.

(c) The shaded cells indicate potential exceedances of the WQO.

Table 5.14 ***Calculated Unionised Ammonia Concentrations due to Increase in Suspended Solids***

Sensitive Receivers	**Maximum Depth-averaged SS Concentration (mg L^{-1})**		**Maximum Ammoniacal Nitrogen (NH_4-N) in Sediment (mg kg^{-1})**	**Maximum Increase in Unionised Ammonia (NH_3-N) (mg L^{-1})**		**Ambient NH_3-N (mg L^{-1})**	**Total NH_3-N (mg L^{-1})**	
	Dry	**Wet**		**Dry**	**Wet**		**Dry**	**Wet**
B1	0.6	1.3	41.2	0.0000012	0.0000028	0.006	0.006	0.006
B2	0.2	0.1	41.2	0.0000005	0.0000002	0.006	0.006	0.006
B3	0.1	0.0	41.2	0.0000002	0.0000001	0.006	0.006	0.006
B4	0.0	0.0	41.2	0.0000000	0.0000000	0.006	0.006	0.006
I1	0.2	0.1	41.2	0.0000004	0.0000003	0.006	0.006	0.006
I2	11.9	8.2	41.2	0.0000245	0.0000170	0.006	0.006	0.006
I3	1.0	0.9	41.2	0.0000020	0.0000018	0.006	0.006	0.006
I4	0.1	0.1	41.2	0.0000001	0.0000001	0.006	0.006	0.006
I5	1.2	1.2	41.2	0.0000026	0.0000024	0.006	0.006	0.006
MP1	0.1	0.0	41.2	0.0000002	0.0000001	0.006	0.006	0.006
MP2	0.1	0.1	41.2	0.0000002	0.0000001	0.006	0.006	0.006
MP3	0.1	0.1	41.2	0.0000002	0.0000001	0.006	0.006	0.006
DM5	0.2	0.1	41.2	0.0000004	0.0000002	0.006	0.006	0.006
NM3	0.2	0.1	41.2	0.0000004	0.0000003	0.006	0.006	0.006
NM5	0.2	0.1	41.2	0.0000004	0.0000002	0.006	0.006	0.006
UR1	0.2	0.1	41.2	0.0000004	0.0000003	0.006	0.006	0.006
UR2	0.2	0.1	41.2	0.0000004	0.0000003	0.006	0.006	0.006
UR3	0.2	0.1	41.2	0.0000004	0.0000002	0.006	0.006	0.006
UR4	0.3	0.1	41.2	0.0000005	0.0000002	0.006	0.006	0.006

Notes:

(a) The maximum NH_4-N in sediment is taken from the maximum concentrations among the three sampling stations.

(b) The ambient concentration level is derived from the EPD monitoring data at NM5.

Heavy Metals and Micro-Organic Pollutants

Elutriate tests were carried out to assess the potential of release of heavy metals and micro-organic pollutants from the dredged marine mud. The test results have been assessed and compared to the relevant water quality standard as shown in *Table 5.15*.

The results show that most dissolved metal concentrations for all samples are below report limits. In addition, all dissolved metal concentrations are found to be well below the water quality standards.

The results also show that all PAHs, PCBs, TBT and chlorinated pesticides are all below reporting limits. This indicates that the leaching of these pollutants is unlikely to occur.

Unacceptable water quality impacts due to the potential release of heavy metals and micro-organic pollutants from the dredged sediment are not expected to occur.

Table 5.15 Comparison between Results of the Elutriation Test of Heavy Metals and Micro-Organic Pollutants and Water Quality Standards

Parameters		Unit	Reporting Limits	Sample at V1	Sample at V2	Sample at V3	Blank Water	Water Quality Standard
Heavy Metals	Arsenic (As)	$\mu g\ L^{-1}$	1	<1	<1	<1	<1	25.0
	Cadmium (Cd)	$\mu g\ L^{-1}$	0.5	<0.5	<0.5	<0.5	<0.5	2.5
	Chromium (Cr)	$\mu g\ L^{-1}$	5	<5	<5	<5	<5	15.0
	Copper (Cu)	$\mu g\ L^{-1}$	1	1.9	2.1	2	<1	5.0
	Lead (Pb)	$\mu g\ L^{-1}$	2	<2	<2	<2	<2	25.0
	Mercury (Hg)	$\mu g\ L^{-1}$	0.2	<0.2	<0.2	<0.2	<0.2	0.3
	Nickel (Ni)	$\mu g\ L^{-1}$	2	<2	<2	<2	<2	30.0
	Silver (Ag)	$\mu g\ L^{-1}$	1	<1	<1	<1	<1	2.3
	Zinc (Zn)	$\mu g\ L^{-1}$	10	<10	<10	<10	<10	40.0
PAHs (Low Molecular Weight)	Naphthalene	$\mu g\ L^{-1}$	0.1	<0.1	<0.1	<0.1	<0.1	-
	Acenaphtylene	$\mu g\ L^{-1}$	0.1	<0.1	<0.1	<0.1	<0.1	-
	Acenaphtene	$\mu g\ L^{-1}$	0.1	<0.1	<0.1	<0.1	<0.1	-
	Fluorene	$\mu g\ L^{-1}$	0.1	<0.1	<0.1	<0.1	<0.1	-
	Phenanthrene	$\mu g\ L^{-1}$	0.1	<0.1	<0.1	<0.1	<0.1	-
	Anthracene	$\mu g\ L^{-1}$	0.1	<0.1	<0.1	<0.1	<0.1	-
PAHs (High Molecular Weight)	Benzo(a)anthracene	$\mu g\ L^{-1}$	0.1	<0.1	<0.1	<0.1	<0.1	-
	Benzo(a)pyrene	$\mu g\ L^{-1}$	0.1	<0.1	<0.1	<0.1	<0.1	-
	Chrysene	$\mu g\ L^{-1}$	0.1	<0.1	<0.1	<0.1	<0.1	-
	Dibenz(ah)anthracene	$\mu g\ L^{-1}$	0.1	<0.1	<0.1	<0.1	<0.1	-
	Fluoranthene	$\mu g\ L^{-1}$	0.1	<0.1	<0.1	<0.1	<0.1	-
	Pyrene	$\mu g\ L^{-1}$	0.1	<0.1	<0.1	<0.1	<0.1	-
	Benzo(b)fluoranthene	$\mu g\ L^{-1}$	0.1	<0.1	<0.1	<0.1	<0.1	-
	Benzo(k)fluoranthene	$\mu g\ L^{-1}$	0.1	<0.1	<0.1	<0.1	<0.1	-
	Indeno(1,2,3-cd)pyrene	$\mu g\ L^{-1}$	0.1	<0.1	<0.1	<0.1	<0.1	-
	Benzo(ghi)perylene	$\mu g\ L^{-1}$	0.1	<0.1	<0.1	<0.1	<0.1	-

Parameters		**Unit**	**Reporting Limits**	**Sample at V1**	**Sample at V2**	**Sample at V3**	**Blank Water**	**Water Quality Standard**
PCBs	PCB 8	μg L^{-1}	0.01	<0.01	<0.01	<0.01	<0.01	-
	PCB 18	μg L^{-1}	0.01	<0.01	<0.01	<0.01	<0.01	-
	PCB 28	μg L^{-1}	0.01	<0.01	<0.01	<0.01	<0.01	-
	PCB 44	μg L^{-1}	0.01	<0.01	<0.01	<0.01	<0.01	-
	PCB 52	μg L^{-1}	0.01	<0.01	<0.01	<0.01	<0.01	-
	PCB 66	μg L^{-1}	0.01	<0.01	<0.01	<0.01	<0.01	-
	PCB 77	μg L^{-1}	0.01	<0.01	<0.01	<0.01	<0.01	-
	PCB 101	μg L^{-1}	0.01	<0.01	<0.01	<0.01	<0.01	-
	PCB 105	μg L^{-1}	0.01	<0.01	<0.01	<0.01	<0.01	-
	PCB 118	μg L^{-1}	0.01	<0.01	<0.01	<0.01	<0.01	-
	PCB 126	μg L^{-1}	0.01	<0.01	<0.01	<0.01	<0.01	-
	PCB 128	μg L^{-1}	0.01	<0.01	<0.01	<0.01	<0.01	-
	PCB 138	μg L^{-1}	0.01	<0.01	<0.01	<0.01	<0.01	-
	PCB 153	μg L^{-1}	0.01	<0.01	<0.01	<0.01	<0.01	-
	PCB 169	μg L^{-1}	0.01	<0.01	<0.01	<0.01	<0.01	-
	PCB 170	μg L^{-1}	0.01	<0.01	<0.01	<0.01	<0.01	-
	PCB 180	μg L^{-1}	0.01	<0.01	<0.01	<0.01	<0.01	-
	PCB 187	μg L^{-1}	0.01	<0.01	<0.01	<0.01	<0.01	-
	Total PCBs	μg L^{-1}	0.01	<0.01	<0.01	<0.01	<0.01	0.03
Tributyltin (TBT)	-	μg L^{-1}	0.015	<0.015	<0.015	<0.015	<0.015	0.1
Chlorinated Pesticides	Alpha-BHC	μg L^{-1}	0.01	<0.01	<0.01	<0.01	<0.01	0.03
	Beta BHC	μg L^{-1}	0.01	<0.01	<0.01	<0.01	<0.01	3.0
	Gamma BHC	μg L^{-1}	0.01	<0.01	<0.01	<0.01	<0.01	0.1
	Delta-BHC	μg L^{-1}	0.01	<0.01	<0.01	<0.01	<0.01	0.0049
	Heptachlor	μg L^{-1}	0.01	<0.01	<0.01	<0.01	<0.01	0.017
	Aldrin	μg L^{-1}	0.01	<0.01	<0.01	<0.01	<0.01	0.16

Parameters	Unit	Reporting Limits	Sample at V1	Sample at V2	Sample at V3	Blank Water	Water Quality Standard
Heptachlor epoxide	µg L^{-1}	0.01	<0.01	<0.01	<0.01	<0.01	-
Alpha Endosulfan	µg L^{-1}	0.01	<0.01	<0.01	<0.01	<0.01	0.053
p, p'-DDT	µg L^{-1}	0.01	<0.01	<0.01	<0.01	<0.01	1.3
p, p'-DDD	µg L^{-1}	0.01	<0.01	<0.01	<0.01	<0.01	0.053
p, p'-DDE	µg L^{-1}	0.01	<0.01	<0.01	<0.01	<0.01	0.034
Endosulfan sulfate	µg L^{-1}	0.01	<0.01	<0.01	<0.01	<0.01	0.13

Note:

(a) The concentrations of the pollutants concerned in the blank seawater sample were all found to be below the reporting limits. The concentrations for the target pollutants in the blank seawater sample were therefore not subtracted from the elutriate test results of the respective pollutants.

Construction of the Additional Berthing Facility

About 39,500 m^3 of armour rock from the existing seawall will be removed to drive the piles for the additional berthing facility. The same lot of rock will be put back upon completion of the piling works. The duration of the material removal from existing seawall and marine piling works will be approximately 4 weeks and 6.5 weeks respectively. It is anticipated that the short duration works will not cause any unacceptable water quality impacts to sensitive receivers.

Piling works will be required for the additional berthing facility. Some of the piles will be located at the existing sloping seawall. Underneath the seawall, there is a rock fill down to approximately -25 mPD on top of sand down to approximately -34 mPD. Some of the piles will be located aside the existing seawall in order to support the 140-m desk.

Marine piling will be conducted for installation of the hollow cylindrical piles. These cylindrical piles will be driven into position and the soil inside the driven-in piles will be not removed. No soil or sediment excavation would be carried out. Bubble jackets/curtains will also be deployed during the pile driving following common local construction practice. It is expected that the marine piling with deployment of bubble jacket/curtain will cause limited disturbance to the sediments and is unlikely to cause unacceptable impacts to the nearby seawater intakes or other WSRs.

Sewage Discharges

Sewage will arise from the construction workforce and site office's sanitary facilities. It is estimated that up to 900 construction workers are assumed to be on site at the peak of the construction programme. It is expected that portable toilets will be provided for site workers and the existing sanitary facilities at the CPPS will not be used by any of the site workers. Portable toilet wastewater should be disposed of by a licensed chemical waste collector.

As sewage discharges are not expected to occur, no unacceptable water quality impacts to sensitive receivers are predicted.

Construction Run-off

During land based construction activities for the proposed FGD system and berthing facility, impacts to water quality may occur from pollutants in site run-off which may enter marine waters. Pollutants, mainly suspended sediments, may also enter the receiving waters if pumped groundwater is not adequately controlled.

Design features and methods that will be used to control surface runoff, reduce the potential for erosion, and prevent offsite siltation of any receiving waters will be adopted. Site inspections will be undertaken to ensure the ongoing suitability and good repair of the adopted erosion control measures. In particular, inspections will be undertaken before and after heavy rainfall events. The site runoff will be treated, if required, and checked for compliance with the appropriate standards prior to being discharged.

As construction runoff is expected to be managed through good site practice, no unacceptable impacts to sensitive receivers are predicted.

5.7 OPERATIONAL PHASE ASSESSMENT

5.7.1 FGD Effluent

In the LS-FGD process, the flue gas is passed through absorbers that contain slurry of ground limestone in fresh water. The sulphur dioxide is removed by reacting with the limestone (calcium carbonate) to form calcium sulphite. The slurry is then aerated to oxidise the calcium sulphite to form gypsum (calcium sulphate). The resulting gypsum slurry is then treated, resulting in dewatered gypsum and a small quantity of liquid effluent. The resulting effluent may have a small chemical oxygen demand and/or reduced dissolved oxygen concentrations. A portion of the ash within the flue gas is likely to be entrained within the limestone slurry. The ash may contain some metals, the quantities of which will depend upon the constituents of the original fuel coal. The metals of environmental concern that may be contained within the ash include arsenic, cadmium, chromium, copper, mercury, lead and zinc.

The treated FGD effluent will then be discharged through the existing main cooling water discharges of the Castle Peak Power Station "B" (CPB) (Outfall B in *Figure 5.7*). The existing flow rate from the CPB outfall is 7,119,360 m^3 day^{-1}. The discharge rate of the treated effluent from the Limestone FGD absorber will be 1,440 m^3 day^{-1}, which means that the total discharge from the CPB cooling water outfall will increase to 7,120,800 m^3 day^{-1} (representing a 0.02% increase when compared with the existing flow).

Treatment method of FGD WWTS has to achieve the WPCO TM. The system will comprise primarily settling, precipitation, biological treatment and pH control.

The technology for the reduction of suspended solids, metals concentration, is precipitation of soluble metals and filtration. Precipitation is achieved through the addition of lime / sulfide to precipitate the metals as the insoluble metals hydroxide / sulfide. Biological treatment would be employed for the removal of total nitrogen, chemical and biological oxygen demand. Biological clarifier effluent is treated in a multimedia filter for suspended solids removal. The sludge from the metals precipitation and biological clarifiers is transferred to the thickener. Thickened sludge will be treated in a filter press for sludge dewatering. A polymer is added to the sludge for conditioning to improve dewatering. Filter press filtrate is collected in a sump and transferred to the system for treatment.

It should be noted that there would be no effect on the quantities of residual chlorine in the discharge. It is conservatively assumed that the temperature

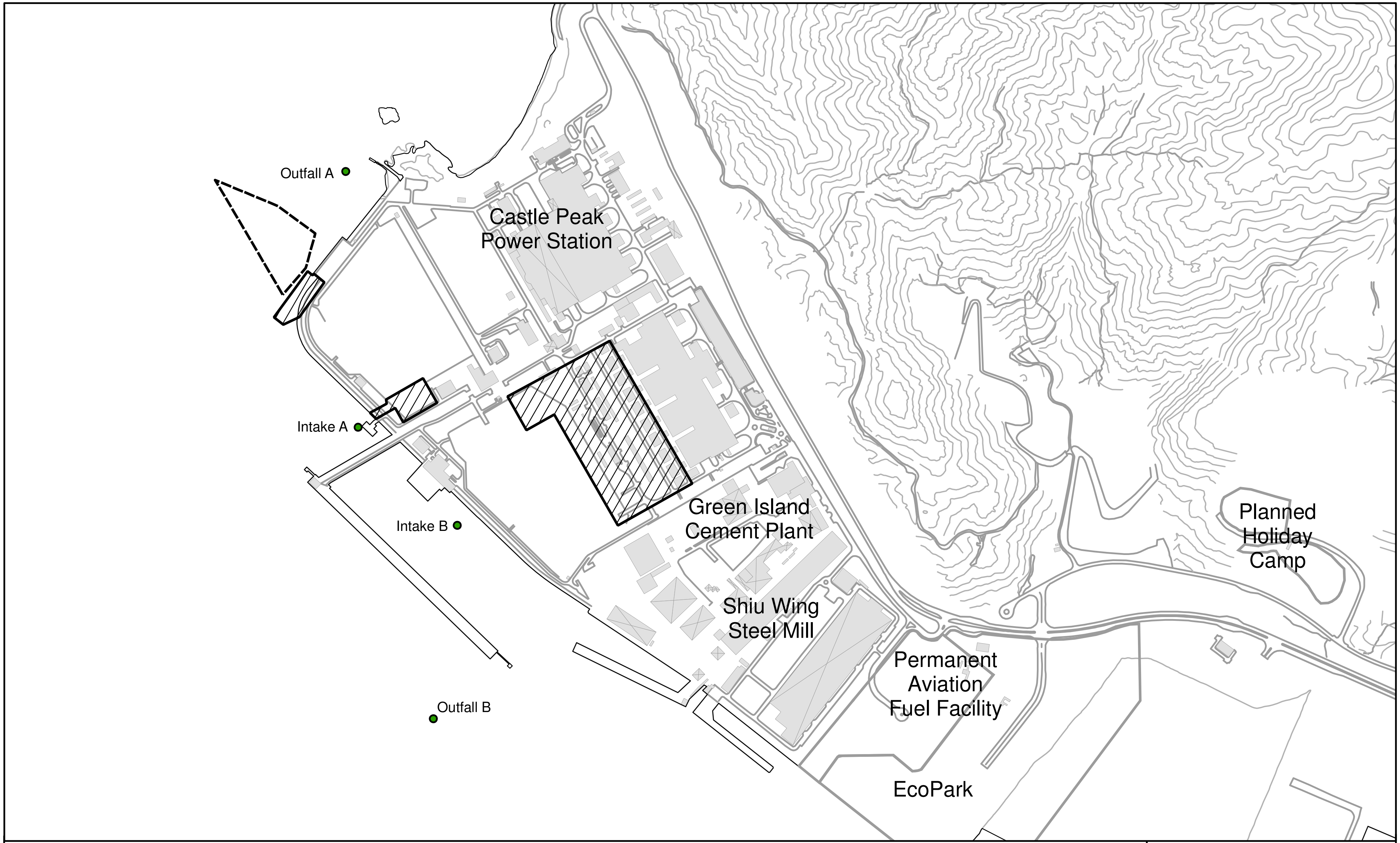

Figure 5.7

Location of Castle Peak A and B Outfalls

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Environmental Resources Management

ERM

of the cooling water discharge from CPB will remain unchanged, although there would likely be a small decrease due to the introduction of the small quantity of the treated effluent from the LS-FGD absorber.

The treated effluent from the Limestone FGD absorber will have the following properties, prior to its introduction to the CPB cooling water outfall (1):

- Salinity – 0 ppt (fresh water is mixed with limestone to form the absorber slurry);
- Biochemical Oxygen Demand (BOD) – 20 mg L^{-1};
- Chemical Oxygen Demand (COD) – 80 mg L^{-1};
- Increased concentrations of sulphate ions; and
- Suspended ash particles, which are likely to contain metals.

Based on the ratio of flows (0.02% of total discharge is represented by the FGD effluent) the final incremental COD in the outfall discharge is **0.016 mg L^{-1}** and the incremental BOD of **0.004 mg L^{-1}**. It is likely that the oxygen demand will then be dispersed and diluted and then exerted on the marine waters to cause a small dissolved oxygen reduction. It is anticipated that the minor increase in COD and BOD concentrations in the effluent will not cause any unacceptable impacts to the receiving water.

The DO depletion caused by the FGD effluent is predicted to be negligible, the subsequent effect on dissolved oxygen within the surrounding waters is, therefore, predicted to be minimal and adverse impacts to marine ecological resources including the Indo-Pacific Humpback Dolphins are not expected.

The ambient salinity is assumed to be 30.1 ppt, which is derived from the average concentrations near the sea bed and thus represents the higher value, which gives the greater deficit for the worst case. Based on the ratio of flows, the final salinity deficit is thus **0.006 ppt** less than the surrounding marine waters. This small salinity deficit is unlikely to cause any adverse impacts to the water quality.

The discharge of the treated effluent discharged into the marine waters should be compiled with the WPCO TM standards and also the effluent standards will be subject to refinement at WPCO licensing stage.

Based on the above, no unacceptable impacts to WSRs are expected to occur as a result of the operation of the FGD.

5.7.2 *Additional Berthing Facility*

A total of about 77 piles, with approximate diameter of 1 m, will stand underneath the deck of the additional berthing facility, which will be constructed parallel and close to the shore. The cross-sectional area of each pile underwater has been estimated to be 0.982 m^2 with the volume of each

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(1) Information supplied by CLP, based on data from the FGD system manufacturer.

pile underwater being 42.2 m^3. In view of the small cross-sectional area occupied by the piles and the closeness to the shore, it is not expected that the structure will result in any adverse impact to the hydrodynamic system.

5.8 CONSTRUCTION PHASE WATER QUALITY MITIGATION MEASURES

Unacceptable impacts to water quality sensitive receivers have largely been avoided through the adoption of the following measures at the project planning stage.

- **Reduction in Indirect Impacts:** The proposed works are located at a sufficient distance from water quality sensitive receivers so that the dispersion of sediments from the construction works does not affect the receivers at levels of concern (as defined by the WQO and tolerance criterion).

- **Adoption of Acceptable Working Rates**: The modelling work has demonstrated that the selected working rates for the dredging operations will not cause unacceptable impacts to the receiving water quality.

The water quality modelling works, with the assumption of no mitigation measures to be adopted, have indicated that for both the dry and wet seasons, no exceedances of the WQO and the evaluation criterion are predicted to occur during the dredging operation. The impact assessment has also shown that other construction works, if properly controlled, are not expected to cause any unacceptable impacts to the surrounding waters and the sensitive receivers. Hence, the operational constraints and good site practice measures for dredging and construction run-off, presented in the following section, are recommended.

5.8.1 Marine Based Construction Activities

Dredging operations should be undertaken in such a manner as to minimse resuspension of sediments. Specific mitigation and standard good dredging practice measures should therefore be implemented including the following requirements which should be written into the dredging contract. These measures are also summarised in *Section 10.2*.

- Silt curtains should be deployed around the closed grab dredger to contain suspended solids within the construction site during dredging;

- A daily dredging rate of a closed grab dredger (with a minimum grab size of 8 m^3) should be less than 5,200 m^3 day^{-1}, with reference to the maximum rate for dredging, which was derived in the EIA;

- Mechanical grabs should be designed and maintained to avoid spillage and should seal tightly while being lifted;

- Barges or hoppers should have tight fitting seals to their bottom openings to prevent leakage of material;

- Loading of barges or hoppers shall be controlled to prevent splashing of dredged material to the surrounding water;

- Barges or hoppers should not be filled to a level which will cause overflow of materials or pollution of water during loading or transportation;

- Excess material should be cleaned from the decks and exposed fittings of barges or hoppers before the vessel is moved;

- Adequate freeboard should be maintained on barges to reduce the likelihood of decks being washed by wave action;

- All vessels should be sized such that adequate clearance is maintained between vessels and the seabed at all states of the tide to ensure that undue turbidity is not generated by turbulence from vessel movement or propeller wash; and

- The works should not cause foam, oil, grease, litter or other objectionable matter to be present in the water within and adjacent to the works site;

5.8.2 Land Based Construction Activities

Appropriate on-site measures are defined to reduce potential impacts, which will be sufficient to prevent adverse impacts to water quality from land based construction activities. These measures are appropriate for general land based construction activities. All effluent discharge from the construction phase will be subject to control under the *WPCO*.

Construction Run-off

- At the start of site establishment, perimeter cut-off drains to direct off-site water around the site should be constructed and internal drainage works and erosion and sedimentation control facilities implemented. Channels, earth bunds or sand bag barriers should be provided on site to direct stormwater to silt removal facilities. The design of efficient silt removal facilities should be based on the guidelines in *Appendix A1* of *ProPECC PN 1/94.*

- All the surface runoff or extracted ground water contaminated by silt and suspended solids should be collected by the on-site drainage system and diverted through the silt traps prior to discharge into storm drain.

- All exposed earth areas should be completed as soon as possible after earthworks have been completed, or alternatively, within 14 days of the cessation of earthworks, where practicable. If excavation of soil cannot be avoided during the rainy season, or at any time of year when rainstorms are likely, exposed slope surfaces should be covered by tarpaulin or by other means.

- All drainage facilities and erosion and sediment control structures should be regularly inspected and maintained to ensure proper and efficient operation at all times and particularly following rainstorms. Deposited silt and grit should be removed regularly and disposed of by spreading evenly over stable, vegetated areas.

- Measures should be taken to reduce the ingress of site drainage into excavations. If the excavation of trenches in wet periods is necessary, they should be dug and backfilled in short sections wherever practicable. Water pumped out from trenches or foundation excavations should be discharged into storm drains via silt removal facilities.

- Open stockpiles of construction materials (for example, aggregates, sand and fill material) of more than 50 m^3 should be covered with tarpaulin or similar fabric during rainstorms. Measures should be taken to prevent the washing away of construction materials, soil, silt or debris into any drainage system.

- Manholes (including newly constructed ones) should always be adequately covered and temporarily sealed so as to prevent silt, construction materials or debris being washed into the drainage system.

- Precautions to be taken at any time of year when rainstorms are likely, actions to be taken when a rainstorm is imminent or forecasted, and actions to be taken during or after rainstorms are summarised in *Appendix A2* of *ProPECC PN 1/94*. Particular attention should be paid to the control of silty surface runoff during storm events, especially for areas located near steep slopes.

- Oil interceptors should be provided in the drainage system and regularly emptied to prevent the release of oil and grease into the storm water drainage system after accidental spillages. The interceptor should have a bypass to prevent flushing during periods of heavy rain.

- All temporary and permanent drainage pipes and culverts provided to facilitate runoff discharge should be adequately designed for the controlled release of storm flows. All sediment traps should be regularly cleaned and maintained. The temporary diverted drainage should be reinstated to the original condition when the construction work has finished or the temporary diversion is no longer required.

Wastewater from Site Facilities

- Sewage from toilets should be collected by a licensed waste collector.

- Vehicle and plant servicing areas, vehicle wash bays and lubrication bays should, as far as possible, be located within roofed areas. The drainage in these covered areas should be connected to foul sewers via a petrol interceptor.

- Oil leakage or spillage should be contained and cleaned up immediately. Waste oil should be collected and stored for recycling or disposal, in accordance with the *Waste Disposal Ordinance*.

Storage and Handling of Oil, Other Petroleum Products and Chemicals

- Waste streams classifiable as chemical wastes should be properly stored, collected and treated for compliance with *Waste Disposal Ordinance* or *Disposal (Chemical Waste) (General) Regulation* requirements.

- All fuel tanks and chemical storage areas should be provided with locks and be sited on paved areas.

- The storage areas should be surrounded by bunds with a capacity equal to 110% of the storage capacity of the largest tank to prevent spilled oil, fuel and chemicals from reaching the receiving waters.

- The Contractors should prepare guidelines and procedures for immediate clean-up actions following any spillages of oil, fuel or chemicals.

- Surface run-off from bunded areas should pass through oil/grease traps prior to discharge to the stormwater system.

5.9 OPERATIONAL PHASE WATER QUALITY MITIGATION MEASURES

5.9.1 Hydrodynamics

The marine works and structures are expected to have minimal effects on hydrodynamics and water quality. Mitigation measures are not considered to be necessary.

5.9.2 Limestone FGD Absorber Effluent

The high degree of mixing inherent in the coastal margin will result in rapid dilution of the effluent to non-significant concentrations, and therefore mitigation measures are considered unnecessary.

5.9.3 Storage and Handling of Oil, Other Petroleum Products and Chemicals

- Waste streams classifiable as chemical wastes should be properly stored, collected and treated for compliance with the requirements under the *Waste Disposal Ordinance* or *Waste Disposal (Chemical Waste) (General) Regulation*.

- All fuel tanks and chemical storage areas should be provided with locks and be sited on paved areas.

- The storage areas should be surrounded by bunds with a capacity equal to 110% of the storage capacity of the largest tank to prevent spilled oil, fuel and chemicals from reaching the receiving waters.

- The Contractors should prepare guidelines and procedures for immediate clean-up actions following any spillages of oil, fuel or chemicals.

- Surface run-off from bunded areas should pass through oil/grease traps prior to discharge to the stormwater system.

5.10 ENVIRONMENTAL MONITORING AND AUDIT (EM&A)

5.10.1 Construction Phase

Although no unacceptable impacts have been predicted to occur during the operation of dredging works and other associated construction works, monitoring of marine water quality during the construction phase is considered necessary to evaluate whether any impacts would be posed by the dredging operations on the surrounding waters during the construction period of the dredging works. The details of the EM&A programme are presented in *Section 10*.

5.10.2 Operational Phase

As no unacceptable impacts have been predicted to occur during the operation of the CPB following the installation of additional emissions control facilities, monitoring of marine water quality during the operational phase is not considered necessary.

5.11 RESIDUAL ENVIRONMENTAL IMPACTS

No unacceptable impacts have been predicted to occur during the construction phase. Given that impacts to water quality have predicted to be transient and no unacceptable impacts expected to occur, residual environmental impacts during the operational phase are not expected.

5.12 CUMULATIVE IMPACTS

At present the only committed project that could have cumulative impacts with the construction of the additional berthing facility is the construction of the Permanent Aviation Fuel Facility (PAFF) for the Airport Authority at Castle Peak which is more than 1.5 km away.

By reviewing the EIA study for PAFF (1), unacceptable water quality impacts due to the construction works of both projects are not expected. In case any concurrent construction works exist, the cumulative impacts from these two projects are thus expected to be minimal. Referring to the PAFF EIA study, the edge of the mixing zone of the SS elevations caused by the dredging works would not be farther than 500 m away from where the dredger locates. In this Study, the predicted plume of 10 mg L^{-1} of maximum depth averaged SS will maximally reach at a point approximately 500m away from the Study

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(1) Mouchel (2002). EIA for Permanent Aviation Fuel Facility. For Hong Kong Airport Authority.

dredging area or approximately 1.1 km away from the PAFF dredging area. Thus, the sediment plumes (< 10 mg L^{-1}) from the two projects are unlikely to overlap each other. It is expected that the construction impacts, if any, due to the dredging works of this Project would be mitigated by implementing the mitigation measures such as deployment of a silt curtain around the grab dredger.

It is noted that there may be a possibility for an overlap of construction schedule between the Project and the potential construction of an Liquefied Natural Gas terminal at South Soko and the associated submarine natural gas pipeline to the Black Point Power Station. Due to the remote distance (greater than 4 km) between these two project works areas, as well as the low severity of water quality impacts as assessed in this Study, cumulative impacts are not likely to occur.

The above-mentioned Liquefied Natural Gas (LNG) terminal project has not been confirmed at the time of the compilation of this Report and therefore appropriate measures should be implemented to avoid cumulative impacts such as the proper scheduling of the Project-related marine works to prevent them from overlapping with those for the LNG project.

5.13 SUMMARY AND CONCLUSION

5.13.1 Construction Phase

The water quality modelling works, with the assumption of no mitigation measures to be adopted, have indicated that for both the dry and wet seasons, no exceedances of the WQO and the evaluation criterion are predicted to occur during the dredging operations. The impact assessment has also shown that other land-based construction works, if properly controlled, are not expected to cause any adverse impacts to the surrounding waters and the sensitive receivers.

5.13.2 Operational Phase

No effluent is anticipated from the operation of the SCR system and water quality impact is not expected.

In the LS-FGD process, the gypsum slurry from the absorber unit is treated, resulting in dewatered gypsum and a small quantity of liquid effluent. The resulting effluent may have a small chemical oxygen demand and/or reduced dissolved oxygen concentrations.

The effluent will be treated to comply with the discharge standards stipulated in the *Technical Memorandum on Standards for Effluents Discharged Into Drainage And Sewerage Systems, Inland And Coastal Waters* issued under the *Water Pollution Control Ordinance*. It will then be added to the cooling water flows and discharged via the existing sub-marine cooling water outfall of CPB, resulting in a small increase in the total flows from the outfall. The treated FGD effluent would not be expected to have any adverse effect on the temperature of the cooling water or on the quantities of residual chlorine in the discharge. The high degree of mixing inherent in the coastal margin or coastal zone will result in rapid dilution of the effluent to very low concentrations and no unacceptable water quality impact are predicted. The discharge standards should comply with the WPCO TM and will subject to refinement at WPCO licensing stage.. As a result, further mitigation measures are considered unnecessary.

6 WASTE MANAGEMENT

6.1 INTRODUCTION

The Project involves the demolition of existing facilities and retrofitting of emissions control facilities to four existing 677MW generating units of CPB. This section identifies the potential wastes arising from the Project and assesses the potential environmental impacts associated with waste handling and disposal. The main issues are:

- disposal of dredged sediments;
- handling and treatment of contaminated soil;
- disposal of construction and demolition (C&D) materials (1) arising from the demolition, excavation and construction works; and
- management of by-products produced from the FGD process.

Opportunities for waste minimisation, recycling, storage, collection, transport and disposal have been examined and procedures for waste reduction and management have been proposed.

6.2 LEGISLATIVE REQUIREMENTS AND EVALUATION CRITERIA

The following discussion on legislative requirements and evaluation criteria applies to both the construction and operational phases of the Project.

The criteria and guidelines for evaluating potential waste management implications are laid out in *Annexes 7* and *15* of the *EIAO-TM* under the *EIAO*.

The following legislation covers, or has some bearing upon, the handling, treatment and disposal of wastes in Hong Kong, and will also be considered in the assessment.

- *Waste Disposal Ordinance* (*Cap 354*);
- *Waste Disposal (Chemical Waste) (General) Regulation* (*Cap 354C*);
- *Land (Miscellaneous Provisions) Ordinance* (*Cap 28*);

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(1) "C&D materials" refers to materials arising from any land excavation or formation, civil/building construction, road works, building renovation or demolition activities. It includes various types of reusable materials, building debris, rubble, earth, concrete, timber and mixed site clearance materials. When sorted properly, materials suitable for land reclamation and site formation (known as public fill) should be reused at a public filling area or other land formation/reclamation projects. The rock and concrete can be crushed and processed to produce rock fill or aggregate for various civil and building engineering applications. The remaining construction waste (comprising timer, paper, plastics and general refuse) are to be disposed of at landfills.

- *Public Health and Municipal Services Ordinance* (*Cap 132*) - *Public Cleansing and Prevention of Nuisances Regulation*; and

- *Dumping at Sea Ordinance* (*Cap 466*).

6.2.1 Waste Disposal Ordinance (Cap 354)

The *Waste Disposal Ordinance* (WDO) prohibits the unauthorised disposal of wastes, with waste defined as any substance or article, which is abandoned. Under the *WDO*, wastes can only be disposed of at a licensed site. A breach of these regulations can lead to the imposition of a fine and/or a prison sentence. The *WDO* also provides for the issuing of licences for the collection and transport of wastes. Licences are not, however, currently issued for the collection and transport of construction waste or trade waste.

The *Waste Disposal (Charges for Disposal of Construction Waste) Regulation* defined construction waste as any substance, matters or things that is generated from construction work and abandoned, whether or not it has been processed or stockpiled before being abandoned, but does not include any sludge, screening or matter removed in or generated from any desludging, desilting or dredging works.

The *Construction Waste Disposal Charging Scheme* entered into operation on 1 December 2005. Starting from 1 December 2005, the main contractor who undertakes construction work under a contract with value of $1 million or above is required to open a billing account solely for the contract. Application should be made within 21 days after the contract is awarded.

For construction work under a contract with value less than $1 million, such as minor construction or renovation work, any person such as the owner of the premises where the construction work takes place or his/her contractor can open a billing account; the account can also be used for contracts each with value less than $1 million. The premises owner concerned may also engage a contractor with a valid billing account to make arrangement for disposal of construction waste.

Under the new construction waste charging scheme, charging for disposal of construction waste started on 20 January 2006 and therefore will apply to this Project.

Depending on the percentage of inert materials in the construction waste, construction waste can be disposed at public fill, sorting facilities, landfills and outlying islands transfer facilities where different disposal cost would be applied. The scheme encourages reducing, reusing and sorting of construction waste such that the waste producer can minimise their disposal fee. *Table 6.1* presents a summary of the government construction waste disposal facilities, types of waste accepted and disposal cost.

Table 6.1 Government Waste Disposal Facilities for Construction Waste

Government Waste Disposal Facilities	Type of Construction Waste Accepted	Charge Per Tonne
Public fill reception facilities	Consisting entirely of inert construction waste	$27
Sorting facilities	Containing more than 50% by weight of inert construction waste	$100
Landfills	Containing not more than 50% by weight of inert construction waste	$125
Outlying Islands Transfer Facilities	Containing any percentage of inert construction waste	$125

6.2.2 Waste Disposal (Chemical Waste) (General) Regulation (Cap 354C)

Chemical waste as defined under the *Waste Disposal (Chemical Waste) (General) Regulation* includes any substance being scrap material, or unwanted substances specified under *Schedule 1* of the *Regulation*, if such a substance or chemical occurs in such a form, quantity or concentration so as to cause pollution or constitute a danger to health or risk of pollution to the environment.

A person should not produce, or cause to be produced, chemical wastes unless he is registered with the EPD. Producers of chemical wastes must treat their wastes, utilising on-site plant licensed by the EPD or have a licensed collector take the wastes to a licensed facility. For each consignment of wastes, the waste producer, collector and disposer of the wastes must sign all relevant parts of a computerised trip ticket. The system is designed to allow the transfer of wastes to be traced from cradle-to-grave.

The *Regulation* prescribes the storage facilities to be provided on site including labelling and warning signs. To minimise the risks of pollution and danger to human health or life, the waste producer is required to prepare and make available written procedures to be observed in the case of emergencies due to spillage, leakage or accidents arising from the storage of chemical wastes as well as provide employees with training in such procedures.

6.2.3 Land (Miscellaneous Provisions) Ordinance (Cap 28)

The inert portion of C&D materials (also called public fill) may be taken to public filling facilities. Public filling areas usually form part of land reclamation schemes and are operated by the Civil Engineering and Development Department (CEDD) and others. The *Land (Miscellaneous Provisions) Ordinance* requires that individuals or companies who deliver public fill to the public filling facilities obtain Dumping Licences from the CEDD.

Under the licence conditions, public filling areas will accept only inert building debris, soil, rock and broken concrete. There is no size limit on rock and broken concrete, and a small amount of timber mixed with inert material is permissible. The material should, however, be free from marine mud, household refuse, plastic, metal, industrial and chemical wastes, animal and vegetable matter and any other materials considered unsuitable by the public filling supervisor.

6.2.4 Public Health and Municipal Services Ordinance (Cap 132) - Public Cleansing and Prevention of Nuisances Regulation

This *Regulation* provides a further control on the illegal dumping of wastes on unauthorised (unlicensed) sites. The illegal dumping of wastes can lead to a fine and imprisonment.

6.2.5 Dumping at Sea Ordinance (Cap 466)

This *Ordinance* came into operation in April 1995 and empowers the Director of Environmental Protection to control the disposal and incineration of substances and articles at sea for the protection of the marine environment. Under the *Ordinance*, a permit from the Director of Environmental Protection is required for the disposal of regulated substances within and outside the waters of the Hong Kong SAR. The permit contains terms and conditions that includes the following specifications:

- Type and quantity of substances to be dumped;
- Location of the disposal grounds;
- Requirements of equipment for monitoring the disposal operations; and
- The need for environmental monitoring.

Management of Dredged/Excavated Sediments for Marine Disposal

Marine disposal of any dredged / excavated sediment is subject to control under the *Dumping at Sea Ordinance 1995.* The *Ordinance* has replaced the *Dumping at Sea Act 1974 (Overseas Territories) Order 1975 (App. III p. DK1)* in its application in Hong Kong SAR. In addition, dredged / excavated sediment destined for marine disposal is classified based on its contaminant levels with reference to the *Chemical Exceedance Levels* (CEL), as stipulated in *ETWBTC No. 34/2002: Management of Dredged/Excavated Sediment*. This Technical Circular includes a set of sediment quality criteria, as presented in *Table 6.2*, which includes heavy metals and metalloids, organic pollutants and a class of contamination level for highly contaminated sediment not suitable for marine disposal.

Table 6.2 *Dredged/Excavated Sediment Quality Criteria for the Classification under the ETWBTC No 34/2002*

Contaminants	**Lower Chemical Exceedance Level (LCEL)**	**Upper Chemical Exceedance Level (UCEL)**
Metals (mg kg^{-1} dry weight)		
Cd	1.5	4
Cr	80	160
Cu	65	110
Hg	0.5	1
Ni (a)	40	40
Pb	75	110
Silver (Ag)	1	2
Zinc (Zn)	200	270
Metalloid (mg kg^{-1} dry weight)		
Arsenic (As)	12	42
Organic-PAHs (μg kg^{-1} dry weight)		
Low Molecular Weight (LMW) PAHs	550	3,160
High Molecular Weight (HMW) PAHs	1,700	9,600
Organic-non-PAHs (μg kg^{-1} dry weight)		
Total PCBs	23	180
Organometallics (μgTBT l^{-1} in interstitial water)		
Tributyl-tin (a)	0.15	0.15

Note:

(a) The contaminant level is considered to have exceeded the UCEL if it is greater than the value shown.

In accordance with *ETWBTC 34/2002*, the sediment is classified into three categories based on its contamination levels:

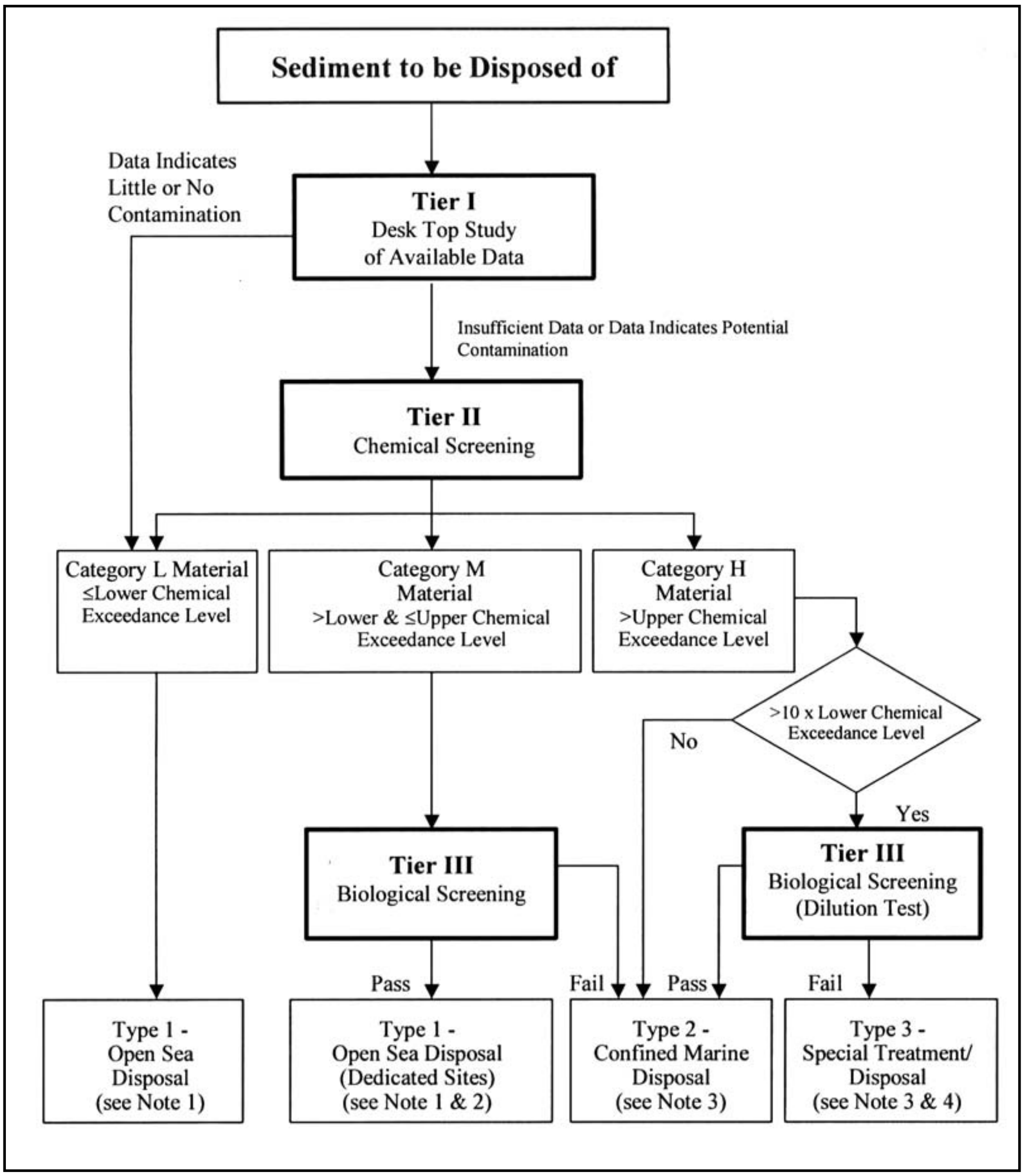
Category L : Sediment with all contaminant levels not exceeding the LCEL. The material must be dredged, transported and disposed of in a manner which minimises the loss of contaminants either into solution or by re-suspension.

Category M : Any one or more contaminants in the sediment exceed the - the LCEL and none exceeding the UCEL. The material must be dredged and transported with care, and must be effectively isolated from the environment upon final disposal unless appropriate biological tests demonstrate that the material will not adversely affect the marine environment.

Category H : Any one or more contaminants in the sediment exceed the exceeding the UCEL. The material must be dredged and transported with great care, and must be effectively isolated from the environment upon final disposal.

Figure 6.1 summarises the sediment classification and disposal arrangements. EPD will base on the sediment and biological test results to determine the most appropriate disposal site (eg open sea or confined marine disposal site).

Figure 6.1 ***Management Frameworks for Dredged/Excavated Sediment***



Notes:

(a) Most open sea disposal sites are multi-user facilities and as a consequence their management involves a flexibility to accommodate varying and unpredictable circumstances. Contract documents should include provisions to allow the same degree of flexibility should it be necessary to divert from one disposal site to another during the construction period of a contract.

(b) Dedicated Sites will be monitored to confirm that there is no adverse impact.

(c) For sediment requiring Type 2 or Type 3 disposal, contract documents should state the allocation conditions of Marine Fill Committee (MFC) and DEP. At present, East Sha Chau Mud Pits are designated for confined marine disposal.

(d) If any sediment suitable for Type 3 disposal (Category H sediment failing the biological dilution test) is identified, it is the responsibility of the project proponent, in consultation with DEP, to identify and agree with him / her, the most appropriate treatment and / or disposal arrangement. Such a proposal is likely to be very site and project specific and therefore cannot be prescribed. This will not preclude treatment of this sediment to render it suitable for confined marine disposal.

(e) The allocation of disposal space may carry a requirement for the project proponent to arrange for chemical analysis of the sediment sampled from 5% of the vessels en-route to the disposal site. For Category M and certain Category H sediment, the chemical tests will be augmented by biological tests. Vessel sampling will normally entail mixing five samples to form a composite sample from the vessel and undertaking laboratory tests on this composite sample. All marine disposal sites will be monitored under the general direction of the CEDD. However, exceptionally large allocations might require some additional disposal site monitoring. These will be stipulated at the time of allocation.

(f) Trailer suction hopper dredgers disposing of sediment at the East Sha Chau Mud Pits must use a down-a-pipe disposal method, the design of which must be approved in advance by Director of the CEDD. The dredging contractor must provide equipment for such disposal.

Source: Appendix C, ETWBTC 34/2002

6.2.6 *Other Relevant Guidelines*

Other 'guideline' documents, which detail how the works contractor should comply with the WDO and its associated regulations, are as follows:

- *Waste Disposal Plan for Hong Kong* (December 1989), Planning, Environment and Lands Branch Government Secretariat, Hong Kong Government;
- *Chapter 9 Environment (1999),* Hong Kong Planning Standards and Guidelines, Hong Kong Government;
- *New Disposal Arrangements for Construction Waste* (1992), EPD & CEDD, Hong Kong Government;
- *Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes* (1992), EPD, Hong Kong Government.
- *Works Branch Technical Circular (WBTC) No. 32/92, The Use of Tropical Hard Wood on Construction Site*; Works Branch, Hong Kong Government;
- *WBTC No. 2/93, Public Dumps.* Works Branch, Hong Kong Government;
- *WBTC No. 2/93B, Public Filling Facilities*, Works Branch, Hong Kong Government;
- *WBTC No. 16/96, Wet Soil in Public Dumps*; Works Branch, Hong Kong Government;
- *WBTC Nos. 4/98* and *4/98A, Use of Public Fill in Reclamation and Earth Filling Projects*; Works Bureau, Hong Kong SAR Government.
- *Waste Reduction Framework Plan, 1998 to 2007*, Planning, Environment and Lands Bureau, Government Secretariat, 5 November 1998;
- *WBTC Nos. 25/99, 25/99A* and *25/99C, Incorporation of Information on Construction and Demolition Material Management in Public Works Sub-committee Papers*; Works Bureau, Hong Kong SAR Government;
- *WBTC No. 12/2000, Fill Management*; Works Bureau, Hong Kong SAR Government;
- *WBTC No. 19/2001, Metallic Site Hoardings and Signboards;* Works Bureau, Hong Kong SAR Government;
- *WBTC Nos. 6/2002* and *6/2002A, Enhanced Specification for Site Cleanliness and Tidiness.* Works Bureau, Hong Kong SAR Government;

- *WBTC No. 11/2002, Control of Site Crusher.* Works Bureau, Hong Kong SAR Government;

- *WBTC No. 12/2002, Specification Facilitating the Use of Recycled Aggregates.* Works Bureau, Hong Kong SAR Government;

- *ETWBTC No. 33/2002, Management of Construction and Demolition Material Including Rock*; Environment, Transport and Works Bureau, Hong Kong SAR Government;

- *ETWBTC No. 34/2002, Management of Dredged/Excavated Sediment;* Environment, Transport and Works Bureau, Hong Kong SAR Government;

- *ETWBTC No. 31/2004, Trip Ticket System for Disposal of Construction & Demolition Materials*, Environment, Transport and Works Bureau, Hong Kong SAR Government; and

- *ETWBTC No. 19/2005, Environmental Management on Construction Sites;* Environment, Transport and Works Bureau, Hong Kong SAR Government.

6.3 EXPECTED WASTE SOURCES

6.3.1 Construction Phase

During the construction phase, the main activities, which will result in generation of waste, include demolition, site formation, dredging, filling and concreting.

The typical waste types associated with these activities include:

- Dredged marine sediment;
- Contaminated soil;
- C&D materials;
- Chemical waste;
- Sewage; and
- General refuse.

Proper waste management is important to prevent and mitigate potential environmental impacts.

6.3.2 Operational Phase

The following wastes are expected to be generated during the operational phase:

- Gypsum generated from FGD processes;
- Sludge from FGD wastewater treatment;
- Industrial waste; and
- General refuse.

6.4 ASSESSMENT METHODOLOGY

The potential environmental impacts associated with the handling and disposal of waste arising from the construction and operation of the Project are assessed in accordance with the criteria presented in *Annexes 7* and *15* of the *EIAO-TM*, which are summarised as follows:

- estimation of the types and quantities of the wastes to be generated;
- assessment of the secondary environmental impacts due to the management of waste with respect to potential hazards, air and odour emissions, noise, wastewater discharges and traffic; and
- assessment of the potential impacts on the capacity of waste collection, transfer and disposal facilities.

6.5 WASTE MANAGEMENT ASSESSMENT

6.5.1 Construction Phase

Dredged Marine Sediment

The existing Heavy Load Berth along the north-western waterfront of the Castle Peak Power Station will be extended to form a multi-purpose wharf and to provide the additional berthing facility required for future loading and unloading of the reagent and by-products of the new emission control system. Dredging will be required for the development of the additional berthing facility. The dredging works are expected to be carried out within about six weeks in early to mid 2007. The exact extent and boundary of the dredging works is still being streamlined but the total area required to be dredged is currently estimated to be approximately 30,000 m^2. Due to the small dredging area, one dredger is expected to be employed for the dredging works. The existing seabed level is about -6 mPD and the dredged level is expected to be up to a depth of –8.2 mPD with the estimated total dredged volume to be about 80,700 m^3. The proposed dredged area is shown in *Figure 2.3*.

Based on the existing sediment quality data published by EPD for the monitoring stations at Pillar Point and Urmston Road (NS3 and NS4), the sediment quality in the area is considered to be not contaminated. To confirm no contamination of the marine sediment, vibrocore samples of sediment were taken at three locations evenly distributed within the area to be dredged based on the total area expected to be dredged. The sampling locations are presented in *Figure 2.3*. Detailed sampling plan and sampling method are presented in Sediment Quality Plan (SQP) which has been submitted to EPD (*Annex D*).

The results of the chemical analyses of the marine sediment are presented in *Table 6.3*.

As shown in *Table 6.3,* all the results are below their respectively LCEL / reporting limit at all sampling locations and all sampling depths. The findings indicate that the marine sediment within the dredged area is likely to be uncontaminated but further sampling and testing in accordance with the detailed requirements of *ETWBTC No. 34/2002* will be required for the actual allocation of sediment disposal site and the application for a dumping permit under the *Dumping at Sea Ordinance (Cap 466)* prior to the commencement of the dredging activities. In the event that these further tests show the sediment to be uncontaminated, it would be suitable for disposal at open sea. Should the sediment be found to be contaminated, confined marine disposal would be appropriate. Based on a maximum daily dredging rate of about 5,200m^3, about 8 barge trips per day will be required, assuming a carrying capacity of about 700 m^3 per barge, for the disposal of the dredged sediment.

Table 6.3 Marine Sediment Testing Results

Sample Reference		**Heavy Metals (mg kg^{-1})**									**Total PCBs (µg/kg)**	**PAHs (Low MW) (µg/kg)**	**PAHs (High MW) (µg/kg)**	**TBT in Interstitial Water (µg/L)**
Drill-hole No.	**Depth below Existing Seabed (m)**	**Cadmium (Cd)**	**Chromium (Cr)**	**Copper (Cu)**	**Nickel (Ni)**	**Lead (Pb)**	**Zinc (Zn)**	**Mercury (Hg)**	**Arsenic (Ar)**	**Silver (Ag)**				
	From-To													
Reporting Limits		0.1	1	1	1	1	10	0.05	1	0.1	2	55	170	0.015
LCEL		**1.5**	**80**	**65**	**40**	**75**	**200**	**0.5**	**12**	**1**	**23**	**550**	**1700**	**0.15**
UCEL		**4**	**160**	**110**	**40**	**110**	**270**	**1**	**42**	**2**	**180**	**3160**	**9600**	**0.15**
V1	0.00-0.90	0.2	35	18	21	54	83	0.13	12	0.1	<2	330	1700	<0.015
V1	0.90-1.70	0.1	28	15	18	36	72	0.10	12	<0.1	<2	330	1700	<0.015
V2	0.20-0.90	0.2	35	63	22	55	110	<0.05	12	0.4	<2	330	1700	<0.015
V2	0.90-2.20	0.1	35	46	20	45	97	0.17	12	0.2	<2	330	1700	<0.015
V3	0.05-1.10	0.2	30	37	19	46	110	0.14	10	0.4	<2	330	1700	<0.015

Table 6.3 Marine Sediment Testing Results (Continue)

Sample Reference		**Chlorinated Pesticides (mg/kg)**												**Overall Sediment Classification** (a)	**Final Disposal** (b)
Drill-hole No.	**Depth below Existing Seabed (m) From-To**	**Alpha-BHC**	**Beta BHC**	**Gamma BHC**	**Delta-BHC**	**Heptachlor**	**Aldrin**	**Heptachlor epoxide**	**Endosulfan 1**	**p, p'-DDT**	**p, p'-DDD**	**p, p'-DDE**	**Endosulfan sulfate**		
Reporting Limits		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01		
V1	0.00-0.90	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	L	Type 1
V1	0.90-1.70	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	L	Type 1
V2	0.20-0.90	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	L	Type 1
V2	0.90-2.20	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	L	Type 1
V3	0.05-1.10	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	L	Type 1

Notes:

(a) "L' = little or no contamination (refer to *Section 6.2.5*).

(b) Type 1 Disposal = Disposal at open sea (refer to *Figure 6.1*).

Contaminated Soil

To accommodate the new development, demolition works are required to demolish or relocate a number of existing facilities including:

- CPB Fuel Oil Day Tank (FODT);
- Dangerous Goods (DG) Store to the south of the FOPH;
- Oil interceptor for FODT and APS Transformer Compound (West & East Ends);
- Pipe works in trenches connecting between FODT to FOTPH;
- Pipe works connecting with FOPH and oil interceptor;
- Intermediate pressure reduction station (IPRS), LPG compound and CO_2 storage tanks.

Potential leakage and/or spillage (if any) of oil from the operation of these facilities may cause land contamination to the underlying soil.

A *Contamination Assessment Plan* (CAP) has been prepared, submitted to and was approved by EPD in April 2006 (see *Annex E*). It reviewed the historical land uses and existing conditions of the site and recommended a site investigation programme to determine if the site is contaminated and if so, the types and degree of contamination. Site investigation was conducted at four trial pits and eight drillholes. Based on the finding of the site investigation, total petroleum hydrocarbon (TPH) was found at 0.9 m below ground level at TP3. However, since no contamination were found at the adjacent trail pits/boreholes, it is anticipated that the TPH contamination is localized at TP3. The estimated amount of potentially contaminated soil within the Project boundary is 50 m^3 (with a bulking factor of 1.2 applied to the *in-situ* volume). Details of the finding of the site investigation were reported in the Annex *E1 – Contamination Assessment Report (CAR).*

The excavated contaminated soil will be treated onsite using bioremediation method. The remediation actions involve excavation, testing, on-site treatment (i.e., biodegradation) and verification sampling and analysis. The treated soils will be reused within the Project as far as possible or disposed of at the public fill bank at Tuen Mun Area 38.

The *Remediation Action Plan* (RAP) in *Annex E* details the measures required.

C&D Materials

<u>Demolition Materials</u>

Facilities to be demolished to provide space for installing FGD plants in this Project have been discussed above.

The demolition and relocation works will take about 6.5 months and are scheduled to commence in the first half of 2007.

A total of about 835 tonnes of scrap metals will be produced from the demolition of FODT, LPG and CO_2 tanks, pumps and the associated fixtures / appendages such as pipeline, spiral stair and catwalk attached to the oil tanks. The steel sheet of the circular roof and sidewall will be cut into small panels in regular size for easy transportation. All the scrap steel will be transported off-site by barge / trucks for recycling.

A total of about 1,830 m^3 uncontaminated reinforced concrete (after applying a bulking factor of 1.4) will be generated from demolition of the retaining walls of FODT, DG stores, LPG switch room and vaporiser room and LPG tank foundation. These materials are not contaminated and will be separated from other wastes to avoid contamination. The reinforced concrete (public fill) can be reused on-site or sent to public filling area at Tuen Mun Area 38 and / or other reclamation site for reuse.

Excavated Materials

Excavation works would be required for the construction of the foundations to support the new facilities. A total of approximately 30,000 m^3 (with a bulking factor of 1.2 applied) of non-contaminated excavated materials (assumed to be mainly soft materials) will be generated from the excavation for the foundations of new facilities. The excavated soil will be temporarily stockpile onsite at the existing coal yard located to the north of the Stacker Reclaimer and is expected to be reused for the filling activities in this Project.

The portion of the existing coal yard to be used for the new FGD facilities (located south of existing ash sump and ACP Plant House) will need to be raised from the existing level of +5 to +6mPD to an approximate level of +7mPD. Public fill material will still need to be imported even after reusing the excavated materials generated from the Project and therefore no surplus excavated materials is expected from the Project.

C&D Materials Arising from New Building Construction

C&D materials consisting of packing materials, plastics, metal, concrete, wood etc will be generated from the new building construction. The main structures to be constructed at the site would be the CO_2 tank, LPG tank, IPRS, FGD and SCR equipment, limestone and gypsum storage facilities and urea storage area. The majority of these new facilities are steel structures and also pre-fabricated, and therefore the quantity of C&D materials generated is expected to be small. These materials should be sorted on-site in order to minimise the amount of construction waste to be disposed of at landfills and the cost for disposal of the C&D materials arising from the Project. Recyclables could be reused on site or sold to recyclers / recycling facilities. Construction waste will be disposed of at the refuse transfer station at North West New Territories or directly to the WENT landfill by trucks.

Chemical Wastes

Chemical waste, as defined under the *Waste Disposal (Chemical Waste) (General) Regulation*, includes any substance being scrap material, or unwanted substances specified under *Schedule 1* of the *Regulation*. A complete list of such substances is provided under the *Regulation*; however, substances likely to be generated from the construction of the SCR and FGD plants and the associated building will, for the most part, arise from the maintenance of construction plant and equipment. These may include, but need not be limited to the following:

- Scrap batteries or spent acid / alkali from their maintenance;
- Used paint, engine oils, hydraulic fluids and waste fuel;
- Contaminated oily water from the flushing and cleaning of the light oil tanks and the oil / water separation sump prior to their demolition;
- Spent mineral oils / cleaning fluids from mechanical machinery; and
- Spent solvents / solutions, some of which may be halogenated, from equipment cleaning activities.

Chemical wastes may pose environmental, health and safety hazards if not stored and disposed of in an appropriate manner as outlined in the *Waste Disposal (Chemical Waste) (General) Regulation* and the *Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes*. These hazards may include:

- Toxic effects to workers;
- Adverse effects on air, water and land from spills; and
- Fire hazards.

Oily water and oily sludge will be generated from the cleaning of the FODT and oil transfer pipelines to be demolished. The amount of chemical waste that will arise from other construction activities will be highly dependent on the Contractor's on-site maintenance activities and the quantity of plant and equipment utilised. With respect to the nature of construction works, the number of construction plant and equipment to be used on site, it is estimated that about a few hundred litres of used lubricant oil will be generated during the construction period. It is anticipated that the quantities of waste solvent and waste paint will be minimal.

With the incorporation of suitable arrangements for the storage, handling, transportation and disposal of chemical wastes under the requirements stated in the *Code of Practice on the Packaging, Labelling and Storage of Chemical Waste*, no adverse environmental and health impacts will result from the handling, transportation and disposal of chemical waste arising from the Project.

Sewage

Sewage will arise from the construction workforce and site office's sanitary facilities. These wastes should be managed properly to avoid any adverse water quality impact, odour and potential health risks to the workforce by attracting pests and other disease vectors.

It is estimated that about 900 construction workers will be working on site at the peak of the construction programme. With a sewage generation rate of 0.15 m^3 per worker per day, about 135 m^3 of sewage will be generated per day. It is expected that portable toilets will be provided for site workers and the existing sanitary facilities at the CPPS will not be used by any of the site workers. A licensed contractor should be employed to remove the sewage and dispose of it to sewage treatment works operated by Drainage Services Department. With the implementation of these waste management practices on-site, adverse environmental impacts are not expected.

General Refuse

The presence of a construction site with workers and associated site office will result in the generation of a variety of general refuse requiring disposal. General refuse will mainly consist of food waste, aluminium cans and waste paper.

The storage of general refuse has the potential to give rise to adverse environmental impacts. These include odour if the waste is not collected frequently (for example, daily), windblown litter, water quality impacts if waste enters water bodies, and visual impact. The site may also attract pests, vermin, and other disease vectors if the waste storage areas are not well maintained and cleaned regularly. In addition, disposal of wastes at sites other than approved landfills, can also lead to similar adverse impacts at those sites.

During the peak of construction programme, about 900 construction workers will be worked on site at any one time and the amount of general refuse to be generated is expected be about 585 kg per day based on a general refuse generation rate of 0.65 kg per worker per day.

Recyclable materials (i.e. paper, plastic bottle and aluminium can) should be separated and disposed of at the recycling bins in order to minimise the amount of general refuse to be disposed of at landfills. General refuse generated from the construction workforce will be collected together with other general refuse generated from the existing CPB by contractor and subsequently sent to the refuse transfer station in North West New Territories or directly to WENT landfill for disposal. With respect to the small quantity of general refuse to be generated, it is anticipated that no additional traffic will be generated due to its disposal.

Provided that the mitigation measures recommended in *Section 6.6* are adopted, the environmental impacts caused by the storage, handling, transport and disposal of general refuse are expected to be minimal.

Summary

Table 6.4 summarised the waste arising during construction of the Project.

Table 6.4 Waste Arising During Construction Phase

Type	Estimated Quantity	Disposal / Treatment Site
Dredged Sediment	• 80,700 m^3 (likely to be uncontaminated)	• Disposal to open sea (if confirmed by further tests in accordance with *ETWBTC No. 34/2002* to be uncontaminated); or • confined marine disposal (if confirmed by further tests to be contaminated)
Contaminated Soil	• 50 m^3 (bulk)	On-site treatment (bioremediation) and the treated soil will be reused as fill materials with the Project or disposal of at public fill bank in Tuen Mun Area 38
Scrap Steel	• 835 tonnes	Off-site recycling
Public Fill	• 1,830 m^3 (uncontaminated concrete) • 30,000 m^3 (bulk) (excavated soil)	Reuse on-site for site formation and backfilling
Construction Waste	• minor	Refuse transfer station in North West New Territories or WENT Landfill
Chemical Waste	• fuel oil day tank and oil separator sump demolition. • Less than one hundred litres per month from all construction activities.	Chemical Waste Treatment Centre and/or other licensed lube oil recycling facility
Sewage	• 135 m^3/day (on average)	Provision of portable toilets and regular collection by contractor for off-site treatment
General Refuse	• 585 kg/day (on average)	Transported together with other general refuse generated from the existing CPPS to refuse transfer station in North West New Territories or WENT Landfill

6.5.2 Operational Phase

Gypsum Generated from FGD Processes

The limestone FGD processes will generate two principal types of by-product or waste. They are the gypsum and the sludge from treatment of the FGD wastewater.

Gypsum is a non-hazardous and non-toxic substance. It is produced in the form of fine, white, crystalline powder consisting predominantly of calcium sulphate. The quantity of gypsum generated will depend on a number of factors including the sulphur content of the fuel used and the operational profile of CPB.

Gypsum is a useful construction material in building industry and the demand for gypsum is high in both Hong Kong and Mainland China.

About 240,000 tonnes of commercial grade gypsum will be produced per year in addition to a small amount of lower grade gypsum at about 17,000 tonnes per year (i.e., 6.6% of the total gypsum generated).

Commercial Grade Gypsum : The commercial grade gypsum produced could be used for a number of purposes such as the production of plasterboard, cement, etc. CAPCO can liaise with the overseas limestone supplier to take back the gypsum generated from the limestone FGD system at CPB. Currently, the *Hongkong Electric Company* has entered into a buyback agreement with the overseas limestone supplier to take back the gypsum generated from the FGD process at the Lamma Power Station. It is likely that the buyback agreement could also be feasible for the limestone FGD system at CPB.

Another feasible way to reuse the gypsum is to sell to cement manufacturers in PRD and East-Asia region. The demand for gypsum from the cement and plasterboard sectors in Guangdong Province is likely to exceed the supply. Many multi-national cement manufacturers have acquired sizable cement production plants in the East-Asia region and their potential demand for gypsum is therefore well in excess of the level of supply by CAPCO. It is therefore likely that multi-national cement manufacturers could take all the FGD gypsum to be produced at CPB under a long-term arrangement to supply various cement plant around the region.

Barges will be employed to transport the commercial grade gypsum offsite. One to two barge trips per week are anticipated for gypsum transport.

Lower Grade Gypsum: A small amount of lower grade gypsum (about 17,000 tonnes per year or 6.6% of the total gypsum generated) will also be generated as a result of the FGD process. Despite its lower grade, the gypsum can still be reused for cement production. Similar to the case of commercial grade gypsum, CAPCO can liaise with the limestone supplier to take back also the lower grade gypsum. As a fallback option in the rare event of the lack of demand for lower grade gypsum, it can be disposed of at a designated area of the Tsang Tsui Ash Lagoons. The dewatered gypsum will be transported by trucks. Assuming 365 working days per year, 47 tonnes of lower grade gypsum (or about 20 m^3 of lower grade gypsum based on a density of 2.3 tonne per cubic metre) will be generated per day. Based on a carrying capacity of 7 m^3 for each truckload, about three additional truck trips will be generated per day from the Project on the Lung Kwu Tan Road and Nim Wan Road for the transportation of lower grade gypsum.

Sludge from FGD Wastewater Treatment

The dewatered gypsum cake will need to be washed with fresh water to remove the soluble chlorides to meet the specification for commercial grade gypsum. The wash water, containing excessive chlorides, will be treated in a chloride purge treatment system to remove the suspended solids and trace elements, to reduce the residual COD and to adjust the pH before it is discharging with the cooling water of the CPB to Urmston Road.

About 60 tonnes of sludge dry solids per day (or about 180 tonnes per day at 30% dry solids) will be generated from the chloride purge treatment system. The typical quality of the sludge is presented in *Table 6.5*.

Table 6.5 Typical Chemical Composition of Chloride Purge Treatment Sludge

Component	Content
Calcium sulphate	40%
Calcium sulphite	1%
Calcium carbonate	4%
Inerts	20%
Flyash	5%
Others (surplus sludge from biological treatment system)	30%

Design optimisation of the FGD wastewater treatment system has commenced. One of the key design optimisation objective is to minimise the influent throughput to the wastewater treatment system which would result in a lower quantity of sludge arising. This would help to reduce the amount of sludge requiring disposal. In addition, the feasibility of other disposal options such as off-take by the limestone supplier and gypsum off-taker to minimise the quantity of sludge to be disposed of at landfills would be further explored in the detailed design stage.

Industrial Waste

Most of the industrial waste generated from the maintenance of the limestone FGD system will be scrap metal, which can be recycled. It is therefore anticipated that no adverse environmental impacts will result from the handling and disposal of the industrial waste to be generated from the operation of the FGD system.

General Refuse

CAPCO will deploy the existing CPB staff to manage the new emission control system and it is not anticipated to have significant increase of number of staff. Hence, no additional general refuse will be generated from the workforce.

Summary

Table 6.6 summarises the waste arising during the operation of the Project.

Table 6.6 Waste Arising During Operational Phase

Type	**Estimated Quantity**	**Disposal / Treatment Site**
Gypsum	• Commercial grade gypsum : 240,000 tonnes per year • Lower grade gypsum : 17,000 tonnes per year	• Commercial grade gypsum : To be collected by the limestone supplier or sold to plasterboard and / or cement manufacturers • Lower grade gypsum : To be collected by the limestone supplier or sold to cement manufacturers. As a fall-back option, disposal at a designated area of Tsang Tsui Ash Lagoons may be considered
Sludge	• 60 tonnes dry solid per day or about 180 tonnes per day at 30% dry solids	• Minimising the influent throughput to the wastewater treatment system which would result in a lower quantity of sludge arising; • Feasibility of other disposal options to be further explored in detailed design stage
Industrial waste	• Few kg of scrap metal per month	• To be collected by recyclers / recycling facilities

6.6 MITIGATION MEASURES

There are no major waste management issues associated with the operation of the new emission control system. This section recommends the mitigation measures to avoid or minimize potential adverse environmental impacts associated with handling, collection and disposal of waste arising from the construction of the new emission control system.

It is the Contractor's responsibility to ensure that only licensed chemical waste collectors are used for collection and transportation of chemical waste to the licensed disposal facility and that appropriate measures are taken to minimize adverse environmental impacts, including windblown litter and dust from the transportation of wastes. In addition, the Contractor must ensure that all the necessary waste permits are obtained for the construction and operational phases.

6.6.1 Dredged Sediments

According to the requirements stipulated in *ETWBTC No. 34/2002*, the dredged sediment should be disposed of only at designated disposal sites allocated by the Marine Fill Committee (MFC) based on the findings of further sediment quality tests. A dumping licence should also be obtained from EPD prior to the commencement of the dredging works.

Regardless of the sediment disposal method and site, the Contractor should:

- Dredge the sediments using closed grabs;

- Use split barges of not less than 750 m^3 capacity when transporting the sediment to the disposal site;

- Regularly maintain the barge hoppers to ensure that they are capable of rapid opening and discharge at the designated disposal site; and

- Monitor the barge load against loss of materials during transportation.

6.6.2 Contaminated Soil

For excavated contaminated soil, mitigation measures recommended in the *RAP, Annex E* should be implemented.

6.6.3 Excavated Materials

Wherever practicable, excavated materials should be segregated from other wastes to avoid contamination thereby ensuring that it can be re-used onsite avoiding the need for disposal at landfills.

Management of Waste Disposal

Construction Waste Disposal Charging Scheme was launched on 1 December 2005 and the charging for disposal of construction waste was commenced on 20 January 2006.

The Contractor should open a billing account with EPD in accordance with the *Waste Disposal (Charges for Disposal of Construction Waste) Regulation* for the payment of disposal charges. Every waste load transferred to Government waste disposal facilities such as public fill, sorting facilities, landfills or transfer station would required a valid "chit" which contains the information of the account holder to facilitate waste transaction recording and billing to the waste producer. A trip-ticket system will be established in accordance with the *ETWBTC No. 31/2004* to monitor the reuse of surplus excavated materials offsite and disposal of C&D waste and general refuse at transfer station/landfills, and to control fly-tipping. The billing "chit" and trip-ticket system will be included as one of the contractual requirements and implemented by the contractor. CAPCO will also conduct regular audits of the waste management measures implemented on site as described in the Waste Management Plan.

A recording system (similar to summary table as shown in Annex 5 and Annex 6 of Appendix G of *ETWBTC No. 19/2005*) for the amount of waste generated, recycled and disposed of (including the disposal sites) should be established during the construction stage.

Measures for the Reduction of C&DM Generation during Planning and Design Stages

The various waste management options can be categorized in terms of preference from an environmental viewpoint. The options considered to be more preferable have the least impacts and are more sustainable in the long term. Hence, the waste management hierarchy is as follows:

- Avoidance and minimization, that is, reduction of waste generation through changing or improving practices and design;
- Reuse of materials, thus avoiding disposal (generally with only limited reprocessing);
- Recovery and recycling, thus avoiding disposal (although reprocessing may be required); and
- Treatment and disposal, according to relevant law, regulations, guidelines and good practice.

This hierarchy should be used to evaluate the waste management options, thus allowing maximum waste reduction and reduced disposal costs. Records of quantities of wastes generated, recycled and disposed (locations) shall be kept.

Measures for the Reduction of C&DM Generation during Construction

All C&D materials will be reused within the Project. Public fill and construction waste should be segregated and stored in different containers or skips to facilitate reuse or recycling of materials and their proper disposal of construction waste. Specific areas of the work site should be designated for such segregation and temporary storage if immediate use is not practicable.

The construction waste should be collected by Contractor and transported to landfills for disposal.

The use of wooden hoardings should not be allowed. An alternative material, which can be reused or recycled, for example, metal (aluminium, alloy, etc) should be used.

To reduce the potential dust impact, C&D materials should be wetted as quickly as possible during excavation works.

6.6.4 Chemical Waste

The Contractor should register as a chemical waste producer with the EPD. Chemical waste, as defined by *Schedule 1* of the *Waste Disposal (Chemical Waste) (General) Regulation*, should be handled in accordance with the *Code of Practice on the Packaging, Handling and Storage of Chemical Wastes* as follows:

Containers used for storage of chemical wastes should:

- be suitable for the substance they are holding, resistant to corrosion, maintained in a good condition, and securely closed;
- have a capacity of less than 450 L unless the specifications have been approved by the EPD; and

- display a label in English and Chinese in accordance with instructions prescribed in Schedule 2 of the *Regulations*.

The storage area for chemical wastes should:

- be clearly labelled and used solely for the storage of chemical waste;
- be enclosed on at least 3 sides;
- have an impermeable floor and bunding, of capacity to accommodate 110% of the volume of the largest container or 20% by volume of the chemical waste stored in that area, whichever is the greatest;
- have adequate ventilation;
- be covered to prevent rainfall entering (water collected within the bund must be tested and disposed of as chemical waste, if necessary); and
- be arranged so that incompatible materials are appropriately separated.

Disposal of chemical waste should be:

- via a licensed waste collector; and
- to a facility licensed to receive chemical waste, such as the Chemical Waste Treatment Centre which also offers a chemical waste collection service and can supply the necessary storage containers.

6.6.5 Sewage

The sewage sludge from the portable toilet should be collected by a reputable collector on a regular basic.

6.6.6 General Refuse

General refuse should be stored in enclosed bins or compaction units separately from construction and chemical wastes. General refuse should be removed from the site, separately from construction and chemical wastes, on a daily basis to minimise odour, pest and litter impacts. Burning of refuse on construction site is prohibited by law.

Aluminium cans are often recovered from the waste stream by individual collectors if they are segregated and made easily accessible. As such, separate, labelled bins for their deposit should be provided if feasible. Materials recovered will be re-used on site or sold for recycling.

6.6.7 Staff Training

Training will be provided to workers on the concepts of site cleanliness and on appropriate waste management procedures, including waste reduction, reuse and recycling at the beginning of the Contract.

6.7 RESIDUAL ENVIRONMENTAL IMPACTS

With the implementation of the recommended mitigation measures, no residual impacts are anticipated from the construction and operation of the Project.

6.8 ENVIRONMENTAL MONITORING AND AUDIT

6.8.1 Construction Phase

Joint site audits by the CAPCO and the contractor should be undertaken on a weekly basis. Particular attention should be given to the contractor's provision of sufficient spaces, adequacy of resources and facilities for on-site sorting and temporary storage of C&D materials. The C&D materials to be disposed of from the site should be visually inspected. The C&D waste to be disposed of at refuse transfer stations or landfills should contain no as practicable observable inert or reusable / recyclable C&D materials (e.g. soil, broken rock, metal, and paper / cardboard packaging, etc). Any irregularities observed during the weekly site audits should be raised promptly to the contractor for rectification.

6.8.2 Operational Phase

No adverse environmental impact will arise with the implementation of good waste management practices and therefore, no environmental monitoring and audit programme is required.

6.9 CONCLUSION

6.9.1 Construction Phase

The key potential impacts during the construction phase are related to management of dredged sediments, demolition materials, excavated materials and construction waste.

About 80,700 m^3 of marine sediment will be dredged in connection with the provision of the additional berthing facility. The final disposal site for the material will be determined by the MFC and a dumping licence will be obtained from EPD prior to the commencement of the dredging works with reference to the results of further tests to be undertaken in accordance with the detailed requirements of *ETWBTC No. 34/2002*.

An estimated total of 50 m^3 total petroleum hydrocarbon (TPH) contaminated soil will be excavated and the material should be remediated by using bioremediation method, as discussed in *Section 7* and the RAP in *Annex E*. The treated soil will be reused within the Project or disposed of at the public fill bank in Tuen Mun Area 38.

A total of about 835 tonnes of scrap steel will be produced during demolition of oil tanks and the associated fixtures/ appendages. All the scrap steel will be delivered off-site by barge/truck for recycling.

A total of about 30,000 m^3 of uncontaminated excavated soil will be generated from the demolition and construction works. All excavated soil will be reused for the backfilling on-site.

Small quantities of chemical wastes (less than 100 litres per month), sewage (a maximum of 135 m^3 per day) and general refuse (a maximum of 585 kg per day) will be generated during the construction phase.

With the implementation of the recommendations in *Section 6.6*, the potential environmental impacts arising from storage, handling, collection, transport and disposal of wastes should be able to meet the criteria specified in the *EIAO-TM*. No unacceptable waste management impact is anticipated.

6.9.2 Operational Phase

Commercial grade gypsum (about 240,000 tonnes per year) can be recycled in PRD and East-Asia regional market. Similarly the lower grade gypsum (about 17,000 tonnes per year) can also be reused for cement production. The sludge from FGD wastewater treatment (about 180 tonnes at 30% dry solids per day) will be generated. Design optimization of FGD wastewater system has been commenced and one of the key objectives is to minimize the influent throughput to the wastewater treatment system as a result in lowering the quantity of sludge arising. This would help to reduce the amount of sludge requiring disposal. Alternative disposal options such as off-take by the limestone supplier and gypsum off-taker and incineration of the sludge will be explored in the detailed design stage.

With the implementation of the recommended mitigation measures, the potential environmental impacts associated with the storage, handling, collection, transport and disposal of a small quantity of industrial waste and general refuse arising from the operation of the Project will meet the criteria specified in the *EIAO-TM* and no unacceptable waste management impact is anticipated.

7 LAND CONTAMINATION

7.1 INTRODUCTION

Demolition or relocation of a number of existing facilities will be required to accommodate the proposed emissions control facilities. These existing facilities include:

- the CPB Fuel Oil Day Tank (FODT) and associated pipe works connecting with fuel oil pump house (FOPH) and oil interceptor;
- the Dangerous Goods (DG) stores; and
- the Intermediate Pressure Reduction Station (IPRS), LPG compound and CO_2 storage tanks.

The existing facilities indicated above were identified as potential sources of contamination following a walkthrough of the Project Areas on 16 November 2005. A land contamination assessment was conducted in accordance with the requirements of the *Study Brief*. This section describes the land contamination assessment and makes reference to the Contamination Assessment Plan (CAP), Contamination Assessment Report (CAR) and Remediation Action Plan (RAP) that were prepared.

7.2 LEGISLATIVE REQUIREMENTS AND EVALUATION CRITERIA

The land contamination assessment was carried out following the methodology and procedures prescribed in the CAP, which made reference to the following documents published by EPD:

- *Practice Note for Professional Persons: Contaminated Land Assessment and Remediation* (*ProPECC PN 3/94*); and
- *Guidance Notes for Investigation and Remediation Contaminated Site of Petrol Filling Stations, Boatyard and Car Repair/Dismantling Workshops*.

The CAP was approved by the EPD in April 2006. A copy of the approved CAP is included in *Annex E*.

7.3 LAND CONTAMINATION ASSESSMENT

7.3.1 Site Investigation Programme

The land contamination assessment included soil and groundwater sampling, laboratory analyses for target parameters, preparation of the CAR and preparation of the RAP. A copy of the CAR and the RAP is provided in *Annex E*.

The Site Investigation (SI) for the land contamination assessment was conducted within the Project Areas and comprised the following:

- manual excavation and soil sampling at four trial pits (TP1 to TP4); and
- soil boring by rotary drilling and sampling at eight locations (DH1 to DH8).

The SI programme also incorporated a field and laboratory quality assurance/quality control (QA/QC) programme. A total of eight soil samples and eight groundwater samples (exclusive of QA/QC samples) were collected from the Project Areas for laboratory analysis of total petroleum hydrocarbons (TPHs), polycyclic aromatic hydrocarbons (PAHs), benzene, toluene, ethyl benzene and xylene (BTEX), volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs).

7.3.2 Site Investigation Results

The concentration of TPHs, including light diesel (C10-C14), heavy diesel (C15-C28) and heavy oil (C29-C36) fractions, in the soil sample collected at location TP3 and at 0.9 m below ground level (bgl) exceeded the Dutch "B" value but was below the Dutch "C" value. No TPH contamination was detected in the soil collected from other sampling locations and therefore the contamination observed at TP3 was considered to be localised.

TPH (light diesel, heavy diesel and heavy oil) contamination at above Dutch "B" and "C" levels has been reported in all the groundwater samples (DH1 to DH8). The TPH concentrations detected in the groundwater samples from DH1 and DH2 were primarily attributable to the light diesel and heavy diesel fractions. TPH concentrations at DH3 to DH8 were primarily attributable to the heavy diesel and heavy oil fractions. These TPH findings are all located on a well-established reclaimed area of CPB, which is far from sensitive use.

7.4 REMEDIAL MEASURES

Under the current engineering design, the level of the area in which TPH contamination in soil has been identified will need to be raised by filling to the same level as the surrounding ground and major excavation is not envisaged. Any excavated contaminated soil should be remediated in accordance with the EPD's *Guidance Notes for Investigation and Remediation of Contaminated Sites of Petrol Filling Stations Boatyards, and Car/Repair/Dismantling Workshops*. Details of the remediation measures and procedures for TPH soil contamination recommended for the Site are provided in the RAP.

As groundwater is not abstracted for either domestic or industrial use at the Site and in the adjacent areas and taking into consideration the absence of free-floating products, human exposure to the contaminated groundwater may only occur during the construction of foundations for the emissions control facilities, eg excavation for the construction of bored piles. If groundwater is encountered during the construction works and removal of groundwater from the work areas is required, the groundwater should be collected and recharged back to the underlying ground.

7.5 *SUMMARY AND CONCLUSION*

With the implementation of the remedial measures in the RAP, the hazards and environmental impacts associated with the potential land and groundwater contamination are considered to be low.

8 ECOLOGICAL ASSESSMENT

8.1 INTRODUCTION

This section of the EIA report presents the findings of the ecological impact assessment of the activities proposed for the Project as outlined in *Section 2.4* of this report.

The operations of the Project will be located within the existing site of the CPB with the exception of the construction and operation of an additional berthing facility to handle process reagents and by-products via marine transport. The existing Heavy Load Berth along the north-western waterfront of the Castle Peak Power Station will be extended to form a multi-purpose berth and to provide the additional berthing facility required. An area of approximately 30,000 m^2 to the west of the berth will be dredged to a depth of approximately –8.2 mPD to allow the safe approach and berthing of marine vessels up to 10,000 dwt.

The marine environment may however be affected by the marine works of the Project and will therefore be the main focus of this section. The chosen Study Area for this ecological assessment is the same as that adopted in the water quality assessment (*Figure 5.1* in *Section 5*). Sensitive marine habitats in the Study Area have been identified and the assessment of potential direct and indirect impacts associated with the construction and operation of the additional berthing facility discussed.

The area directly impacted by the construction and operation of the additional berthing facility will be referred to as the Project Area which delineates the permanent footprint of the Project and comprises the additional berthing facility and the dredged area (*Figure 2.2*).

8.2 EVALUATION CRITERIA AND LEGISLATIVE REQUIREMENTS

The main criteria for the evaluation of marine ecological impacts adopted for the present assessment are the ones laid out in the *Technical Memorandum on Environmental Impact Assessment Process under the Environmental Impact Assessment Ordinance (EIAO-TM). Annex 16* sets out the general approach and methodology for assessment of marine ecological impacts arising from a project or proposal. This approach allows a complete and objective identification, prediction and evaluation of the potential marine ecological impacts associated with the Project. *Annex 8* of the *EIAO-TM* recommends the criteria that can be used for evaluating marine ecological impacts.

Legislative requirements and other evaluation criteria relevant to the protection of species and habitats of marine ecological importance are listed and summarised below.

- *Marine Parks Ordinance* (*Cap 476*);
- *Wild Animals Protection Ordinance* (*Cap 170*);
- *Animals and Plants (Protection of Endangered Species) Ordinance* (*Cap 187*);
- *Town Planning Ordinance* (*Cap 131*);
- *Hong Kong Planning Standards and Guidelines Chapter 10* (*HKPSG*);
- *Technical Memorandum on Environmental Impact Assessment Process under the Environmental Impact Assessment Ordinance* (*EIAO-TM*);
- *United Nations Convention on Biodiversity* (1992);
- *Convention on Wetlands of International Importance Especially as Waterfowl Habitat* (the Ramsar Convention);
- *Wild Animal Protection Law* of the PRC;
- City University of Hong Kong (2001). Agreement No. CE 62/98, Consultancy Study on Fisheries and Marine Ecological Criteria for Impact Assessment, AFCD, Final Report July 2001.

8.2.2 Marine Parks Ordinance (Cap 476)

The *Marine Parks Ordinance (Cap 476)* provides for the designation, control and management of marine parks and marine reserves. It also stipulates the Director of Agriculture and Fisheries as the Country and Marine Parks Authority which is advised by the Country and Marine Parks Board. The Marine Parks and Marine Reserves Regulation was enacted in July 1996 to provide for the prohibition and control certain activities in marine parks or marine reserves.

8.2.3 Wild Animals Protection Ordinance (Cap 170)

Under the *Wild Animals Protection Ordinance (Cap 170)*, designated wild animals are protected from being hunted, whilst their nests and eggs are protected from destruction and removal. All birds and most mammals including all cetaceans are protected under this Ordinance, as well as certain reptiles (including all sea turtles), amphibians and invertebrates. The Second Schedule of the Ordinance that lists all the animals protected was last revised in June 1997.

8.2.4 Animals and Plants (Protection of Endangered Species) Ordinance (Cap 187)

The purpose of the *Animals and Plants (Protection of Endangered Species) Ordinance (Cap 187)* is to restrict the import and export of scheduled species. The Ordinance is primarily related to controlling trade in threatened and endangered species and restricting the local possession of them. Certain types of corals are listed in Schedule 1 and 2 of the Ordinance, including Blue coral (*Heliopora coerulea*), Organ pipe corals (family *Tubiporidae*), Black corals (order *Antipatharia*), Stony coral (order *Scleractinia*), Fire corals (family *Milleporidae*) and Lace corals (family *Stylasteridae*). The import, export and possession of scheduled corals, no matter dead or living, is restricted.

8.2.5 Town Planning Ordinance (Cap 131)

The recently amended *Town Planning Ordinance (Cap 131)* provides for the designation of areas such as “Coastal Protection Areas”, “Sites of Special Scientific Interest (SSSIs)”, “Green Belt” and "Conservation Area” to promote conservation or protection or protect significant habitat.

8.2.6 Hong Kong Planning Standards and Guidelines Chapter 10

Chapter 10 of the HKPSG covers planning considerations relevant to conservation. This chapter details the principles of conservation, the conservation of natural landscape and habitats, historic buildings, archaeological sites and other antiquities. It also addresses the issue of enforcement. The appendices list the legislation and administrative controls for conservation, other conservation related measures in Hong Kong, and Government departments involved in conservation.

8.2.7 Technical Memorandum on Environmental Impact Assessment Process under the Environmental Impact Assessment Ordinance

Annex 16 of the *EIAO-TM* sets out the general approach and methodology for assessment of ecological impacts arising from a project or proposal, to allow a complete and objective identification, prediction and evaluation of the potential ecological impacts. *Annex 8* recommends the criteria that can be used for evaluating ecological impacts.

8.2.8 United Nations Convention on Biological Diversity of 1992

The Peoples’ Republic of China (PRC) is a Contracting Party to the *United Nations Convention on Biological Diversity* of 1992. The Convention requires signatories to make active efforts to protect and manage their biodiversity resources. The HKSARG has stated that it will be “committed to meeting the environmental objectives” of the Convention (1).

8.2.9 Convention on Wetlands of International Importance Especially as Waterfowl Habitat (the Ramsar Convention)

The *Convention on Wetlands of International Importance Especially as Waterfowl Habitat* (the Ramsar Convention) applies to the HKSAR. The Convention requires parties to conserve and make wise use of wetland areas, particularly those supporting waterfowl populations. Article 1 of the Convention defines wetlands as ‘areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters.’ The Mai Po/Inner Deep Bay wetland was

(1) Planning Environment and Lands Bureaux 1996. Environmental Policy Commitments.

declared a Wetland of International Importance ("Ramsar site") under the Convention in 1995.

8.2.10 Wild Animal Protection Law of the PRC

The PRC in 1988 ratified the *Wild Animal Protection Law* of the PRC, which lays down basic principles for protecting wild animals. The Law prohibits killing of protected animals, controls hunting, and protects the habitats of wild animals, both protected and non-protected. The Law also provides for the creation of lists of animals protected at the state level, under Class I and Class II. There are 96 animal species in Class I and 156 in Class II. Class I provides a higher level of protection for animals considered to be more threatened.

8.2.11 City University of Hong Kong (2001). Agreement No. CE 62/98, Consultancy Study on Fisheries and Marine Ecological Criteria for Impact Assessment, AFCD, Final Report July 2001.

This study provides fisheries and marine ecological assessment criteria for eight key water quality parameters, including dissolved oxygen (DO) and suspended materials (SS) for use in impact assessments. The study involved measuring the biological effects of changes in water quality on five local species of great ecological significance, representing important nekton, benthos, zooplankton and phytoplankton in the marine environment of Hong Kong. These biological effects data together with overseas data were used to derive fisheries and marine ecological criteria for Hong Kong in terms of continuous and maximum concentration values. Application of these criteria protects local marine biota from the chronic effects as well as short-term acute effects of pollution.

8.3 EXISTING TERRESTRIAL ECOLOGICAL RESOURCES

The northwest New Territories have had a long history of human impact on the landscape. Despite the low population density, much of the area is an example of the ecological impacts which have arisen from deforestation and repeated hill fires on granitic slopes. The steep terrain of the Castle Peak Range has mainly grass cover due to exposure to strong wind, thin top soil and frequent erosion (1).

The proposed land-based works will be confined to within the existing industrial site (*Figure 8.1*). To the west of the existing industrial site, shrublands are found on the hills and plantations are found along the road. *Cratoxylum cochinchinense, Scolopia saeva* and *Litsea rotundifolia* are commonly recorded in the shrubland(2). Due to the thin soil profile and rocky substrate of the steep slope, the sub-storey growth of the shrubland is simple and poor (1).

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(1) ERL Asia Ltd (1992). Environmental Impact Assessment of the Proposed 6000MW Thermal Power Station at Black Point: Initial Assessment Report Volume 1 The Surrounding Environment.

(2) Atkins (2005). Castle Peak Cable Tunnel. Project Profile pPrepared for CLP Power and submitted for Applications for Permission to Apply Directly for an Environmental Permit.

Figure 8.1

Aerial Photograph of the Project Area

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Patches of plantation can also be recorded in the north of the industrial site. The plantation is simple in structure and the sub-storey and under-storey growth was found to be poor with little vegetative growth (1). The tree species recorded at the north of industrial site were dominated by exotic fast growing trees including *Acacia confusa, Leucaena leucocephala, Casuarina equisetifolia, Albizia lebbeck* and *Pinus elliottii*, and accompanied by a few native tree species such as *Ficus virens, Ficus microcarpus, Hibiscus tiliaceus, Macaranga tanarius, Bridelia tomentosa, Celtis chinensis* and *Sapium sebiferum* (1).

No natural habitats will be affected by the Project and no adverse impacts are foreseen on the surrounding natural terrestrial habitats, and therefore do not need to be addressed further in this EIA.

8.4 EXISTING MARINE ECOLOGICAL RESOURCES

8.4.1 Introduction

A review of relevant scientific literature, reports and EIA's has been conducted in order to assess the baseline ecological conditions of the Study Area including, but not limited to, the following:

- *New Airport Master Plan (Greiner-Maunsell, 1991);*
- *Proposed Aviation Fuel Receiving Facility at Sha Chau: Environmental Impact Assessment (ERM, 1995);*
- *Feasibility Study & Environmental Impact Assessment for Aviation Fuel Pipeline (Montgomery Watson, 1996);*
- *EIA Study for Disposal of Contaminated Mud in the East Sha Chau Marine Borrow Pit (ERM, 1997);*
- *Feasibility Study for Additional Cross-border Links Stage 2 (Mouchel, 1998);*
- *EIA for the Proposed Sand Extraction from The Brothers' Marine Borrow Area (Hyder Consulting, 1998);*
- *Population Biology of the Indo-Pacific Hump-backed Dolphin (Sousa chinensis Osbeck 1765) in Hong Kong Waters. AFCD-funded study conducted by Ocean Park Conservation Foundation (Jefferson, 1998; 2000a).*
- *Improvement to Castle Peak Road between Ka Loon Tsuen and Siu Lam (Maunsell 2002);*
- *EIA for Permanent Aviation Fuel Facility for Hong Kong International Airport (Mouchel 2002);*
- *EIA Study for Construction of Lung Kwu Chau Jetty (Maunsell 2002);*

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(1) ERM (2005). Tree Survey for Castle Peak Tunnel Project: Tree Survey Report. Report for CLP Power.

- *Environmental Monitoring and Audit for Contaminated Mud Pit IV at East of Sha Chau (ERM, 1999; Mouchel, 2001a; ERM 2006-ongoing);*

- *EA Study for Backfilling of Marine Borrow Pits at North of the Brothers (Mouchel, 2004);*

- *Detailed Site Selection Study for a Proposed Contaminated Mud Disposal Facility within the Airport East/East of Sha Chau Area. EIA and Final Site Selection Report (ERM 2005)*

- *Monitoring of Chinese White Dolphins (Sousa chinensis) in Hong Kong waters – Data Collection, Final Report (AFCD 2006).*

As mentioned in *Section 8.1*, no adverse impacts to the terrestrial ecology of the area are expected to occur as a result of the construction and operation activities of the Project as the works on land are confined to existing modified habitats. The baseline characterisation of the Study Area is therefore focused solely on the marine environment.

8.4.2 Baseline Ecological Conditions

Castle Peak Power Station is located in the north-western waters of the Hong Kong and falls within the North-Western Water Control Zone. The CPPS fronts the Urmston Road Channel and its marine waters are characterised by depths down to -22 mPD.

In terms of water quality, the Study Area experiences relatively dynamic estuarine-influenced conditions. The waters are a mixture of flows from Deep Bay which mainly come from the Pearl River Estuary and the Shenzhen River, and oceanic waters. The former two flows are freshwater and the latter is saline marine water, which mix together and result in wide variations of salinity with depth, location and time. During the wet season when river flows are at their highest, the surface salinity decreases to estuarine conditions, whereas, during the dry season, typical oceanic salinity prevails throughout the water column.

Within the Study Area, there is one site of recognised conservation interest. The Lung Kwu Chau and Sha Chau Marine Park was designated in November 1996 and covers an area of of approximately 1,200 ha (see *Figure 5.2*). It is one of four currently designated Marine Parks and one Marine Reserve in Hong Kong. The Marine Park encloses the Lung Kwu Chau, Tree Island and Sha Chau SSSI, which was designated for ornithological interest. The major function of the Marine Park is to assist the conservation of the Indo- Pacific Hump Back Dolphin. The Marine Park is located approximately 2.5 km to the west of the proposed additional berthing facility. For the purposes of the assessment, the Marine Park is identified as a Key Marine Ecological Sensitive Receiver of high ecological importance.

Based on the literature review the following habitats and/or organisms of ecological interest have been identified within the Study Area:

- Hard Bottom Habitats;
  - *Intertidal Hard Bottom Habitats*
  - *Subtidal Hard Bottom Habitats (Coral Community)*
- Soft Bottom Habitats;
  - *Subtidal Soft Bottom Habitats*
    - Epifaunal Assemblages
    - Infaunal Assemblages
- Horseshoe Crabs;
- Marine Mammals;
- Sha Chau and Lung Kwu Chau Marine Park.

8.4.3 Hard Bottom Habitats

Approximately 80% of Hong Kong's complex shorelines and many islands are composed of rocky outcrops. Shores in Hong Kong display characteristic zonation patterns, with a progression of different species along the vertical gradient from terrestrial to marine environments. For the purposes of this review, information will be presented on assemblages that occur along the full gradient from the essentially marine, subtidal area, to the semi-terrestrial, intertidal area. The hard bottom habitats within the Project Area are shown in *Figure 8.2*.

The zonation, composition and abundance of the species are strictly related to the morphology of the coastline and the type of rocky outcrop. In general terms biodiversity increases with the complexity of the coastal morphology and decreases with the simplification of the natural habitats.

Intertidal Hard Bottom Habitats

No recent intertidal surveys have been conducted on the shoreline at Castle Peak. A study in 2000 reported that the majority of intertidal species recorded in the northern part of Lung Kwu Tan Bay were common in Hong Kong and of generally low abundance and diversity (1). No species of conservation value were recorded.

Qualitative intertidal surveys have been conducted in June 2006. There were two types of coastal habitats, including natural rocky shore and artificial shoreline, recorded within the Study Area (*Figure 8.2)*. The littorinid snails, including *Nodilittorina radiata* and *Littoraria articulata*, were the dominant species in the high intertidal zone on the rocky shore and artificial shoreline. The snails *Monodonta labio, Nerita albicilla* and predatory dogwhelk *Thais clavigera* were recorded in the mid and low shore region. Sessile filter-

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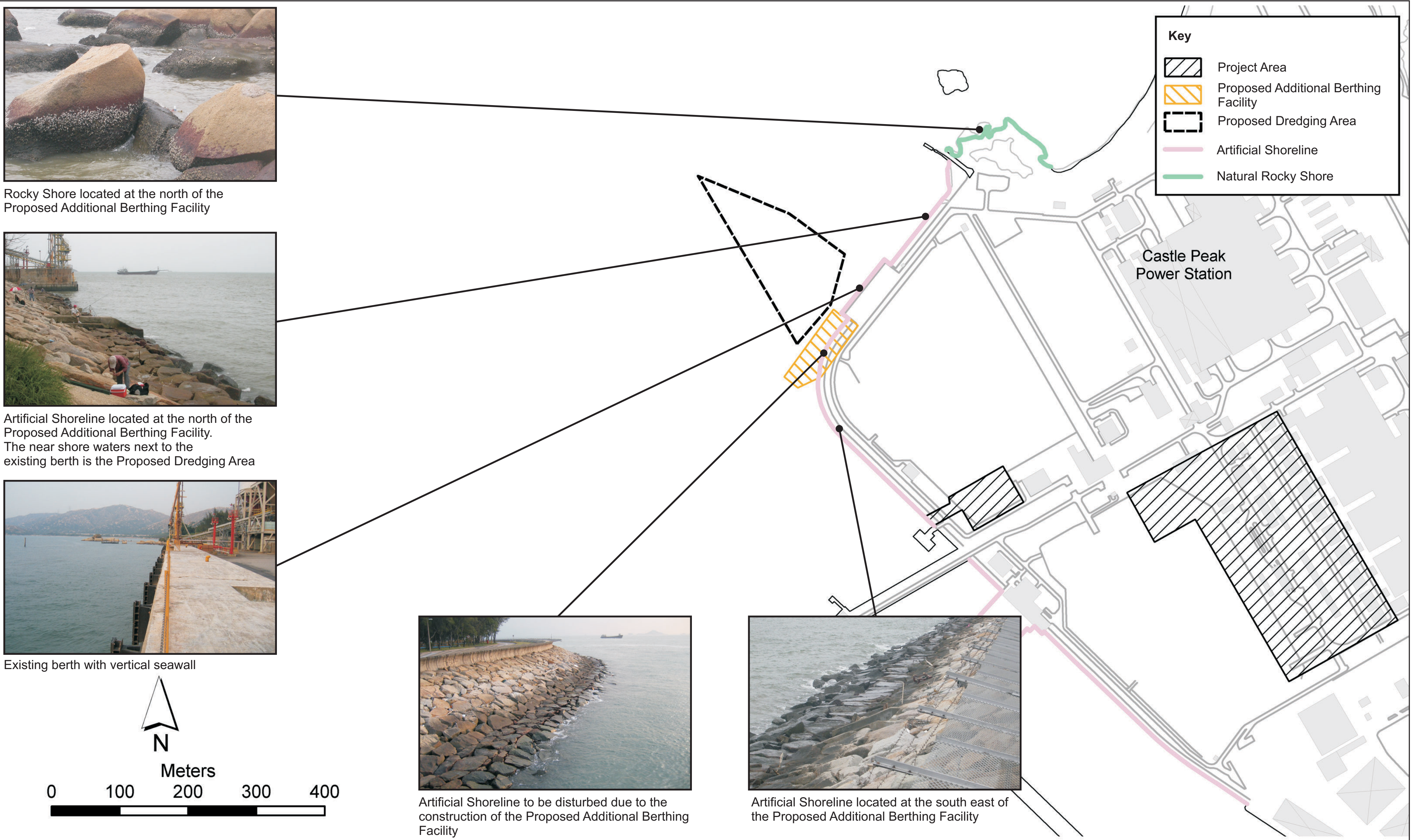
(1) ERM - HK Ltd. 2000. Sludge Treatment and Disposal Strategy: Site Specific Feasibility Study of Sludge Management Strategy (SMS) and Sludge Disposal Plan (SDS). Final Report for the Environmental Protection Department.



Rocky Shore located at the north of the Proposed Additional Berthing Facility

Artificial Shoreline located at the north of the Proposed Additional Berthing Facility.
The near shore waters next to the existing berth is the Proposed Dredging Area

Existing berth with vertical seawall

Artificial Shoreline to be disturbed due to the construction of the Proposed Additional Berthing Facility

Artificial Shoreline located at the south east of the Proposed Additional Berthing Facility

Figure 8.2

Existing Conditions of the Intertidal Habitats along the Coastlines of the Proposed Additional Berthing Facility

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feeding organisms such as the rock oyster (*Saccostrea cucullata*) and barnacles (*Tetraclita squamosa, Balanus amphitrite*) were also recorded on the shores. The faunal communities present on the artificial seashore and natural rocky shore were very similar. All of the species recorded are common and widespread in Hong Kong and occur in low abundance on the surveyed shore in the Study Area.

Biological diversity within the intertidal hard bottom habitat of the Study Area is not, therefore, considered to be high. The artificial nature of long sections of the shoreline within the Project Area further reduces the ecological value of the intertidal hard bottom habitats.

Subtidal Hard Bottom Habitats - Coral

The Agriculture, Fisheries and Conservation Department reports that there are over 80 species of corals recorded in Hong Kong waters (1). It appears that coral distribution in Hong Kong is primarily controlled by hydrodynamic conditions as Hong Kong's western waters are influenced by the Pearl River Estuary, which lowers salinities. The greatest diversity and abundances of corals are generally found in the northeastern waters of Hong Kong due to the optimal environmental conditions for settlement, growth and survival found in these waters. The western and southern waters of Hong Kong are influenced by the Pearl River Estuary, greatly reducing salinities, increasing turbidity and therefore reducing light penetration. Ahermatypic octocorals, including soft and black corals, which unlike the hermatypic hard corals do not require light for zooxanthellae photosynthesis, are more widely distributed and often occur at greater depths.

As part of a study for the EIA of the Aviation Fuel Receiving Facility at Sha Chau, dive surveys were undertaken in order to investigate the hard bottom communities (2). The surveys found that only a few hermatypic hard corals (Family Faviidae) were present within the subtidal of the survey area. Solitary corals have also been reported at Sham Tseng and Tsing Lung Tau adjacent to Castle Peak Road (3). Common blue coloured gorgonian short seawhip soft coral (*Euplexaura* sp.) was recorded attached to a shipwreck structure located at the east of Lung Kwu Chau (4).

The results of these surveys are deemed representative of the type and quality of the subtidal hard bottom habitats of the Study Area. As such, coral communities of ecological value are not predicted to occur within the Study Area. Whilst it is possible that solitary gorgonians and sea pens may be present within the subtidal areas, large or important communities of

(1) AFCD. 2004. Ecological Status and Revised Species Records of Hong Kong's Scleractinian Corals, undertaken by Marine Conservation Division.

(2) ERM – HK Ltd. 1995. Environmental Impact Assessment of the Proposed Aviation Fuel Receiving Facility at Sha Chau, prepared for the Provisional Airport Authority.

(3) Maunsell 2001. Marine Ecology Baseline Survey for Castle Peak Road Improvements between Area 2 and Ka Loon Tsuen Wan. Prepared for Highways Department..

(4) Maunsell 2002. Environmental Impact Assessment Study for Construction of Lung Kwu Chau Jetty, prepared for Civil Engineering Department..

hermatypic hard corals are not expected due to the unfavourable conditions imposed by the water quality.

Further to update the current conditions of the proposed additional berthing facility and dredging area, dive survey along the potentially affected artificial seashore and seismic survey within the potentially disturbed seabed were undertaken in January 2006.

The dive survey indicated that the visibility of the site was very poor and generally ranged between 0.1 m and 0.3 m and deteriorated with depth. The surface of the boulders was covered by a thick layer of sediments. Isolated gorgonians *Echinomuricea*, which are considered to be common in Hong Kong, were recorded in low abundance (the percentage cover estimates less than 5%) and all the colonies were small in size. The results of the seismic surveys showed that the seabed within the proposed dredging area is comprised of coarse sandy sediments and is highly disturbed with numerous anchor scars and trawl marks (1). No coral colonies (hard or soft coral) would be expected to occur within the proposed dredging area due to the high degree of disturbance by vessel activities.

Taking into consideration the limited ecological resources, high sediment loads and highly disturbed seabed, the proposed additional berthing facility site and dredging area are considered to be of low ecological concern.

8.4.4 Soft Bottom Habitats

Soft bottom habitats can be subdivided in intertidal and subtidal habitats. Intertidal soft bottom habitats in Hong Kong are primarily represented by mangroves, mudflats and seagrass. From a review of the existing literature it emerges that intertidal soft bottom habitats are not present within the Project Area and therefore do not need to be addressed further in this EIA. Conversely subtidal soft bottom habitats consisting of mud, clay and sand are the dominant seabed type of Hong Kong and will therefore be the focus of the following section.

Subtidal Soft Bottom Habitats

Soft bottom habitats support both infauna and epibenthic faunal marine communities, which in turn play a role as a food source for the majority of Hong Kong's inshore fisheries resources.

Epifaunal Assemblages

Subtidal soft bottom habitats, as well as supporting infaunal species, commonly support macro-benthic epifauna. These organisms are generally greater than 1mm in size and live either on or within the surface sediments.

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(1) EGS (Asia) Limited 2006. Proposed Heavy Load Berth Extension at Castle Peak Power Station: Hydrographic and Geophysical Surveys. Report for CLP Power.

A review of 10-years of data on fisheries resources collected from demersal trawls conducted as part of the ongoing marine monitoring of contaminated mud disposal at the East of Sha Chau Contaminated Mud Pits provides representative data on epifaunal assemblages of the Study Area (in the vicinity of the Lung Kwu Chau and Sha Chau Marine Park) (1). The data indicate that epifaunal assemblages are dominated by gastropods (e.g. *Turritella terebra*), crabs and mantis shrimps. Abundance and species composition is considered to be relatively low in comparison to other areas in Hong Kong (such as the eastern and southern Hong Kong waters) and no species of conservation value have been recorded.

Based on the above, the epifaunal assemblages of the Study Area are considered to be of low abundance, diversity and biomass in comparison to other areas of Hong Kong and , thus, have not been identified of conservation interest.

Infaunal Assemblages

Soft sediments consisting of silt, clay and sand dominate the seabed of Hong Kong. These soft bottom habitats support infaunal assemblages that act as a food source for Hong Kong's inshore commercial fisheries resources. Due to the general dominance of these habitats in Hong Kong's subtidal marine environment, extensive studies have been conducted on infaunal assemblages throughout Hong Kong. However, the majority of these studies have focussed on providing a "snapshot" of infaunal assemblages either within or in close proximity to a proposed area for development, or as part of a specific monitoring programme. In order to provide an indication of the potential ecological value of the infaunal assemblages at the Castle Peak location, it is considered useful to review studies that have investigated infaunal assemblages in Hong Kong on a wide scale. Where considered useful, studies of infaunal assemblages at specific locations have also been included in the review.

The waters around the proposed terminal site were surveyed as part of a Hong Kong wide study conducted in 1976 (2), however, the findings of this study are considered to be no longer applicable due to the extensive development in both Hong Kong and the Pearl River Estuary that has since occurred.

The most up-to-date study on soft bottom assemblages has revealed that the benthic communities in Hong Kong can be divided into the following broad types: a relatively similar benthic community covering the majority of Hong Kong waters; an impoverished community in the northeastern waters; a

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(1) ERM HK Ltd. 2004. Detailed Site Selection Study for a Proposed Contaminated Mud Disposal Facility within the Airport East/East of Sha Chau Area. Environmental Monitoring Data Review for Civil Engineering Department.

(2) Shin PKS, Thompson GB 1982. Spatial distribution of the infaunal benthos of Hong Kong. Marine Ecology Progress Series 10, 37-47.

coarser sediment benthic group in Victoria Harbour; and a distinct benthic group in Deep Bay (1).

The results of the 2001 study also indicated that the species diversity and abundance of the benthos adjacent to Castle Peak were low to moderate in comparison to other areas in Hong Kong.

A recent study in the Tuen Mun area found that the benthic infauna near Lung Kwu Tan, in the vicinity of Project Area, has a generally mid-range total biomass and relatively high total number of individuals in comparison to other areas of Hong Kong (2). The fauna was found to be primarily polychaetes, which is typical for Hong Kong. The species richness was high compared to other sites surveyed but overall the site was found to exhibit the same characteristics and ecological structure as other areas in the north Lantau and NWNT areas.

8.4.5 Horseshoe Crabs

Two species of Horseshoe Crabs (*Tachypleus tridentatus* and *Carcinoscorpius rotundicauda*) have been recorded in Hong Kong waters (3). In Hong Kong, the intertidal sand/sandy-mud flats at Shui Hau and San Tau, on Lantau Island, the mud flats at Pak Nai, in Deep Bay have recorded juveniles of both species, whereas, adult horseshoe crabs are occasionally fished from the subtidal mud along the northwest coast to the Lantau Island, including Tai O, Yi O, Sham Wat Wan, Sha Lo Wan and Tung Chung Bay. All of the horseshoe crab breeding grounds are located far away from the project site. The nearest breeding grounds were recorded at Lung Kwu Sheung Tan and Pak Nai, which are located more than 2km and 6km away respectively.

8.4.6 Marine Mammals

A total of 16 (and possibly up to 18) species of marine mammals, or cetaceans, have been recorded in Hong Kong waters (4). The Indo-Pacific Humpback Dolphin, *Sousa chinensis,* and the Finless Porpoise, *Neophocaena phocaenoides,* are the only two species of marine mammals regularly sighted in Hong Kong waters (5) (6).

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(1) City U Professional Services Ltd. 2002. Consultancy Study on Marine Benthic Communities in Hong Kong: Final Report, prepared for Agriculture, Fisheries and Conservation Department.

(2) ERM - HK Ltd. 2000. Sludge Treatment and Disposal Strategy: Site Specific Feasibility Study of Sludge Management Strategy (SMS) and Sludge Disposal Plan (SDS). Final Report for the Environmental Protection Department.

(3) Chiu HMC and Morton B. 2001. The Biology, Distribution and Status of Horseshoe Crabs, *Tachypleus tridentatus* and *Carcinoscopius rotundicauda* (Arthropoda: Chericerata): Recommendations for Conservation and Management. Final Report.

(4) Jefferson, pers comm.

(5) Parsons C, Mary L. Felly and Lindsay J. Porter. 1995. An Annotated Checklist of Cetaceans recorded from Hong Kong's Terrestrial Waters. The Swire Institute of Marine Science, The University of Hong Kong, Cape d' Aguilar, Shek O, Hong Kong.

(6) Jefferson T.A. 2000. Conservation Biology of the Finless Porpoise (*Neophocaena phocaenoides*) in Hong Kong waters: Final Report. Ocean Park Conservation Foundation Ocean Park Aberdeen, Hong Kong.

Studies on the distribution, abundance, habitat use, and life history of humpback dolphins within Hong Kong have been undertaken since 1995 (1) (2) (3). The results of these ongoing studies indicated in 2004 that approximately 1,300 individual dolphins are estimated to utilise the waters of the Pearl River Estuary. Of these individual dolphins, approximately 360 are thought to include waters within Hong Kong as part of their range.

Historically, marine mammal data have been presented in terms of sightings (4). Recent analysis adopted in the marine mammals monitoring study (5) (6) (7) has allowed data to be standardised to reflect numbers of sightings in terms of survey effort. Such data are considered to be closer to a direct indication of abundance and habitat usage than raw observational data. In order to utilise the most up-to-date data, yet still allow comparison with previous studies to be made, both types of data will be discussed.

Abundance of humpback dolphins in Hong Kong waters is highest in the north and west Lantau areas (*Figure 8.3*). North Lantau and West Lantau are considered to be the major habitats for humpback dolphins in Hong Kong waters where individuals of humpback dolphins have been consistently sighted throughout the year.

Humpback dolphins exhibit a seasonal shifting in abundance and density and thus a seasonal variation of abundance in different locations (*Figure 8.4*). The variation is thought to be due to the increased input of freshwater from the discharge of the Pearl River Estuary and the subsequent movements of estuarine prey species (8) (9) (10) .

Recently published information indicates that the abundance of dolphins in Hong Kong ranges from 78 in spring to 217 in winter (11). Similar to the previous studies, the encounter rate in 2005 was the highest in West Lantau (19.9 sighting per 100 km), which is 2.3 times higher than Northwest Lantau (8.8), 7.4 times higher than Northeast Lantau (2.7) and 12.4 times higher than

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(1) Jefferson T.A. 2000. Population Biology of the Indo-Pacific Humpback dolphin in Hong Kong waters. *Wildlife Monographs 144*:1-65.

(2) Jefferson T.A., S.K. Hung, L. Law, M. Torey and N. Tregenza.2002. Distribution and Abundance of Finless Porpoise in Hong Kong and Adjacent Waters of China. *The Raffles Bulletin of Zoology 2002 Supplement No. 10*: 43-55.

(3) Jefferson T.A. and S.K. Hung. 2004. A review of the status of the Indo-Pacific humpback dolphin in Chinese waters. *Aquatic Mammals (Special Issue) 30*: 149-158.

(4) AFCD. 2004. Monitoring of Chinese White Dolphins (*Sousa chinensis*) in Hong Kong waters – Data collection, Final Report (1 April 2003 to 31 March 2004), prepared by Hong Kong Cetacean Research Project

(5) AFCD. 2004. Monitoring of Chinese White Dolphins (*Sousa chinensis*) in Hong Kong waters – Data collection, Final Report (1 April 2003 to 31 March 2004), prepared by Hong Kong Cetacean Research Project

(6) AFCD. 2005. Monitoring of Chinese White Dolphins (*Sousa chinensis*) in Hong Kong waters – Data collection, Final Report (1 April 2004 to 31 March 2005), prepared by Hong Kong Cetacean Research Project

(7) AFCD. 2006. Monitoring of Chinese White Dolphins (*Sousa chinensis*) in Hong Kong waters – Data collection, Final Report (1 April 2005 to 31 March 2006), prepared by Hong Kong Cetacean Research Project

(8) Jefferson T.A. 2000. Population Biology of the Indo-Pacific Humpback dolphin in Hong Kong waters. *Wildlife Monographs 144*:1-65.

(9) Jefferson T.A. and S.K. Hung. 2004. A review of the status of the Indo-Pacific humpback dolphin in Chinese waters. *Aquatic Mammals (Special Issue) 30*: 149-158.

(10) Barros, N.B., T.A. Jefferson, and E.C.M. Parsons. 2004. Feeding habits of Indo-Pacific humpback dolphins (Sousa chinensis) stranded in Hong Kong. *Aquatic Mammals (Special Issue) 30*: 179-188.

(11) Jefferson T.A. and S.K. Hung. 2004. A review of the status of the Indo-Pacific humpback dolphin in Chinese waters. *Aquatic Mammals* (Special Issue) 30: 149-158.

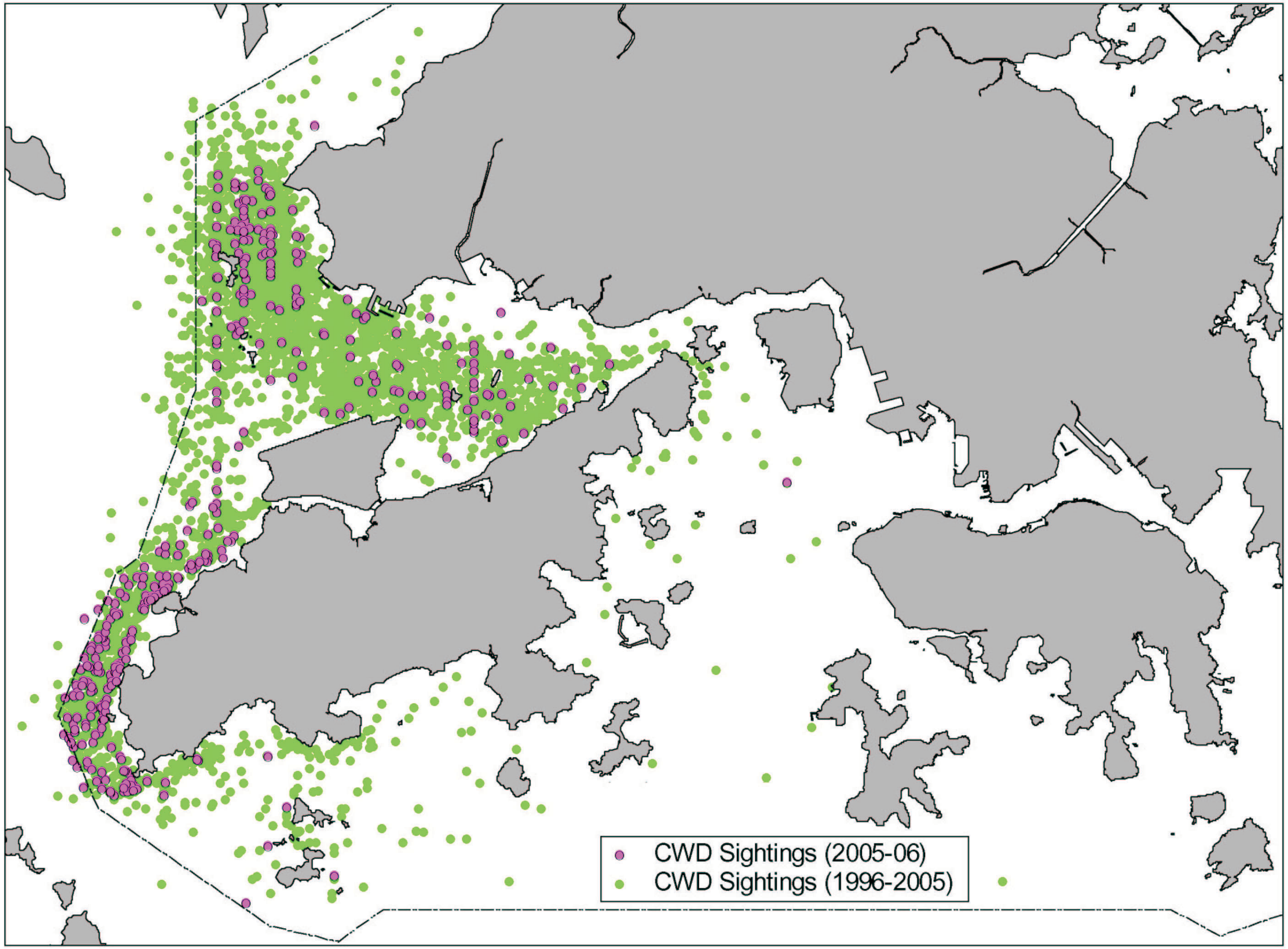

Figure 8.3

Distribution of the Indo-Pacific Humpback Dolphin, *Sousa chinensis*, in Hong Kong waters.
Data Collected between 1995 and 2006 (AFCD 2006)

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DATE: 06/06/2006

Environmental
Resources
Management

ERM

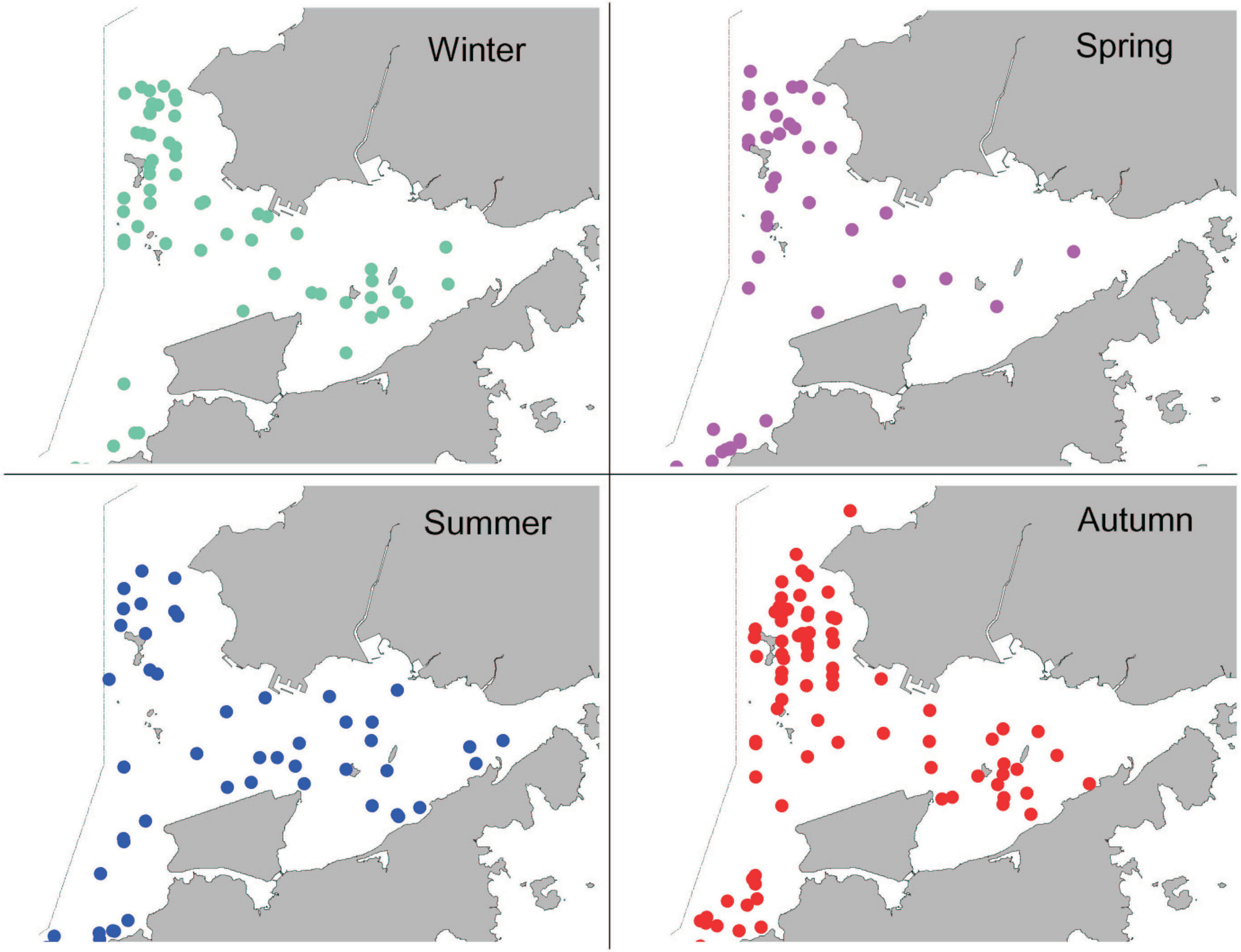

Figure 8.4

Seasonal Distribution of the Indo-Pacific Humpbacked Dolphin, *Sousa chinensis*, in Hong Kong waters.
Data Collected between April 2005 - March 2006 (AFCD 2006)

FILE: 0024405x5.cdr
DATE: 06/06/2006

**Environmental
Resources
Management**

ERM

South Lantau (1.6) (1). Most of the sightings of unspotted calves and unspotted juveniles were made throughout West Lantau, and another area of high concentration was in waters between Lung Kwu Chau and Sha Chau in Northwest Lantau during the survey between April 2005 to March 2006 (2). No sightings of unspotted calves and unspotted juveniles reported within or in the vicinity of Castle Peak during the AFCD study (3).

The recent studies on marine mammals in Hong Kong have attempted to conduct quantitative analysis of habitat use (4). Sighting densities have been calculated in terms of number of on-effort sightings per km^2, with the survey area mapped using a 1 km by 1 km grid. These data are presented as Sightings Per Survey Effort (SPSE) values. The average SPSE per grid in West Lantau (most of the grids has SPSE value >20) is the highest (14.3) compared with the average in Northwest Lantau of 5.97. The grids around Castle Peak where the proposed additional berthing facility located have SPSE values (using data from 1996-2006) ranging between 0.1 – 4 (*Figure 8.5*). The results indicate that the area around project site has low density for dolphins (5), and with moderate density in the nearby waters (~1 km). The nearest high density area is along the east coast of Lung Kwu Chau (~5 km away).

In contrast to humpback dolphins, studies on the finless porpoise indicate that the majority of sightings have been recorded in the southern and eastern waters of Hong Kong. Few sightings have been recorded in the waters surrounding the proposed project site (6) (7).

Based on an examination of the standardised dolphin sightings density data, the waters in and around the Project Area are characterised as an area of low to moderate level use by dolphins and it must be noted that the lowest dolphin sighting densities occur in waters close to shore.

8.5 EVALUATION OF ECOLOGICAL IMPORTANCE

The ecological resources and importance of marine habitats have been characterised with reference to the available literature, comparisons with other similar habitats in Hong Kong and the criteria presented in *Annexes 8* and *16* of the *Technical Memorandum on Environmental Impact Assessment Process under the Environmental Impact Assessment Ordinance (EIAO-TM).*

The ecological importance of habitats is determined according to the *EIAO-TM Annex 8* criteria, as follows:

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(1) AFCD. 2006. Monitoring of Chinese White Dolphins (*Sousa chinensis*) in Hong Kong waters – Data collection, Final Report (1 April 2005 to 31 March 2006), prepared by Hong Kong Cetacean Research Project

(2) AFCD. 2006. *ibid.*

(3) AFCD. 2006. *ibid.*

(4) AFCD. 2006. *ibid.*

(5) AFCD. 2006. ibid.

(6) Jefferson, pers. comm.

(7) AFCD. 2006. ibid.

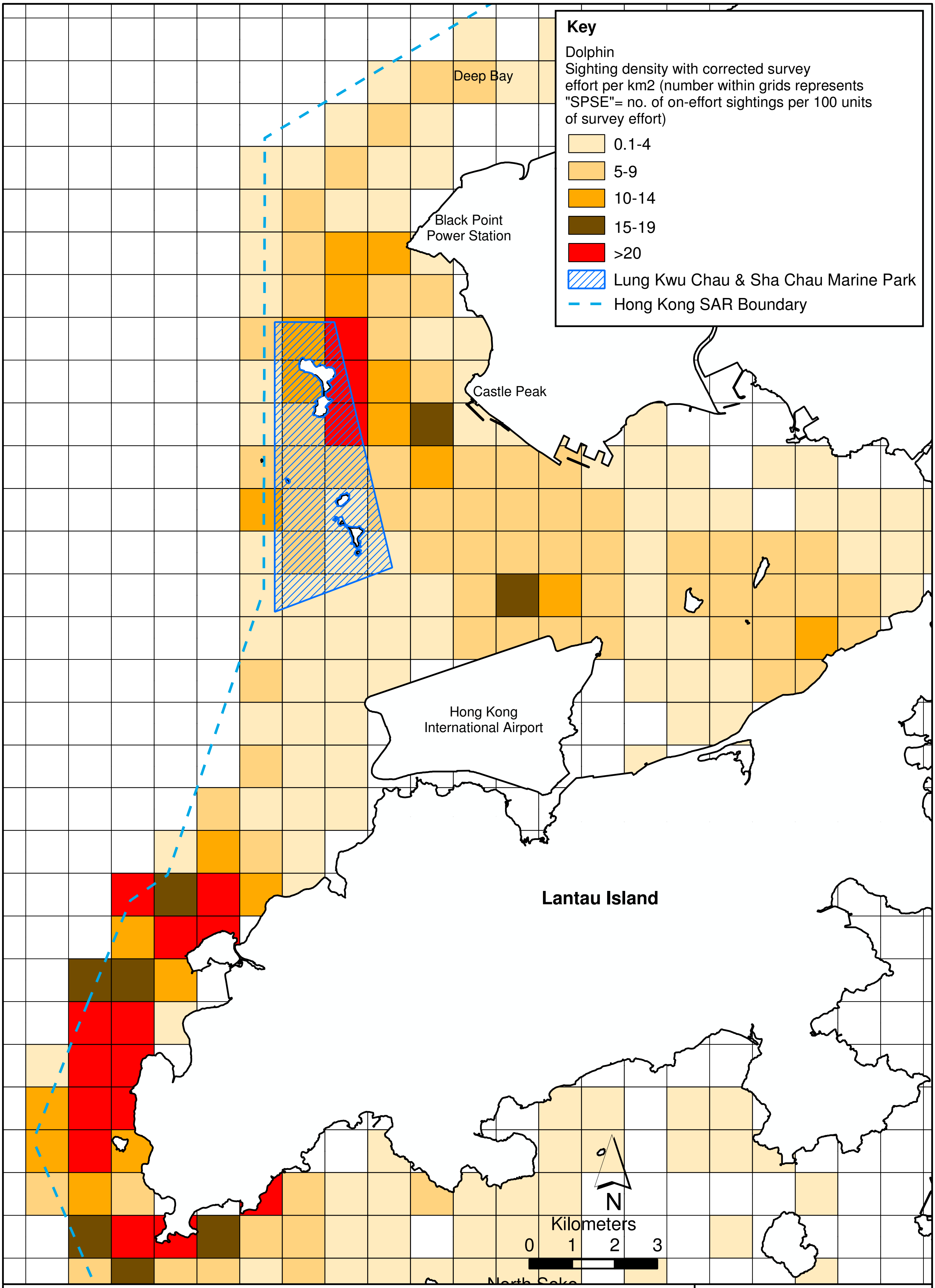

FIGURE 8.5

SPSE Densities from AFCD Study
Data Collected between 1996-2006

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Date: 06/06/2006

Environmental
Resources
Management

ERM

- Naturalness
- Size
- Diversity
- Rarity
- Re-creatability
- Fragmentation
- Ecological Linkage
- Potential Value
- Nursery Ground
- Age
- Abundance

8.5.1 Intertidal Hard Bottom Habitat

The criteria listed above have been applied to the information gathered or reviewed on the marine ecology of the intertidal habitats. The evaluation is presented in *Table 8.1*.

Table 8.1 Ecological Importance of Intertidal Hard Bottom Habitat

Criteria	**Intertidal Artificial Shoreline**	**Intertidal Rocky Shore**
Naturalness	Low. Intertidal habitat in the Project Area as well as the areas in the vicinity primarily consists of constructed artificial rubble mound seawall.	Medium. Nearby natural rocky shore appears to be relatively unaffected by human disturbance, but small in size.
Size	Artificial seawall is the predominant hard bottom habitat in the vicinity of the Project Area due to Castle Peak Power Station being partially situated on reclaimed land.	The extent of intertidal hard bottom habitat consisting natural rocky shore in the vicinity of the Project Area is small.
Diversity	The intertidal communities are composed of typical biota of semi-exposed rocky shores in Hong Kong, but with relatively low diversity. Survey results indicate that sloping artificial shores support similar assemblages.	The intertidal communities are composed of typical biota of semi-exposed rocky shores in Hong Kong, but with relatively low diversity. Survey results indicate that the natural rocky shore support similar assemblages.
Rarity	No species recorded are considered rare or of recognised conservation interest.	No species recorded are considered rare or of recognised conservation interest.
Re-creatability	Habitat is re-creatable. Intertidal biota may recolonise intertidal hard bottom shores.	Habitat is re-creatable. Intertidal biota may recolonise intertidal hard bottom shores.
Fragmentation	Low. Intertidal hard bottom habitat form a high proportion of intertidal habitats along neighbouring coasts.	Low. Intertidal hard bottom habitat form a high proportion of intertidal habitats along neighbouring coasts.

Criteria	**Intertidal Artificial Shoreline**	**Intertidal Rocky Shore**
Ecological Linkage	The habitat is not functionally linked to any high value habitat in a significant way.	The habitat is not functionally linked to any high value habitat in a significant way.
Potential Value	None identified. It is unlikely that this habitat in the vicinity of the Project Area can develop conservation interest.	None identified. It is unlikely that this habitat in the vicinity of the Project Area can develop conservation interest.
Nursery Area	No significant records identified in the literature review or field survey.	No significant records identified in the literature review or field survey.
Age	Artificial rubble mound seawall was constructed approximately 30 years ago.	Artificial rubble mound sloping seawall was constructed approximately 30 years ago.
Abundance	Survey findings indicate intertidal biota occur in low abundance.	Survey findings indicate intertidal biota occur in low abundance.
SUMMARY	The intertidal hard bottom habitat supports assemblages of relatively low diversity and abundance, consisting of common and widespread intertidal species with no recognised conservation interest.	The intertidal hard bottom habitat supports assemblages of relatively low diversity and abundance, consisting of common and widespread intertidal species with no recognised conservation interest.
Ecological Importance	**Low**	**Low**

The intertidal hard bottom habitat at Castle Peak was considered to be of low ecological importance given that it supports a low diversity and abundance of intertidal biota, which consist of common and widespread species with no recognised conservation interest. Furthermore the naturalness of this habitat is low since it is predominantly composed of artificial seawall.

8.5.2 *Subtidal Hard Bottom Habitat – Coral*

In accordance with the criteria listed above, an evaluation of subtidal hard bottom habitat based on the gathered or reviewed baseline information is presented in *Table 8.2.*

Table 8.2 Ecological Importance of Subtidal Hard Bottom Habitat - Coral

Criteria	**Subtidal Hard Bottom Habitat - Coral**
Naturalness	Low. Subtidal hard bottom habitat in the Project Area as well as the areas in the vicinity is mostly formed by artificial sloping seawall. Hard surfaces were covered by a thick layer of sediment. Dive surveys indicate adjacent seabed is subject to a high degree of physical disturbance.
Size	Subtidal hard bottom habitat in the vicinity of the Project Area is limited in extent being confined to narrow strip at the base of the seawall.
Diversity	Low. Small isolated colonies of gorgonian coral from the genus *Echinomuricea* were recorded in the project area
Rarity	No corals were identified which are considered rare. *Echinomuricea* is among the most commonly occuring gorgonian corals in Hong Kong with a widespread distribution.
Re-creatability	Habitat is re-creatable. Subtidal biota including corals may recolonise subtidal hard bottom habitat.
Fragmentation	Low. Subtidal hard bottom habitat form long continuous expanses along the margins of neighbouring rocky coasts.
Ecological Linkage	The habitat is not functionally linked to any high value habitat in a significant way.
Potential Value	Low. It is unlikely that this habitat in the vicinity of the Project Area can develop conservation interest.
Nursery Area	No significant records identified in the literature review or field survey.
Age	Artificial rubble mound seawall was constructed approximately 30 years ago.
Abundance	Low. A sparse cover (<5%) of small isolated gorgonians was recorded by dive surveys.
SUMMARY	The subtidal hard bottom habitat along the potentially affected coast is characterised as a poor habitat for coral growth owing to thick sediment layer on hard surfaces, estuarine conditions and disturbance of adjacent seabed. The potentially affected coast, which is artificial in origin, supported sparse cover of small and isolated colonies of one type of gorgonian coral, which is known to be commonly occurring across Hong Kong.
Ecological Importance	**Low**

The ecological importance of subtidal hard bottom habitat was classified as low. Based on dive survey observations, the subtidal hard bottom habitat is characterised as a poor habitat for coral growth owing to the observed thick sediment layer on hard surfaces. Prevailing estuarine conditions and disturbance also restrict the potential for coral growth at this site. Although gorgonian coral were recorded on the potentially affected coast, which is artificial in origin, its presence was not considered to be a significant record. The gorgonian *Echinomuricea* is a common species which occurs across Hong Kong. Furthermore, its abundance was sparse with only small and isolated colonies observed.

8.5.3 *Subtidal Soft Bottom Habitat Epifaunal Assemblages*

The criteria listed above have been applied to the information reviewed on the marine ecology of the subtidal soft bottom epifaunal assemblages habitat within the Study Area. The evaluation is presented in *Table 8.3*.

Table 8.3 Ecological Importance of the Subtidal Soft Bottom Epifaunal Assemblages

Criteria	**Subtidal Soft Bottom Epifaunal Assemblages**
Naturalness	Habitat in the vicinity of the Project Area is disturbed by fisheries activities and anchoring and may be affected by regional water pollution to some extent.
Size	Large in extent. Nearly all subtidal areas in the vicinity of the Project Area consist of soft bottom habitat
Diversity	Assemblages are considered to be of low diversity in comparison to other areas in Hong Kong.
Rarity	No organisms were recorded that are considered as rare or of recognised conservation interest.
Re-creatability	Subtidal soft bottom habitats can be easily re-created. Benthic organisms may recolonise the disturbed seabed area within a relatively short time.
Fragmentation	The habitat is not fragmented
Ecological Linkage	Epibenthic fauna act as a food source for demersal fisheries; however the habitat is not functionally linked to any high value habitat.
Potential Value	Low. Subtidal soft bottom epifaunal assemblages are unlikely to develop conservation interest.
Nursery Area	No significant records identified in the literature review or field survey.
Age	The sediments in the habitat are constantly accreting and eroding and the fauna present there are typically short lived.
Abundance	In comparison to other parts of Hong Kong waters the assemblages are of low abundance.
SUMMARY	Subtidal soft bottom epifaunal assemblages in the vicinity of the Project Area occur over a large unfragmented area, are disturbed to some extent by fisheries activities and pollution, and consist of epibenthic fauna in low abundance and diversity in comparison to other areas in Hong Kong. Epibenthos act as a food source for demersal fisheries and do not consist of species of recognised conservation interest.
Ecological Importance	**Low - Medium**

Subtidal soft bottom epifaunal assemblages are large in extent and are subject to frequent disturbance by fisheries activities. Although the epifauna were recorded to have low abundance and diversity, epifauna serve as a food source for demersal fisheries. The ecological importance of this habitat was therefore considered to be low to medium.

8.5.4 *Subtidal Soft Bottom Habitat Infaunal Assemblages*

Information on the marine ecology of soft bottom infaunal assemablages has been evaluated in accordance with the criteria listed above. The evaluation is presented in *Table 8.4*.

Table 8.4 Ecological Importance of the Subtidal Soft Bottom Infaunal Assemblages

Criteria	**Subtidal Soft Bottom Infaunal Assemblages**
Naturalness	Habitat in the vicinity of the Project Area is disturbed by fisheries activities and anchoring and may be affected by regional water pollution to some extent.
Size	Large in extent. Nearly all subtidal areas in the vicinity of the Project Area consist of soft bottom habitat
Diversity	Low to moderate in comparison to other areas in Hong Kong
Rarity	No organisms were recorded that are considered as rare or of recognised conservation interest.
Re-creatability	Subtidal soft bottom habitats can be easily re-created. Benthic organisms may recolonise the disturbed seabed area within a relatively short time.
Fragmentation	The habitat is not fragmented.
Ecological Linkage	The benthic infauna act as a food source for epibenthic organisms, however the habitat is not functionally linked to any high value habitat.
Potential Value	Low. Subtidal soft bottom infaunal assemblages are unlikely to develop conservation interest.
Nursery Area	No significant records identified in the literature review.
Age	The sediments in the habitat are constantly accreting and eroding and the fauna present there are typically short lived.
Abundance	Low to moderate in comparison to other areas in Hong Kong.
SUMMARY	Subtidal soft bottom infaunal assemblages in the vicinity of the Project Area occur over a large unfragmented area, are disturbed to some extent by fisheries activities and pollution, and consist of infauna in low to moderate abundance and diversity in comparison to other areas in Hong Kong. Infauna act as a food source for demersal fisheries and do not consist of species of no particular conservation interest.
Ecological Importance	**Low - Medium**

Subtidal soft bottom infaunal assemblages also occur over large areas. In comparison to other areas in Hong Kong, the soft bottom habitat in the vicinity of Castle Peak supports a low to moderate abundance and diversity of infauna. Although disturbed to some extent by fisheries activities and pollution, infauna act as a food source for demersal fisheries. Based on these considerations, subtidal soft bottom infaunal assemblages in the vicinity of Castle Peak were considered to be of low to moderate ecological importance.

8.5.5 Horseshoe Crab Habitat

Based on the criteria listed above the ecological importance of horseshoe crab habitat is evaluated in *Table 8.5*.

Table 8.5 Ecological Importance of the Horseshoe Crab Habitat

Criteria	**Horseshoe Crab Habitat**
Naturalness	Subtidal soft bottom habitat in the vicinity of the Project Area is disturbed by fisheries activities and anchoring. Horseshoe crab breeding grounds recorded at sites along the Deep Bay and North Lantau coasts, which are located far away from the Project Area (at least >2km), may be affected by regional water pollution to some extent.
Size	There are no records in the literature of Horseshoe crabs in the immediate vicinity of the Project Area. The nearest known breeding grounds occur along relatively short stretches of Deep Bay coast at Lung Kwu Sheung Tan and Pak Nai, which are distant from the proposed site.
Diversity	Two species: *Tachypleus tridentatus* and *Carcinoscorpius rotundicauda*
Rarity	Locally, Horseshoe crabs are considered to be species of conservation interest.
Re-creatability	Horseshoe crab habitats are not easily re-created.
Fragmentation	Marine waters inhabited by Horseshoe Crabs are not fragmented. Horseshoe crab breeding grounds are spread along the Deep Bay and North Lantau coast at about a dozen locations.
Ecological Linkage	The habitat is not functionally linked to any high value habitat in a significant way.
Potential Value	The area in the vicinity of the proposed project is unlikely to develop conservation interest.
Nursery Area	The artificial rocky shore of the Project Area is not suitable and cannot be used as a nursery grounds for Horseshoe Crabs. There are no records of Horseshoe Crab nursery grounds in the vicinity of the Project Area.
Age	The sediments in the habitat are constantly accreting and eroding though Horseshoe Crabs can be long-lived.
Abundance	Populations of Horseshoe crab are known to have declined drastically in recent years.
SUMMARY	There are no records of Horseshoe crabs in the vicinity of the Project Area. This area, therefore does not appear to be important habitat for Horseshoe Crabs. The subtidal soft bottom habitat in the vicinity of the project area is disturbed, particularly by fisheries activities and the potentially affected hard bottom coast is not amenable to function as a Horseshoe Crab nursery. Nursery grounds for Horseshoe Crabs, which are of high ecological importance are located at distant locations from the proposed project area.
Ecological Importance	**Low**

Based on a review of the relevant literature, there are no records of Horseshoe crabs in the vicinity of the Project Area in terms of captured or live sighting on the shore. It would appear that the area in the vicinity of Castle Peak is not important habitat for Horseshoe Crabs. Furthermore, the subtidal soft bottom habitat in the vicinity of the project area is disturbed, particularly by fisheries activities. It can also be noted that the potentially affected coast is not amenable to function as a Horseshoe Crab nursery since it is not a soft bottom habitat. For all these reasons, the marine area in the vicinity of Castle Peak is rated as being of low ecological importance to horseshoe crabs. In contrast, known nursery grounds for Horseshoe Crabs , which are located elsewhere along the Deep Bay and North Lantau coast but not in the vicinity of Castle Peak, are considered to be of high ecological importance.

8.5.6 Marine Mammal Habitat

The same assessment criteria have been applied to the marine waters within the Study Area with regard to the usage of the area by marine mammals. The evaluation is presented in *Table 8.6*.

Table 8.6 Ecological Importance of Marine Mammal Habitat

Criteria	**Marine Mammal Habitat**
Naturalness	The marine mammal habitat in the vicinity of the Project Area is disturbed by marine traffic using the Urmston Road Channel as well as fisheries operations and regional water pollution to some extent.
Size	Waters in the vicinity of the project area comprise a small portion of the range of the Indo-Pacific Humpback dolphin, which includes virtually all of North Lantau waters.
Diversity	The resident species, Indo-Pacific Humpback dolphin, *Sousa chinensis* is the only species sighted in the vicinity of the Project Area.
Rarity	There are approximately 1,300 dolphins in the Pearl River Estuary of which about 360 are thought to include Hong Kong waters as part of their range.
Re-creatability	This habitat cannot be recreated.
Fragmentation	Marine mammal habitat is not fragmented.
Ecological Linkage	Sightings of dolphins are more frequent to the west and north west of the Project Area.
Potential Value	Owing to their location next to the busy Urmston Road, it is unlikely that waters in vicinity of the Project Area would develop high conservation value. The Lung Kwu Chau and Sha Chau Marine Park is already recognised to be of high value.
Nursery Area	No sightings of unspotted calves and unspotted juveniles have been recorded in the vicinity of the Project Area.
Age	Habitats provided by marine waters are permanent.
Abundance	Waters around the project site are a low density area for dolphins (SPSE 0.1 – 4). Moderate dolphin densities (SPSE 15 – 19) occur in nearby waters (~1km away), while high density areas (SPSE >20) are located off the east coast of Lung Kwu Chau (5 km away).
SUMMARY	The waters in and around Castle Peak are an area of low to moderate level use by dolphins as indicated by dolphin densities data. The lowest dolphin sightings densities occur close to shore including waters in the vicinity of the Project Area.
Ecological Importance	**Low for the Project Area** **Medium for the waters in the immediate vicinity of Castle Peak (within 1 km)**

Taken as a whole, North Lantau waters are recognised as a major marine mammal habitat since sightings records indicate Indo-Pacific humpback dolphins are widely distributed in these waters and are present in all seasons. Through ongoing long term monitoring, there is a considerable amount of baseline data which provides a detailed picture of habitat utilisation. Based on both the sighting density and sightings distribution data, it can be seen that the waters in and around Castle Peak are an area of low to medium level use by dolphins. Of particular relevance to this assessment, analysis of the dolphin monitoring data show lowest dolphin sightings densities occur close to shore off Castle Peak. While cognisant of the overall importance of North Lantau waters to Indo-Pacific humpback dolphins, it is considered that waters specifically in the vicinity of Castle Peak are of medium ecological importance as marine mammal habitat.

8.5.7 Species of Recognised or Potential Conservation Interest Conservation Interest

In accordance with *EIAO-TM Annex 8* criteria, species of recognised or potential conservation value and their conservation and protection status, are presented in *Table 8.7.*

Table 8.7 ***Species of Recognised or Potential Conservation Interest within the Study Area***

Common Name	**Scientific Name**	**Protection Status**	**Distribution, Rarity and other Notes**
Indo-Pacific Humpback Dolphin (also known as the Chinese White Dolphin)	*Sousa chinensis*	Wild Animals Protection Ordinance, Animals and Plant Ordinance Class I Protected Species in the PRC. CITES *Appendix 1*	Range across Pearl River estuary and across Hong Kong western and Southern Waters from Deep Bay to Lamma. Listed as 'data deficient. in IUCN Red Book
Horseshoe Crabs	*Tachypleus tridentatus* and *Carcinoscorpius rotundicauda*	Not protected in Hong Kong or PRC	Populations have drastically declined in recent years. Distribution primarily known from records on intertidal nursery grounds at locations across Hong Kong from Deep Bay and Lantau to Port Shelter and Mirs Bay, but not recorded within the Project Area and areas in the close vicinity.

8.5.8 Summary of the Ecological Importance of Marine Habitats

According to the evaluation presented above, the ecological importance of habitats in the vicinity of Castle Peak varied in the range of low to low-medium as summarised in *Table 8.8.* No marine habitats of high ecological importance were identified in the vicinity of the project area.

Located about 5km to the west of Castle Peak is the Lung Kwu Chau and Sha Chau. As discussed previously, this designated area of high conservation value is included as key marine ecological sensitive receiver.

Table 8.8 Ecological Importance of Marine Habitats

Habitat	Ecological Importance
Intertidal Hard Bottom	Low
Subtidal Hard Bottom	Low
Subtidal Soft Bottom-Epifauna	Low-Medium
Subtidal Soft Bottom-Infauna	Low-Medium
Horseshoe Crab	Low
Marine Mammal	Low for the Project Area Medium for the waters in the vicinity of Castle Peak

8.6 ASSESSMENT METHODOLOGY

A desk-top literature review presented in the previous sections was conducted in order to establish the ecological profile of the Study Area. The importance of potentially impacted marine ecological resources identified within the Study Area was assessed using the methodology defined in the *EIAO-TM*. The potential impacts on the marine environment due to the construction and operational phases of the Project were then assessed (following the *EIAO-TM Annex 16* guidelines) and the significance of the impacts evaluated (based on the criteria in *EIAO-TM Annex 8*).

8.7 POTENTIAL SOURCES OF IMPACT

The Project's construction and operation potential sources of impact to the marine ecological resources of the Study Area have been identified in the following sections.

8.7.1 Construction Phase

As discussed in *Section 1*, the construction of the proposed additional berthing facility will involve the following marine works:

- Removal and reinstatement of boulders on the existing seawall;
- Dredging of the foundations of the additional berthing facility;
- Construction of the additional berthing facility and seawall which will include percussive piling and laying of armour rock;
- Dredging of a turning basin to a depth of approximately –8.2 mPD of an area of about 3 ha to the west of the existing Heavy Load Berth.

Impacts to marine ecological resources arising from the Project's construction works may be divided into direct and indirect impacts:

- *Direct Impacts* are those attributable to direct disturbances to the habitat such as the loss of habitat due to dredging or removal of existing substrates (soft and hard). Direct impacts have been identified only within the Project Area which delineates the permanent footprint of the Project;

- *Indirect Impacts* are those attributable to perturbations to key physical and chemical water quality parameters such as suspended solids, contaminants, dissolved oxygen, etc. Other potential indirect impacts to the marine environment include: underwater noise emissions from construction activities (construction vessels, percussive piling, etc.) and increased marine traffic.

Direct Impacts

Habitat Loss

Intertidal and Subtidal Hard Bottom Habitats

A total length of approximately 100 m of low ecological value artificial shore will be temporarily lost as the materials of the existing seawall will partially be removed to allow the construction of the additional berthing facility.

The results of the literature review indicated that the intertidal and subtidal assemblages recorded on the rocky shores within the Project Area are typical of rocky shore communities observed in Hong Kong and do not support habitats or species of conservational value. Furthermore the existing intertidal and subtidal hard bottom habitat will be replaced by the additional berthing structure of approximately 140 m in length and the new seawall which will, with time, support similar assemblages of intertidal and subtidal fauna and flora, allowing for an overall increase of hard bottom substrate within the Project Area.

It is anticipated that assemblages of intertidal and subtidal organisms, which included marine snails, barnacles, oysters and gorgonians, will settle on and recolonise the new structures as they rely primarily on larval settlement for recruitment (1) (2). Assuming that there is a regular supply of larvae brought to the area, regeneration of the existing habitat will occur in a relatively short time as the environmental conditions of the area will remain similar to existing conditions that have allowed the growth of intertidal and subtidal organisms.

In view of the low ecological value of the existing hard bottom habitats within the Project Area, the short term duration of the works and the overall increase in artificial hard bottom habitats, which will provide suitable substrata for recolonisation by similar assemblages, the impacts associated with the temporary loss of intertidal and subtidal hard bottom habitats within the Project Area would be minor.

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(1) Binnie Consultants Limited. 1996. Coral Growth at High Island Dam, for Civil Engineering Department.

(2) Binnie Consultants Ltd. 1997. Chek Lap Kok Qualitative Survey Final Report. For the Geotechnical Engineering Office, Civil Engineering Department, December 1997.

Subtidal Soft Bottom Habitats

To allow access to the proposed additional berthing facility, there is a requirement for dredging of a turning basin. Dredging will involve the removal of the upper strata of sediments (an average thickness of approximately 2.5 m) to a depth of approximately -8.2 mPD which will lead to the loss of the benthic assemblages present. This dredging will lead to the temporary loss of approximately 3 ha of subtidal soft bottom habitat. According to the proposed construction schedule, these works will be conducted by one grab dredger and will take about 6 weeks to complete.

A review of the baseline ecological conditions of the Study Area indicates subtidal soft bottom assemblages comprise typical species in low or moderate abundance and diversity and are of no particular conservation interest. It was noted that these assemblage are subjected to disturbance from sources, particularly bottom trawling activities by fishing vessels and water pollution. The marked contribution of pollution tolerant species to infaunal assemblages reflects the effects of water pollution on these assemblages.

The size of the proposed dredging area (about 3 ha) is considered to be relatively small in the context of large expanse of contiguous subtidal soft bottom habitat of the Study Area. Subtidal soft bottom habitat is the predominant type of bottom substrata throughout the marine study area.

The loss of subtidal soft bottom habitat in the turning basin is considered to be temporary in nature. Following the completion of the dredging works, the newly exposed bottom sediment will be available for recolonisation by benthic fauna.

The speed of recovery of the benthic community, through an influx of colonising organisms, is dependent on the timing of the dredging in relation to the timing of reproduction and or migration. While this may only be on a few occasions during the year for the macrobenthic organisms, studies of meiofaunal recolonisation after sediment disturbance indicate that partial recovery occurs within a few tidal cycles (1).

Furthermore it must be noted that benthic species that live in dynamic estuarine conditions such as those present within the Project Area will be naturally tolerant to disturbances of the substrate and sediment movement and will most probably have high recolonisation ability.

Indirect Impacts

Changes in Water Quality

Construction activities will involve dredging of the existing marine sediments within the Project Area to provide suitable foundations for the additional berthing facility and sufficient depth to allow the safe approach and

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(1) Sherman, K. M. and B. C. Coull. 1980. The response of meiofauna to sediment disturbance. J. Exp. Mar. Biol. and Ecol. 46:59-71.

manoeuvre of the bulk carriers. Dredging works will involve one grab dredger for a duration of 6 weeks. As assessed in the *Water Quality Assessment* (*Section 5*), these dredging activities will lead to a localised increase in the concentration of suspended solids (SS) in the water column.

Several potential impacts to the water quality parameters and in turn the marine environment are associated with an increase in SS concentration, namely:

- Physical Damage or Disturbance: Physical damage or disturbance (displacement from the natural habitat) of organisms may occur as a result of the deposition of SS which will smother or bury the substrates within and around the Project Area. SS have the potential to harm filter-feeding sessile organisms (e.g. bivalves) or damage gill membranes potentially leading to suffocation;

- Reduction in Dissolved Oxygen (DO): Increase in natural turbidity and reduction of incident solar radiation may impair photosynthesis and ultimately reduce the concentration of DO. Additionally SS may contain organic matter which is subject to oxidation and may aggravate oxygen depletion;

- Increase in Nutrients concentration: due to the re-suspension of nutrients "trapped" within the sediments potentially leading to eutrophication and algal blooms;

- Increase the concentrations of polluting agents or contaminants potentially present in the re-suspended solids.

It should be noted, that owing to seasonal inputs from the Pearl and Shenzhen Rivers, suspended solids in the North-western waters of Hong Kong vary over a wide range occasionally exceeding levels of 100 mg L^{-1} in the dry season (1) and it is likely that the organisms present are adapted to short-term elevated suspended solid inputs.

In addition, the water quality assessment in *Section 5* predicted that the elevations in suspended solids due to the dredging would be localised and mostly confined to the bed layer and well within the range of natural variability for north-western waters. According to the model, elevations in SS due to the dredging would not exceed 50 mg L^{-1} and WQO levels (see *Annex C2 - Figures C1 & C2*). The model also predicted that there would not be any substantial accumulation of re-deposited sediments likely to adversely affect benthic or pelagic organisms. Moreover, in line with common local construction practice, the dredging vessel will be equipped with a silt curtain which will serve to limit sediment dispersion away from the dredger.

(1) Mouchel 2001. Environmental Monitoring and Audit for Contaminated Mud Pit IV at East Sha Chau. Additional Monitoring Programme: Final Report on Intensive Water Quality Monitoring for Maintenance Capping (October 2001). Prepared for CEDD.

The following sections outline the potential impacts of the SS deriving from the construction activities of the Project on the marine habitats identified within the Study Area.

Physical Damage or Disturbance:

- *Intertidal* and *Subtidal Hard Bottom Habitats:* Due to the low quality of the hard bottom habitats identified within the Study Area and their natural exposure to high levels of suspended solids in the Pearl River Estuary, adverse impacts to the intertidal assemblages arising from elevated SS levels are not anticipated. Furthermore, no subtidal hard bottom habitats (including hard and soft coral assemblages) of ecological interest have been recorded within or in the vicinity of Project Area. Gorgonians observed during dive surveys are known to be highly tolerant of high turbidity conditions. Owing to their flexible branches and erect growth form, gorgonians are not prone to sediment accumulation. No adverse impacts to corals are predicted to occur.

- *Subtidal Soft Bottom Habitats*: The subtidal soft bottom habitat within the Study Area is considered to be of low to medium ecological value. However, the benthic organisms within and around the Project Area will be susceptible to the effects of increased sediment loads through smothering and burial. Although sediment may be deposited on the seabed outside the Project Area during dredging activities, the dispersion of sediment plumes is expected to be confined to a small area as sediment will be deposited within a short distance of the dredging works (*Section 5*). As the area is characterised by SS laden discharges from the Pearl River and often disturbed by demersal trawling, the organisms present are assumed to be adapted to high sediment deposition rates and seabed disturbances. Based on the above assumptions, it is estimated that the indirect adverse impacts on subtidal soft bottom habitats due to SS are acceptable and of little significance.

- *Horseshoe Crab Habitat*: The extent of the horseshoe crab habitat identified within the Study Area is very limited and overall of low ecological value. Furthermore, levels of SS identified in *Section 5* for the areas identified in the literature review as horseshoe crab nursery grounds (ie Deep Bay) are deemed to be sufficiently low to predict that no unacceptable impacts are expected to occur.

- *Marine Mammals*: High SS levels do not have a direct impact on dolphins. Indo-Pacific Humpback Dolphins are well-adapted for hunting in turbid waters owing to their use of echolocation rather than visual information. In addition, dolphins are air breathing and therefore SS in the water column has no effect on their respiratory surfaces. However it must be noted that the proposed dredging may cause perturbations to the fisheries resources on which the Indo-pacific humpback dolphin feeds (especially Sciaenidae, Engraulids, Clupeids and Trichiurids). A deterioration in water quality has the potential to displace these fish from the affected area thus interfering with the dolphin normal feeding patterns. From a review of the *Water Quality Assessment* results (*Section 5*) it emerges that indirect adverse impacts on fisheries are not expected to occur due to the localized nature of the impact on the water quality parameters. Furthermore, in line with common local construction practice, the dredger will be equipped with a silt curtain which will serve to limit sediment dispersion away from the dredger. Furthermore, it should be noted that the the dolphin, and their prey species are naturally exposed to high levels of suspended solids in the Pearl River Estuary, further reducing any potential impacts associated with SS. For instance, ambient SS levels off of Castle Peak range up to 210 mg L^{-1} (refer to *Table 5.5*). In comparison, elevations in SS levels due to the dredging works (<50 mg L^{-1}) are relatively small and within the range of natural variability.

- *Sha Chau and Lung Kwu Chau Marine Park*: Though of high ecological value, the levels of SS identified in *Section 5* in correspondence of the Marine Park's waters are deemed to be sufficiently low to envisage no unacceptable impacts on the Park's marine ecological resources (including the artificial reefs).

Dissolved Oxygen:

The concentration of suspended solids in water is directly correlated with the quantity of light penetrating the water column (turbidity). As the concentration of suspended solids increases, light penetration is reduced which in turn lowers the rate of photosynthesis by phytoplankton (primary productivity). The reduced productivity lowers the rate of oxygen production in the water column potentially adversely impacting the eggs and larval stages of marine organisms, as at these stages of development high levels of oxygen in the water are required for growth to support high metabolic rates.

The results of the *Water Quality Assessment* (*Section 5*) examining the dispersion of sediment plumes associated with all marine works has shown that the predicted maximum levels are localised. Concentrations within the Study Area as a whole will remain compliant with the Water Quality Objectives (WQOs). The subsequent effect on dissolved oxygen within the surrounding waters is, therefore, predicted to be minimal and unacceptable impacts to marine ecological resources are not expected to occur.

Nutrients:

High levels of nutrients (total inorganic nitrogen - TIN and ammonia) in seawater can cause rapid increases in phytoplankton to the point where an algal bloom may occur. An intense bloom of algae can lead to sharp increases in DO levels in surface water. However, at night and when these algae die there is usually a sharp decrease in the levels of dissolved oxygen in the water, as dead algae fall through the water column and decompose on the bottom. Anoxic conditions may result if DO concentrations are already low or are not replenished. This may result in mortality to marine organisms due to oxygen deprivation. The results of the *Water Quality Assessment* (*Section 5*) have indicated that low levels of SS elevations are expected outside of the Project Area. Consequently, elevations in nutrients desorbed from the sediment particles are expected to be in low concentrations. Algal blooms are therefore not expected through works and unacceptable impacts to the marine ecological habitats and populations present in the Study Area will not occur.

Contaminants:

As outlined in *Sections 5* and *6,* the sediments within the Study Area are not heavily contaminated therefore an increase in polluting agents or contaminants released by the sediment particles during dredging activities is not expected to occur and no unacceptable impacts to the marine ecological resources of the Study Area are estimated.

Underwater Noise

Overview

Cetaceans use two functional classes of sound: echolocation and communication. Echolocation is used for orientation, navigation, prey detection and learning about the surrounding environment, whilst communication is primarily used for intraspecies signalling (1). Indo-Pacific Humpback Dolphin vocalise through the production of clicks, rapid click sequences (screams) and whistles (2). Noise is transmitted efficiently through water and cetaceans are known to be able to detect submarine noise created by activities such as shipping over several kilometres from the source (3). Sounds introduced into the marine environment have the potential to interfere with the dolphins' ability to detect calls from other individuals, echolocation pulses or other natural sounds (4). Noise can also lead to a disruption of dolphin behaviour. Disruption of feeding, resting and social interactions have all been attributed to elevated sounds. Elevated noise of sufficient intensity can also damage the hearing sensitivity and loud impulsive sounds from activities such as percussive piling not only have the potential to cause disturbance, but also cause physical damage. The organs used in hearing and air-filled cavities such as the lungs are particularly susceptible to physical injury from extremely loud impulsive sounds.

Elevated noise levels are potentially the most important impact to the dolphin population in the Study Area. The main underwater noise sources attributable to the Project's construction activities are:

(1) Richardson WJ 1995. Introduction. In: Marine Mammals and Noise. (Eds. Richardson WJ, Greene CR, Malme CI and Thomson DH). Academic Press. London, pp. 1-13.

(2) Wursig B 1995. Potential Effect of a Proposed Aviation Fuel receiving Facility at Sha Chau on the Health and Survivability of the Indo-Pacific Humpback (Chinese White) Dolphin, *Sousa chinensis,* in Waters North of Lantau Island, Hong Kong Territory. Prepared for the Provisional Airport Authority.

(3) Richardson. 1995. *ibid.*

(4) Richardson. 1995. *ibid*

- Piling works;

- Construction / Dredging Vessels.

Both sources and their potential impacts on the Indo-pacific humpback dolphin have been addressed in the following sections.

Percussive Piling

Piling works will be required to construct the proposed additional berthing facility and based on the engineering conditions of the proposed construction site, percussive piling techniques will be utilised. The estimated duration of the piling works to complete the 140 m long structure is 6 weeks.

Noise from percussive piling activities will be transmitted to the water via both structure-borne and air-borne noise pathways. Structure-borne vibrations from the percussive hammer will be re-radiated as sound into the water via the piles, the substrata and the piling rig to the barge. The air-borne noise pathway consists of sound propagation from the percussive hammer and the piles through the air and into the water. The noise transmitted to the water via the air-borne noise path is not expected to be significant as a large proportion of this noise will be reflected at the water and air interface and therefore not penetrate the water.

Dolphins, in general have acute hearing above 500Hz and have been found to communicate within the 400 to 800 Hz range (1). Activities such as percussive piling have their highest energy at lower frequencies from about 20Hz to 1kHz and, whilst smaller cetaceans (about 3 to 4m in length) are not known to be highly sensitive to sounds below 1kHz, they can hear in much of this range and sounds in their vicinity could induce changes in behaviour and interfere with communication.

Experience of percussive piling in marine waters of Hong Kong indicates that this type of piling may result in temporary avoidance of the affected area by dolphins. Although it appeared that dolphins avoided the area around The Brothers during the airport construction, they returned on cessation of construction activities, suggesting that disturbance impacts are transient and only present during the construction phase (2). It is noted that this avoidance behaviour only has the potential to affect the small number of individuals that have been sighted in this area of Hong Kong and would not be expected to significantly affect the population as a whole. Sightings density information for the Humpback Dolphins indicates that these species have not been frequently sighted immediately off the coast where the proposed work would be located. AFCD's long term monitoring programme data, has not indicated that the Humpback Dolphins utilise the habitat in the immediate

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(1) Mouchel Asia Limited. 2002. EIA for Permanent Aviation Fuel Facility for Hong Kong International Airport, prepared for Hong Kong Airport Authority.

(2) Hyder. 1998. Supplement EIA for the Proposed Sand Extraction from the Brothers Marine Borrow Area, prepared for CED.

area of the works as frequently as more distant areas such as the Lung Kwu Chau and Sha Chau Marine Park.

Finally, in line with current common local practice, the percussive piling equipment used in Hong Kong is typically fitted with bubble jacket or bubble curtains. This feature of the percussive piling equipment is beneficial to reducing underwater noise (1).

It is apparent from the above that the underwater construction noise will not have any detrimental effect on the populations of the cetaceans. The extent to which dolphins would be affected is expected to be low.

Construction Vessels

Construction activities will result in an increase in marine traffic and underwater noise. Dredging and large vessels traffic generally results in mostly low frequency noise typically in the range of 0.02 to 1 kHz (2) which are below the peak range of 8 to 90 kHz reported for dolphins. For this reason, noise generated by dredging operations is not expected to acoustically interfere with dolphins.

This prediction is consistent with other EIA and environmental monitoring studies in Hong Kong. Contaminated mud disposal facilities have been in operation in the East of Sha Chau area for over ten years. Data available on the use of the surrounding waters does not indicate that the operations of these facilities result in behavioural changes to the dolphins (3).

It should also be noted that, due to the heavy marine traffic that characterises the waters of the Study Area (particularly Urmston Road), the existing background noise level are comparatively high, further reducing any potential impacts to the dolphins due to the underwater noise generated by the dredging or construction vessels.

Marine Traffic

Increased vessel movements during construction activities may increase physical risks to the Indo-pacific humpback dolphins or cause changes in behaviour if dolphins are harassed. In Hong Kong, there have been instances when dolphins have been injured or killed by vessel collisions (4)(5), although the risk is mainly associated with high-speed vessels such as ferries. In terms of potential impacts arising due to increased vessel traffic associated with the dredging works there is some potential to cause behavioural disturbance to

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(1) Wursig B, Greene CR & Jefferson TA (2000) Development of an air bubble curtain to reduce underwater noise of percussive piling. *Marine Environmental Research* 49: 79-93

(2) *Ibid.*

(3) ERM. 2002. Environmental Monitoring and audit for Contaminated Mud Pit IV at East Sha Chau. Report for the Civil Engineering Department.

(4) Parsons Parsons, E. C. M. and T. A. Jefferson. 2000. Post-mortem investigations on stranded dolphins and porpoises from Hong Kong waters. *Journal of Wildlife Diseases* 36(2):342-356.

(5) Jefferson, T. A., B. E. Curry, and R. Kinoshita. 2002. Mortality and morbidity of Hong Kong finless porpoises, with special emphasis on the role of environmental contaminants. *Raffles Bulletin of Zoology* (Supplement) 10:161- 171

any dolphins present in the area. However the risk of vessel collision is considered to be very small as work vessels would be slow moving and in the area for a short duration.

8.7.2 Operational Phase

Hydrodynamic Regime

The construction of the proposed additional berthing facility will bring about a change in the shape of the existing coastline. This may potentially lead to a change in the hydrodynamic regime of the surrounding waters and adversely affect the marine ecological resources within the Study Area. Impacts of this nature could lead to increased seabed current velocities which may cause seabed scour thus impacting subtidal assemblages, or conversely the current speeds may drop, affecting flushing and water exchange of an area. Inadequate flushing could lead to a reduction in dissolved oxygen, an increase in nutrient levels and consequent impacts to marine ecological resources.

The effects of changes in coastal configuration on the current velocities have been assessed (see *Section 5*). The hydrodynamic modelling has indicated that the construction of the proposed additional berthing facility will have little effect on current velocity. Consequently, no operational phase impacts on marine ecological resources due to changes in the hydrodynamic regime are expected.

Vessel Traffic

The daily maximum number of Dry Bulk Carrier movements at the proposed additional berthing facility is not anticipated to be more than 1 per day (1). Owing to the low frequency of the loading and unloading activities of the bulk carriers, no adverse impacts on the marine resources of the Study Area are expected. Moreover the slow approach / manoeuvring speed of the vessels further reduces the risk of collisions or strikes to Indo-Pacific Humpback Dolphins.

Discharge Water

As discussed in *Section 1*, the treated effluent from the FGD process may have a small chemical oxygen demand (COD) and / or reduced dissolved oxygen (DO) concentrations. A residual portion of the ash in the flue gas will likely be entrained within the limestone slurry and retained in the treated effluent.

The treated effluent will be added to the cooling water flows and discharged via the cooling water outfall, resulting in a small increase in the total flows from the outfall. The treated effluent is not expected to increase the temperature or the residual chlorine levels of the cooling water discharge.

The potential impacts of the discharge are principally related to the ecological effects associated with the COD increase and DO reduction. The water

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(1) Capco Heavy Load Berth Extension. Berthing and Marine Impact Assessment (BMT, 2006)

quality model (*Section 5*) has however predicted that the changes in the water quality parameters of the Project Area will be minimal and the effected zone confined to the immediate surroundings of the outfall. No adverse impacts on the marine ecological resources of the Study Area are therefore expected to occur.

8.7.3 *Cumulative Impact*

Two projects are identified which may occur concurrently with the marine works of this proposed project. One of these, The Permanent Aviation Fuel Receiving Facility for Hong Kong Airport, is currently ongoing. The other, the Liquefied Natural Gas (LNG) Receiving Terminal project is a potential project. Based on the provisional details on the nature of construction activities, implementation of their own mitigation measures and their location far away, unacceptable cumulative impacts to ecology are not anticipated.

8.8 *EVALUATION AND SIGNIFICANCE OF THE MARINE ECOLOGICAL IMPACTS*

The following section discusses and evaluates the impacts to marine ecological habitats as a result of the resources identified in the previous Sections. Based upon the information presented above, the significance of the marine ecological impacts associated with the construction and operation of the proposed additional berthing facility have been evaluated in accordance with the *EIAO-TM (Annex 8, Table 1)* as follows:

- *Habitat Quality*: Direct and indirect impacts are predicted to occur only to the low quality coastal habitats (intertidal and subtidal) and benthic habitats identified within the Project Area. The construction and operation activities will not affect habitats of high ecological value such as the Sha Chau and Lung Kwu Chau Marine Park. Operational phase discharges are not expected to impact any habitats of high ecological value.

- *Species:* Organisms of ecological interest reported from the literature include the Indo-Pacific Humpback Dolphin (*Sousa chinensis*). Significant impacts are not predicted to occur to this species due to planned marine works as water quality perturbations are predicted to be transient and compliant with the marine ecological assessment criterion(1). The percussive piling works and its underwater noise disturbance may result in avoidance of areas in the vicinity of the works by dolphins. However, any avoidance of the area would be temporary and individuals are expected to return to the affected area after the marine works are finished. It is anticipated that indirect, temporary disturbance to dolphins are not expected during marine piling works as construction methodologies have been designed to reduce underwater noise.

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(1) City University of Hong Kong. 2001. Agreement No. CE 62/98, Consultancy Study on Fisheries and Marine Ecological Criteria for Impact Assessment, AFCD, Final Report July 2001.

Operational phase discharges or marine vessel movements are not expected to impact the dolphins present in the Study Area.

- *Size:* The total size of the proposed dredged area will be approximately 3 ha. Low ecological value intertidal, subtidal hard surface and waters within the Project Area, and low-medium ecological value benthic assemblages within the Project's footprint will be directly impacted. The low-medium ecological value benthic assemblages within certain areas of the dredged areas will be affected during construction but are expected to become re-established with time.

- *Duration:* The duration of the construction activities is expected to be approximately 10 months. The duration for the percussive piling will last approximately six weeks. The underwater noise impact is unlikely to adversely affect the dolphin assuming provision of proper mitigation measures. Operational phase discharges will continue during the life of power station but are not predicted to cause adverse impacts to marine ecological resources as the alterations to the water quality parameters are minimal.

- *Reversibility:* Impacts to the benthic assemblages inhabiting the soft bottom habitats within the dredged areas are expected to be relatively short term and recolonisation of the sediments is expected to occur. Similarly the low ecological value assemblages present on the artificial seawall can be expected to recolonise the seawall and berthing structure once it is constructed.

- *Magnitude:* No unacceptable impacts to the ecologically sensitive habitats have been predicted to occur. Operational phase impacts are not expected to cause adverse impacts and are considered to be of low magnitude.

The impact assessment presented above indicates that no unacceptable impacts to marine ecology are expected to occur. Although soft bottom habitat will be temporarily lost, it has been demonstrated through long-term monitoring of previously dredged areas and existing Contaminated Mud Pits in the East of Sha Chau area that marine organisms have recolonised the areas following the completion of the works (1). As such, it is anticipated that subtidal assemblages influenced by dredging will settle on and recolonise the seabed returning it to the former conditions.

The previous discussion has indicated that the loss of intertidal and subtidal hard bottom assemblages within the Project Area is expected to be compensated through the recolonisation of the new seawall and berthing structure once construction has been completed. It is anticipated that intertidal and subtidal assemblages similar to the existing ones, will settle on and recolonise the new surfaces.

(1) Qian PY, Qiu JW, Kennish R and Reid C. 2003. Recolonization of benthic infauna subsequent to capping of contaminated dredged material in East Sha Chau, Hong Kong. Estuarine, Coastal and Shelf Science 56: 819-831.

Finally, it is anticipated that the underwater construction noise arising from construction activities may result in temporary avoidance of areas in the vicinity of the works by dolphins. However, individuals are expected to return to the affected area after the marine works are finished. Local construction practice such as bubble curtains/jackets will be used during piling works

8.9 *SUMMARY OF MITIGATION MEASURES*

Measures to mitigate the impact of the construction and operation activities have been developed. The following recommendations should be considered to minimize potential construction and operational impacts on dolphins and porpoises:

- All vessel operators working on the Project construction or operation should be given a briefing, alerting them to the possible presence of dolphins in the area, and the guidelines for safe vessel operation in the presence of cetaceans. If high speed vessels are used, they should be required to slow to 10 knots when passing through a high density dolphin area (west Lantau, Sha Chau and Lung Kwu Chau);

- The vessel operators should be required to use predefined and regular routes, as these will become known to dolphins using these waters;

- The vessel operators should be required to control and manage all effluent from vessels;

- A policy of no dumping of rubbish, food, oil, or chemicals should be strictly enforced. This should also be covered in the contractor briefings;

- Every attempt should be made to minimize the effects of construction of the Project on the water quality of the area;

To limit potential impacts to cetaceans from underwater percussive piling, the following steps should be taken:

- Quieter hydraulic hammers should be used instead of the noisier diesel hammers;

- An exclusion zone of 500 m radius should be scanned around the work area for at least 30 minutes prior to the start of piling. If cetaceans are observed in the exclusion zone, piling should be delayed until they have left the area; and,

- Acoustic decoupling of noisy equipment on work barges should be undertaken. These techniques include the use of a soft sling to retain the pile driving hammer, rubber tyred air compressor for bubble jacket/curtain, rubber pads on barge leaders and guides, and an air curtain around the pile barge.

Periodic re-assessment of mitigation measures for marine mammals and their effectiveness should be undertaken. The cetaceans monitoring should be conducted by a qualified team during the underwater percussive piling.

8.10 RESIDUAL ENVIRONMENTAL IMPACTS

Taking into consideration the ecological value of the habitats discussed in the previous sections and the resultant mitigation requirements, residual impacts occurring as a result of the proposed construction and operation activities have been determined and are as follows.

- The loss of approximately 100 m of artificial intertidal and subtidal hard bottom habitat of low ecological value. The residual impact is considered to be acceptable, as the loss of these habitats will be compensated by the provision of a new seawall and approximately 140 m of the additional berthing facility that have been demonstrated to become recolonised by assemblages of a similar nature after construction;
- Approximately 3 ha of subtidal soft bottom assemblages within the dredged area will be temporarily disturbed. The residual impact is considered to be acceptable as the habitat of low ecological concern will be reinstated shortly after construction and no residual impact will be expected.

8.11 ENVIRONMENTAL MONITORING AND AUDIT

The implementation of the ecological mitigation measures described in *Section 8.9* should be checked as part of the environmental monitoring and audit (EM&A) procedures during the construction period. No other ecology specific measures are considered necessary.

Visual cetaceans monitoring should be conducted during the underwater percussive piling works to evaluate whether there have been any effects on the animals and the details are presented in the *Section 10*.

8.12 CONCLUSIONS

Following a detailed literature review of the existing marine ecological resources of the Study Area, two key sensitive receivers have been identified: the Sha Chau and Lung Kwu Chau Marine Park and the Indo-Pacific Humpback Dolphin (*Sousa chinensis*) habitat. The assessment of the potential construction and operational phase impacts to marine ecological resources has indicated that no significant adverse effects will impact the sensitive receivers as impacts arising from the proposed construction works are predicted to be largely confined to the Project Area which has low ecological sensitivity.

The predicted alterations of the water quality parameters attributable to construction and operation activities are not expected to cause exceedances of the WQO, and hence no significant impacts to the marine ecological resources or marine mammals, are anticipated.

Local construction practice of using bubble curtains/jacket during percussive piling work will be adopted for the construction of the additional berthing facility. Mitigation measures designed to minimise impacts to the population of Indo-pacific humpback dolphins that use the area include restrictions on vessel speed. Other mitigation measures designed to mitigate impacts to water quality to acceptable levels (compliance with WQOs) are also expected to mitigate impacts to marine ecological resources.

9 VISUAL ILLUSTRATION

9.1 INTRODUCTION

The height of the various proposed structures in the Project will not exceed the existing maximum building height of +83 mPD and no additional chimney will be erected in the Project. With reference to *Section 3.4.7* of the *Study Brief*, a visual illustration of the Project is therefore provided in this section, instead of a detailed assessment of the landscape and visual impacts according to the criteria and guidelines in *Annexes 10* and *18* of the EIAO-TM.

The discussion in this section provides an analysis of the following:

- the Site and its surroundings;
- the visible elements of the Project; and
- the potential visibility of the new structures to be built as part of the Project.

9.2 THE EXISTING SITE AND ITS SURROUNDING

9.2.1 Description of the Site

The existing Site is located along the coast of Tap Shek Kok in Tuen Mun. The Site has been used as a power station since the early 1980's and is characterised by a group of large industrial building structures.

Figure 9.1 provides an aerial view of the existing Site and its surroundings. The Site is dominated by the existing Castle Peak Power Station (CPPS) and is surrounded by the open waters of the Urmston Road to the north, west and south. The eastern side of the Site is bordered by the foothills of Castle Peak. The restored Siu Lang Shui Landfill lies to the north-east of the Site. The land uses to the south-east of the Site are mostly industrial in nature. These include a cement plant, a steel mill, the future Permanent Aviation Fuel Facility, the future EcoPark and the River Trade Terminal. The nearest residential settlements are the villages at about 1 km north of the Site.

Figure 9.1 ***Aerial View of the Site and Its Surroundings***

9.2.2 Potential Impact on the Surrounding Landscape

It is considered that the Project will have no impact on the surrounding landscape as all the works will be completely contained within the boundary of the existing CPPS.

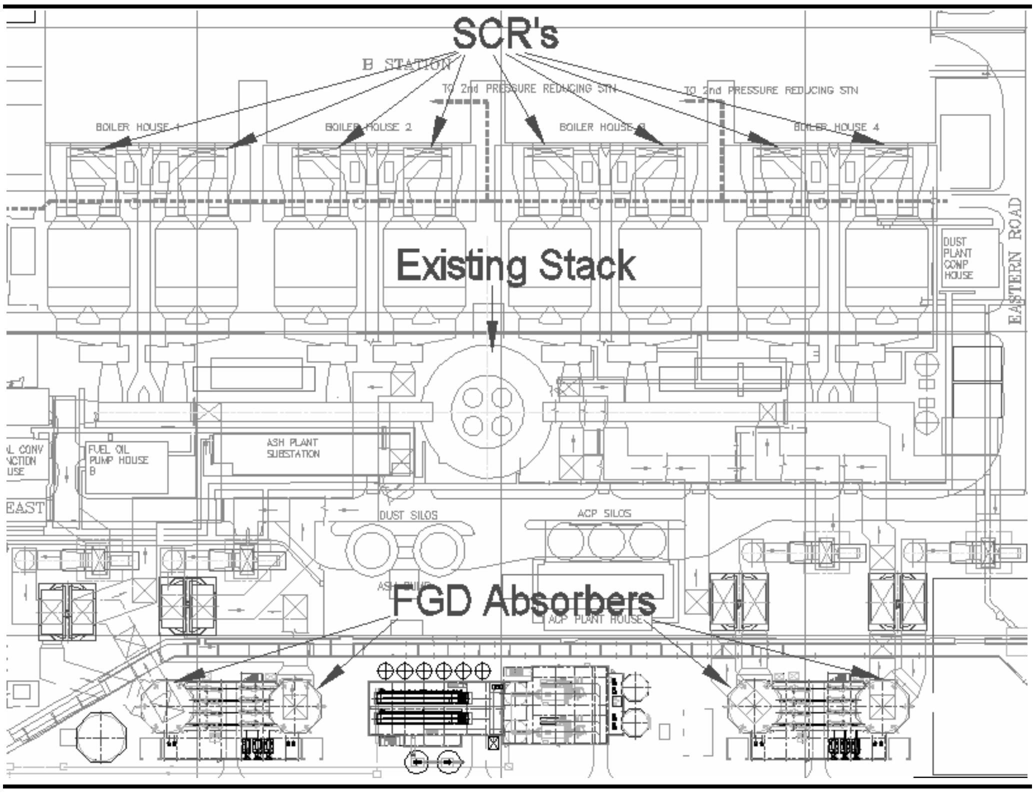
9.3 VISIBILITY OF THE PROJECT

9.3.1 Visible Elements of the Project

FGD and SCR Facilities

The majority of the FGD and SCR facilities to be constructed will be concentrated in an area (approximately 200 m x 300 m) immediately south-west of the four boiler houses of CPB. The currently envisaged layout of these facilities is shown in *Figure 9.2*. The locations of the existing stack of CPB, the FGD absorbers and the SCR units are highlighted for reference.

Figure 9.2 ***Proposed Layout of the Key Elements of the Project including the FGD and SCR Units***



The tallest structures among the above-mentioned group of new facilities will be the SCR units at approximately 65 m. The second tallest structures will be the FGD absorbers with their highest point at approximately 50 m. It is envisaged that the structures of these new facilities will be dwarfed by the existing boiler houses (approximately 78 m tall) and the stack (approximately 245 m tall) and the visibility of these new elements will be low.

Figure 9.3 illustrates the scale of the FGD and SCR facilities in relation to the adjacent existing structures. (Note: all dimensions are in millimetres).

9.3.2 Gypsum Storage

The gypsum storage area will be located adjacent to the West Coal Yard (please refer to *Figure 2.1* for its location). The proposed storage building will be a steel-frame structure covered with metal claddings measuring approximately 70m long x 47m wide x 20m high. This new element will be visible but it will simply appear as another storage area within the existing CPPS.

9.3.3 Additional Berthing Facility

The additional berthing facility for the loading and unloading of process reagents and by-products will be a piled deck structure of a total length of 140 m at the south-western corner of the existing CPPS (please refer to *Figure 2.1* for its location). The structure of the berth will be at the same level as the existing road and the new rail-mounted limestone unloader and gypsum loader will be the only above-ground elements. It is therefore considered

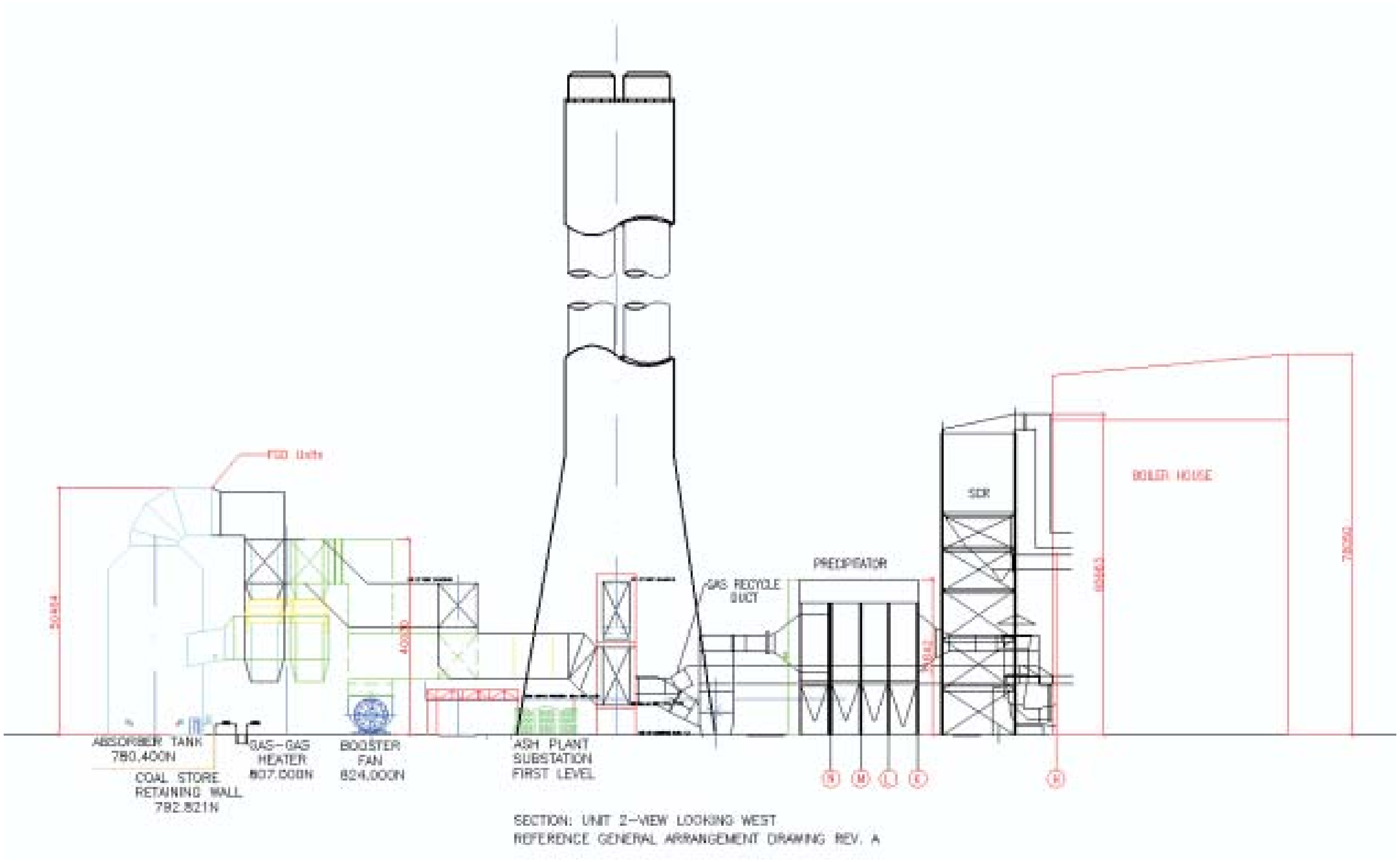


Figure 9.3

Cross Section of the Site showing the FGD and SCR Units in relation to the Existing Facilities - View Looking West

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that the additional berthing facility will have a low visibility from the surrounding areas.

9.3.4 *Rail-Mounted Loader / Unloader*

There will be a limestone loader / gypsum unloader located alongside the additional berthing facility. Technical drawings for this structure are not yet available however it will be approximately 20 m tall, and will be installed at the level of the existing deck. When not in use, the structure will be rotated towards the berthing facility. *Figure F2* shows a typical loading / unloading structure and the structure will not create any adverse visual impacts.

9.3.5 *Proposed Colour Scheme*

It is currently envisaged that the new structures associated with the Project, including those of the additional conveyor systems, will mainly be metal structures painted in a colour scheme that complements the surrounding industrial setting of the existing CPPS.

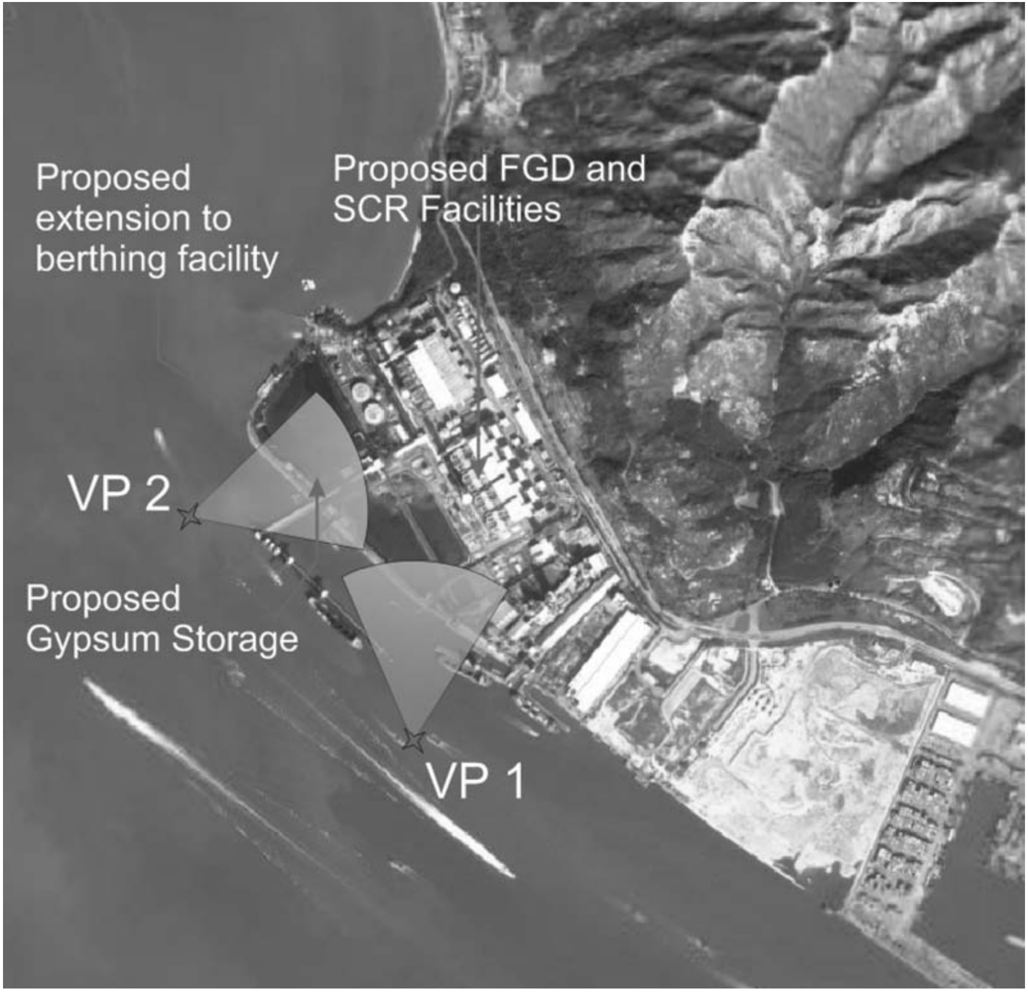
These colours will include shades of off-white, grey and light blues as can be seen used on the existing power station.

9.4 *POTENTIAL VIEWPOINTS*

The potential visibility was determined by a site visit. From the observations during the site visit, the new structures should only be visible from the open waters to the south and west of the Site. The new structures within CPB will most likely be screened by the existing structures of the Castle Peak Power Station "A" Units (CPA) when viewed from the north. The visibility of the new structures would therefore potentially affect passengers on the marine vessels passing the Urmston Road.

Two viewpoints (VPs) from the open waters of the Urmston Road have been selected and are shown in *Figure 9.4*.

Figure 9.4 Selected Viewpoints towards the Site



Annex F contains photomontages that have been prepared from each of the two viewpoints to illustrate the visibility of the new facilities.

Figure F1 shows the view towards the Site from VP1. From this viewpoint, the FGD absorbers and the SCR units will be visible. However, as the height of these elements will not exceed the existing boiler houses, they are considered to have low visibility. The gypsum storage building is also expected to be visible but it will complement the existing industrial building structures of the CPPS.

Figure F2 shows the locations of the FGD and SCR facilities, the gypsum storage building and the additional berthing facility from VP2. From this VP, all three groups of facilities will be visible. However, as with VP1, they are expected to be dwarfed by the existing buildings and therefore are considered to have low visibility.

9.5 SUMMARY AND CONCLUSIONS

The proposed structures associated with the Project will not have any negative impact on the surrounding landscape and will have a very low visibility for the following reasons:

- the proposed structures are located within a large existing industrial facility;
- there will be no impacts on the surrounding landscape area as all structures are contained within the existing industrial site; and
- the new structures are expected to be finished to complement the existing industrial surroundings;

It is considered that the Project will have a low visibility and therefore should not pose any concerns visually.

10 EM&A REQUIREMENT AND IMPLEMENTATION OF MITIGATION

10.1 EM&A REQUIREMENT

The assessments presented in the preceding sections have predicted that the implementation of the Project is not expected to give rise to any adverse environmental impacts. A focused EM&A programme is considered appropriate to ensure that the proposed mitigation measures are effectively implemented and the quality of the surrounding environment is not prejudiced.

10.1.1 Construction Phase

In general, in view of the nature and small scale of the Project, no environmental monitoring is required during construction except water quality monitoring during dredging works and dolphin monitoring during underwater percussive piling works, the details of which is provided in the following section.

Joint environmental audit at the site by CAPCO staff and the Contractor is recommended during construction to ensure the implementation of proper handling and treatment of the construction waste generated from the Project. Details of water quality monitoring and dolphin monitoring are described as below.

Water Quality Monitoring

Monitoring Parameters

The parameters to be measured *in situ* include:

- dissolved oxygen (DO) (% saturation and mg L^{-1});
- temperature;
- turbidity (NTU); and
- salinity (‰or ppt).

The only parameter to be measured in the laboratory includes suspended solids (SS) (mg L^{-1}).

In addition to the water quality parameters, other relevant data should also be measured and recorded in field logs, including the location of the sampling stations and grab dredger at the time of sampling, water depth, time, weather conditions, sea conditions, tidal state, current direction and speed, special phenomena and work activities undertaken around the monitoring and works area that may influence the monitoring results.

Monitoring Equipment and Methodology

For water quality monitoring, the following equipment should be supplied and used by the environmental contractor.

- ***Dissolved Oxygen and Temperature Measuring Equipment*** - The instrument should be a portable, weatherproof dissolved oxygen measuring instrument complete with cable, sensor, comprehensive operation manuals, and should be operable from a DC power source. It should be capable of measuring: dissolved oxygen levels in the range of 0–20 mg L^{-1} and 0-200% saturation; and a temperature of 0-45 degrees Celsius.

  It should have a membrane electrode with automatic temperature compensation complete with a cable of not less than 35 m in length. Sufficient stocks of spare electrodes and cable should be available for replacement where necessary (for example, YSI model 59 meter, YSI 5739 probe, YSI 5795A submersible stirrer with reel and cable or an approved similar instrument).

  Turbidity Measurement Equipment - Turbidity should be measured *in situ* by the nephelometric method. The instrument should be portable and weatherproof using a DC power source complete with cable, sensor and comprehensive operation manuals. It should have a photoelectric sensor capable of measuring turbidity between 0 - 1000 NTU (for example, Hach model 2100P or an approved similar instrument). The cable should not be less than 25m in length. The meter should be calibrated in order to establish the relationship between NTU units and the levels of suspended solids. The turbidity measurement should be carried out on a split water sample from the same water sample collected for suspended solids analysis.

- ***Salinity Measurement Instrument*** - A portable salinometer capable of measuring salinity in the range of 0-40 ppm should be provided for measuring salinity of the water at each monitoring location.

- ***Water Depth Detector*** - A portable, battery-operated echo sounder should be used for the determination of water depth at each designated monitoring station. A detector affixed to the bottom of the work boat, if the same vessel is to be used throughout the monitoring programme, is preferred.

- ***Current Velocity and Direction*** – No specific equipment is recommended for measuring the current velocity and direction. However, the environmental contractor should seek approval of their proposed equipment with the client prior to deployment.

- ***Positioning Device*** - A hand-held or boat-fixed type digital Global Positioning System (GPS) with way point bearing indication or other equipment instrument of similar accuracy, should be provided and used during water quality monitoring to ensure the monitoring vessel is at the correct location before taking measurements. GPS or the equivalent instrument, calibrated at appropriate checkpoint (e.g. Quarry Bay Survey Nail at Easting 840683.49, Northing 816709.55) should be provided and used to ensure the monitoring station is at the correct position before taking measurement and water samples.

- ***Water Sampling Equipment*** - A water sampler, consisting of a transparent PVC or glass cylinder of not less than two litres, which can be effectively sealed with cups at both ends, should be used (Kahlsico Water Sampler 13SWB203 or an approved similar instrument). The water sampler should have a positive latching system to keep it open and prevent premature closure until released by a messenger when the sampler is at the selected water depth.

All *in situ* monitoring instruments should be checked, calibrated and certified by a laboratory accredited under HOKLAS or any other international accreditation scheme before use, and subsequently re-calibrated at monthly intervals throughout all stages of the water quality monitoring. Responses of sensors and electrodes should be checked with certified standard solutions before each use. The turbidity meter should be calibrated to establish the relationship between turbidity readings (in NTU) and levels of SS (in mg L^{-1}) where possible.

For the on-site calibration of field equipment, the *BS 1427: 1993, Guide to Field and On-Site Test Methods for the Analysis of Waters* should be observed. Sufficient stocks of spare parts should be maintained for replacements when necessary. Backup monitoring equipment should also be made available so that monitoring can proceed uninterrupted even when equipment is under maintenance, calibration etc.

Water samples for SS measurements should be collected in high density polythene bottles, packed in ice (cooled to 4° C without being frozen), and delivered to a HOKLAS laboratory as soon as possible after collection.

All laboratory work should be carried out in a HOKLAS accredited laboratory. Water samples of about 1,000 mL should be collected at the monitoring and control stations for carrying out the laboratory determinations. The determination work should start within the next working day after collection of the water samples. The SS laboratory measurements should be provided to the client within 2 days of the sampling event (48 hours). The analyses should follow the standard methods as described in APHA *Standard Methods for the Examination of Water and Wastewater, 19th Edition*, unless otherwise specified (APHA 2540D for SS).

The submitted information should include pre-treatment procedures, instrument use, Quality Assurance / Quality Control (QA / QC) details (such as blank, spike recovery, number of duplicate samples per-batch etc), detection limits and accuracy. The QA / QC details should be in accordance with requirements of HOKLAS or another internationally accredited scheme.

Monitoring Stations

The monitoring station locations have been established to identify potential impacts to water quality sensitive receivers which are shown in *Figure 5.2*.

Prior to, during and after the dredging works, water quality sampling will be undertaken at stations situated around the dredging area. The monitoring at those stations is to ensure the dredging works of the Project do not affect the sensitive areas nearby (shown in *Figure 10.1*).

- **C1** is a Control Station (during ebb tide) located to the north of the dredging area, which is not supposed to be influenced by the construction works;
- **C2** is a Control Station (during flood tide) located to the south of the dredging area with the same coordinates as EPD routine monitoring station NM3, which is not supposed to be influenced by the construction works;
- **SR1** and **SR2** represent Lung Kwu Sheung Tan Beach and Lung Kwu Tan Beach respectively, located to the north of the dredging area;
- **SR3**, **SR4** and **SR5** represent the Castle Peak Power Station Intake, the Shiu Wing Steel Mill Intake and the EcoPark Intake, located to the south of the dredging area;
- **SR6**, **SR7** and **SR8** represent the eastern boundary of Sha Chau and Lung Kwu Chau Marine Park; and
- **G1**, and **G2** are regarded as a Gradient Station in-between the dredging area and the Marine Park, whereas G1 situates at the same location as EPD routine monitoring station NM5.

The suggested co-ordinates of these monitoring stations are listed in *Table 10.1*.

The monitoring stations will be sampled during Baseline Monitoring (prior to the dredging works), Impact Monitoring (during any works related to the dredging works) and Post Project Monitoring (after completion of the dredging).

Table 10.1 Co-ordinates of Baseline, Impact & Post Project Monitoring Stations (HK Grid)

Station	**Easting**	**Northing**
C1	806561	829624
C2	811762	823728
SR1	808295	828795
SR2	809242	827496
SR3	809444	826076
SR4	810241	825355
SR5	810763	825047
SR6	806198	827886

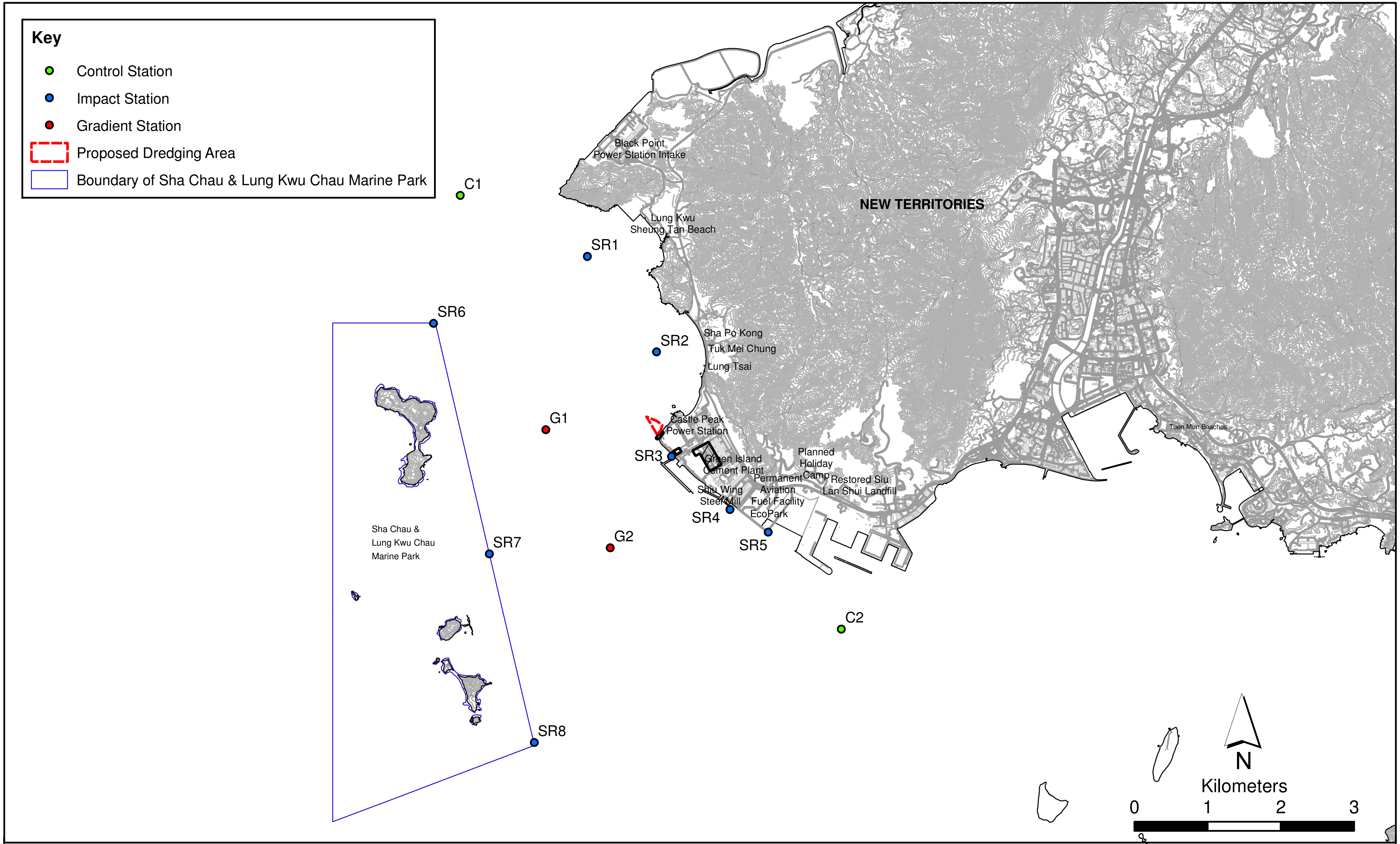


Figure 10.1

Location of Water Quality Monitoring Stations

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Station	Easting	Northing
SR7	806959	824749
SR8	807571	822187
G1	807729	826440
G2	808608	824832

Monitoring Frequency

For baseline, impact and post-project monitoring, monitoring should be undertaken 3 days per week, at mid-flood and mid-ebb tides, with sampling / measurement at the designated stations. The intervals between 2 consecutive sets of monitoring should not be less than 36 hours except where there are exceedances of Action and / or Limit Level, in which case monitoring frequency should be increased. The tidal range for each of the flood and ebb tide should not be less than 0.5m.

The water quality sampling will be undertaken within a 3-hour window of 1.5 hour before and 1.5 hour after mid flood and mid-ebb tides. The environmental contractor will be responsible for liaison with the engineering contractor to confirm whether dredging works are being undertaken during the water quality sampling.

Each station will be sampled and measurements will be taken at three depths, 1 m below the sea surface, mid depth and 1m above the sea bed. For stations that are less than 3 m in depth, only the mid depth sample should be taken.

Replicate *in-situ* measurements and sample collected from each independent sampling event are required for all parameters to ensure a robust statistically interpretable dataset.

Baseline Monitoring: Baseline Monitoring will comprise sampling 3 days a week, at mid-flood and mid-ebb tides, for at least 4 weeks prior to the commencement of the dredging works. The monitoring will be undertaken at twelve locations in total (two control, five impact and two gradient monitoring stations), as shown on *Figure 10.1*. The baseline monitoring schedule should be provided to EPD for agreement at least 2 weeks prior to commencement of the baseline monitoring work.

Impact Monitoring: Impact Monitoring will comprise sampling 3 days a week, at mid-flood and mid-ebb tides, during the dredging works. Samples should be taken at the same location as the Baseline Monitoring Stations. The monitoring schedule should be provided to EPD for agreement prior to commencement of the monitoring work.

Post Project Monitoring: Post Project Monitoring will comprise sampling on 3 days a week, at mid-flood and mid-ebb tides, for at least 4 weeks after completion of the dredging works at the same location as the Baseline Monitoring Stations.

Compliance / Action Event Plan

Water quality monitoring results will be evaluated against Action and Limit levels shown in *Table 10.2*.

Table 10.2 ***Action and Limit Levels for Water Quality (based on the Results of the Baseline Report)***

Parameter	Action Level	Limit Level
SS in mg L^{-1} (depth-averaged [a]) [c]	95%-ile of baseline data, and 20% exceedance of value at any impact station compared with corresponding data from control stations at the same tide of the same day [d, e, f]	99%-ile of baseline data, and 30% exceedance of value at any impact station compared with corresponding data from control stations at the same tide of the same day and specific sensitive receiver water quality requirements [d, e, f]
DO in mg L^{-1} [b]	Surface and Middle 5%-ile of baseline data for surface and middle layer Bottom 5%-ile of baseline data for bottom layers	Surface and Middle 4mg L^{-1} or 1%-ile of baseline for surface and middle layer Bottom 2mg L^{-1} or 1%-ile of baseline data for bottom layer
Turbidity in NTU (depth-averaged [a]) [c]	95%-ile of baseline data, and 20% exceedance of value at any impact station compared with corresponding data from control stations at the same tide of the same day [d. e]	99%-ile of baseline data, and 30% exceedance of value at any impact station compared with corresponding data from control stations at the same tide of the same day [d, e]

Notes:

(a) "Depth-averaged" is calculated by taking the arithmetic means of reading of all three depths.

(b) For DO, non-compliance of the water quality limits occurs when monitoring result is lower than the limits.

(c) For SS and turbidity, non-compliance of the water quality limits occurs when monitoring result is higher than the limits.

(d) An exceedance of Action Level and Limit Level is defined as exceeding both criteria. The comparison of the results of impact stations and control stations will aid to determine the background influence to the water quality sensitive receivers.

(e) C1 is regarded as the Control Station during ebb tide, whereas C2 is regarded as the Control Station during flood tide.

(f) For WSD and Black Point/Castle Peak Power Station intakes, the specific SS criteria are not greater than 20 mg L^{-1} and 764 mg L^{-1}.

Actions to be taken in the event that the Action or Limit Levels are exceeded are shown in *Table 10.3*.

Table 10.3 Event and Action Plan for Water Quality

EVENT	**ACTION**			
	ET	**IEC**	**CAPCO**	**Contractor**
Action Level being exceeded by one sampling day	1. Repeat *in-situ* measurement to confirm findings; 2. Identify source(s) of impact; 3. Inform the IEC and the Contractor and CAPCO; 4. Check monitoring data, all plant, equipment and the Contractor's working methods; 5. Discuss mitigation measures with the IEC and the Contractor;	1. Discuss with the ET and the Contractor on the mitigation measures; 2. Review proposals on mitigation measures submitted by the Contractor and advise the CAPCO accordingly; 3. Assess the effectiveness of the implemented mitigation measures.	1. Discuss with the IEC on the proposed mitigation measures; 2. Make agreement on the mitigation measures to be implemented.	1. Inform the CAPCO and confirm notification of the non-compliance in writing; 2. Rectify unacceptable practice; 3. Check all plant and equipment; 4. Consider changes of working methods; 5. Discuss with the ET and the IEC and propose mitigation measures to the IEC and the CAPCO; 6. Implement the agreed mitigation measures.
Action Level being exceeded by more than one consecutive sampling days	1. Repeat *in-situ* measurement to confirm findings; 2. Identify source(s) of impact; 3. Inform the IEC and the Contractor and CAPCO; 4. Check monitoring data, all plant, equipment and Contractor's working methods; 5. Discuss mitigation measures with the IEC and the Contractor; 6. Ensure mitigation measures are implemented;	1. Discuss with the ET and the Contractor on the mitigation measures; 2. Review proposals on mitigation measures submitted by the Contractor and advise the CAPCO accordingly; 3. Assess the effectiveness of the implemented mitigation measures.	1. Discuss with the IEC on the proposed mitigation measures; 2. Make agreement on the mitigation measures to be implemented; 3. Assess effectiveness of the implemented mitigation measures;	1. Inform the CAPCO and confirm notification of the non-compliance in writing; 2. Rectify unacceptable practice; 3. Check all plant and equipment; 4. Consider changes of working methods; 5. Discuss with the ET and the IEC and propose mitigation measures to the IEC and CAPCO within 3 working days; 6. Implement the agreed mitigation measures.

EVENT	**ACTION**			
	ET	**IEC**	**CAPCO**	**Contractor**
Limit Level being exceeded by one consecutive sampling day	1. Repeat *in-situ* measurement to confirm findings; 2. Identify source(s) of impact; 3. Inform the IEC, the Contractor and the DEP; 4. Check monitoring data, all plant, equipment and the Contractor's working methods; 5. Discuss mitigation measures with the IEC, the CAPCO and the Contractor; 6. Ensure mitigation measures are implemented;	1. Discuss with the ET / Contractor on the mitigation measures; 2. Review proposals on mitigation measures submitted by the Contractor and advise the CAPCO accordingly; 3. Assess the effectiveness of the implemented mitigation measures.	1. Discuss with the IEC, the ET and the Contractor on the proposed mitigation measures; 2. Request the Contractor to critically review the working methods; 3. Make agreement on the mitigation measures to be implemented; 4. Assess the effectiveness of the implemented mitigation measures.	1. Inform the Engineer and confirm notification of the non-compliance in writing; 2. Rectify unacceptable practice; 3. Check all plant and equipment; 4. Consider changes of working methods; 5. Discuss with the ET, the IEC and the CAPCO and propose mitigation measures to the IEC and the CAPCO within 3 working days; 6. Implement the agreed mitigation measures.
Limit Level being exceeded by more than one consecutive sampling days	1. Repeat *in-situ* measurement to confirm findings; 2. Identify source(s) of impact; 3. Inform the IEC, the Contractor and DEP; 4. Check monitoring data, all plant, equipment and Contractor's working methods; 5. Discuss mitigation measures with the IEC, the CAPCO and the Contractor; 6. Ensure mitigation measures are implemented;	1. Discuss with ET and Contractor on the mitigation measures; 2. Review proposals on mitigation measures submitted by the Contractor and advise the CAPCO accordingly; 3. Assess the effectiveness of the implemented mitigation measures.	1. Discuss with the IEC, the ET and the Contractor on the proposed mitigation measures; 2. Request Contractor to critically review working methods; 3. Make agreement on the mitigation measures to be implemented; 4. Assess effectiveness of the implemented mitigation measures; 5. Consider and instruct, if necessary, the Contractor to slow down or to stop all or part of the marine work until no exceedance of Limit Level.	1. Inform the CAPCO and confirm notification of the non-compliance in writing; 2. Rectify unacceptable practice; 3. Check all plant and equipment; 4. Consider changes of working methods; 5. Discuss with the ET, the IEC and the CAPCO and propose mitigation measures to the IEC and the CAPCO within 3 working days; 6. Implement the agreed mitigation measures; 7. As directed by the CAPCO, slow down or stop all or part of the construction activities.

Reporting

A letter report should be provided to CAPCO that should include the monitoring results in addition to operating practices of the dredging works during sampling (including position, quantity of dredged volume per day) and an interpretation of monitoring results. The monitoring data should be provided graphically to show the relationship between the Control and the Impact monitoring stations and compliance or non-compliance with respect to the Action and Limit Levels.

The reports to be provided by the environmental contractor / ET should include one Baseline Monitoring Report; Weekly Impact Monitoring Reports; and one Post Project Monitoring Report.

The ET should prepare and submit a Baseline Environmental Monitoring Report at least 1 month before commencement of impact monitoring. Copies of the Baseline Environmental Monitoring Report will be submitted to the following: the Contractor, the IEC, the CAPCO and the EPD. The ET will liaise with the relevant parties on the exact number of copies required.

A Monthly Impact Monitoring Report should be prepared by the ET and submitted to the Contractor, the IEC, the CAPCO and the EPD within 10 working days at the end of each reporting month.

The Post-Project Monitoring Report should be prepared by the ET and submitted to the Contractor, the IEC, the CAPCO and the EPD within one week of completion of the Post Project Survey.

The format of the reports should follow that specified in *Technical Memorandum on EIA Process* (*EIAO, Cap. 499, S16*), as appropriate.

Dolphin Monitoring

Visual dolphin monitoring should be conducted during the underwater percussive piling works to evaluate whether there have been any effects on the animals. A dolphin exclusion zone within a radius of 500 m from the works area during the construction phase. The exclusion zone around the work area should be scanned for at least 30 minutes prior to the commencement of piling. If cetaceans are observed in the exclusion zone, underwater percussive piling should be delayed until they have left the area.

The observer should stand at a location (eg the piling barge) that allows for an observation height of 4 to 5 m above water level at the observer's eye level and relatively unobstructed forward visibility. Observation by the observer should be conducted by searching with Fujinon 7X50 marine binoculars or equivalent, scanning the area with the naked eye and occasional binocular check. The observer should remain alert at all times during the entire observation period.

A sighting record should be filled in immediately at the initial sighting with data on the time, position, distance and bearing of the sighting. All other information on sea state, weather conditions (ie wind speed according to the Beaufort Scale), as well as notes on dolphin appearance, behaviour, direction of movement, response to boat and any other relevant information can be completed at the end of the sighting.

When dolphins are spotted within the exclusion zone, construction works should cease and should not resume until the observer confirms that the zone has been continuously clear of dolphins for a period of 30 minutes (thereby adequately spanning the approximate maximum dive time of the dolphins of 4 minutes). Dolphin sighting position, data on sighting angle, distance to the group, group size and behaviour should be recorded.

The dolphin surveys will be required solely during underwater percussive piling works. Daily monitoring should be conducted till the completion of underwater percussive piling works.

10.1.2 Operational Phase

CAPCO implements a comprehensive environmental monitoring programme for the operations of the existing Castle Peak Power Station (CPPS) and it is considered that no additional EM&A activities are required for the emissions control operations.

The current operational environmental monitoring programmes for the CPPS that are relevant to the Project include:

Air

- Operation and maintenance of Continuous Emission Monitoring (CEM) System at the stack to continuously monitor the flue gas;

- Transmission of the on-line CEM data to EPD's office through a telemetry system;
- Operation and maintenance of an ambient air monitoring network at San Hui, Butterfly Estate and Lung Kwu Tan in Tuen Mun and Tin Shui Wai;
- Reporting of the stack sampling result, emission data and validated CEM data to EPD; and
- Reporting of the ambient air monitoring and dust monitoring results to EPD.

Water

- Monitoring of the quality of effluents discharged from the CPPS and ash lagoon;
- Monitoring of the quality of marine water around the ash lagoon; and
- Reporting of the wastewater and marine water monitoring results to EPD.

10.2 IMPLEMENTATION SCHEDULE

Mitigation measures discussed in the preceding sections are summarised in the Implementation Schedule in *Table 10.4*.

Table 10.4 Implementation Schedule

EIA Ref.	Environmental Protection Measures	Location/Duration of Measures/Timing of Completion of Measures	Implementation Agent	Implementation Stage				Relevant Legislation & Guidelines
				Des	C	O	Dec	
AIR QUALITY –CONSTRUCTION PHASE								
S3.6.1	• The area at which demolition work takes place should be sprayed with water prior to, during and immediately after the demolition activities so as to maintain the entire surface wet	Within the construction site/Throughout the construction period	Contractor		✓			*Air Pollution Control (Construction Dust) Regulation*
S3.6.1	• Dust screens or sheeting should be provided to enclose the structure to be demolished to a height of at least 1 m higher than the highest level of the structure;	Within the construction site/Throughout the construction period	Contractor		✓			*Air Pollution Control (Construction Dust) Regulation*
S3.6.1	• Any dusty materials should be wetted with water to avoid any fugitive dust emission;	Within the construction site/Throughout the construction period	Contractor		✓			*Air Pollution Control (Construction Dust) Regulation*
S3.6.1	• All temporary stockpiles should be wetted or covered by tarpaulin sheet to prevent fugitive emissions;	Within the construction site/Throughout the construction period	Contractor		✓			*Air Pollution Control (Construction Dust) Regulation*
S3.6.1	• All the dusty areas and roads should be wetted with water;	Within the construction site/Throughout the construction period	Contractor		✓			*Air Pollution Control (Construction Dust) Regulation*
S3.6.1	• All the dusty materials transported by lorries should be covered entirely by impervious sheet to avoid any leakage; and	Within the construction site/Throughout the construction period	Contractor		✓			*Air Pollution Control (Construction Dust) Regulation*
S3.6.1	• The falling height of fill materials should be controlled.	Within the construction site/Throughout the construction period	Contractor		✓			*Air Pollution Control (Construction Dust) Regulation*
AIR QUALITY – OPERATIONAL PHASE Since the Project will significantly reduce SO_2 and NO_x emissions and further reduce particulate emissions from CPB, no mitigation measures are required.								

EIA Ref.	Environmental Protection Measures	Location/Duration of Measures/Timing of Completion of Measures	Implementation Agent	Implementation Stage				Relevant Legislation & Guidelines
				Des	C	O	Dec	
NOISE – CONSTRUCTION PHASE The predicted noise levels are within the stipulated noise criterion as a result of the considerable separation distance plus topography and existing building structures at CPB located between the NSR and the Project. Mitigation measures are not required.								
NOISE – OPERATIONAL PHASE The predicted noise levels are below the daytime and night-time criteria as a result of the considerable separation distance plus topography and existing building structures at CPB located between the NSR and the Project. Mitigation measures are not required.								
WATER QUALITY – CONSTRUCTION PHASE								
Marine-based Construction Activities								
S5.8.1	• Silt curtains should be deployed around the closed grab dredger to contain suspended solids within the construction site during dredging.	Within the construction site / Throughout the construction period	Contractor		✓			-
S5.8.1	• A daily dredging rate of a closed grab dredger (with a minimum grab size of 8 m^3) should be less than 5,200 m^3 day^{-1}, with reference to the maximum rate for dredging, which was derived in the EIA.	Within the construction site / Throughout the construction period	Contractor		✓			-
S5.8.1	• Mechanical grabs should be designed and maintained to avoid spillage and should seal tightly while being lifted.	Within the construction site / Throughout the construction period	Contractor		✓			-
S5.8.1	• Barges or hoppers should have tight fitting seals to their bottom openings to prevent leakage of material.	Within the construction site / Throughout the construction period	Contractor		✓			-
S5.8.1	• Loading of barges or hoppers should be controlled to prevent splashing of dredged material to the surrounding water.	Within the construction site / Throughout the construction period	Contractor		✓			-
S5.8.1	• Barges or hoppers should not be filled to a level which will cause overflow of materials or pollution of water during loading or transportation.	Within the construction site / Throughout the construction period	Contractor		✓			-

EIA Ref.	Environmental Protection Measures	Location/Duration of Measures/Timing of Completion of Measures	Implementation Agent	Implementation Stage				Relevant Legislation & Guidelines
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S5.8.1	• Excess material should be cleaned from the decks and exposed fittings of barges or hoppers before the vessel is moved.	Within the construction site / Throughout the construction period	Contractor		✓			-
S5.8.1	• Adequate freeboard should be maintained on barges to reduce the likelihood of decks being washed by wave action.	Within the construction site / Throughout the construction period	Contractor		✓			-
S5.8.1	• All vessels should be sized such that adequate clearance is maintained between vessels and the seabed at all states of the tide to ensure that undue turbidity is not generated by turbulence from vessel movement or propeller wash.	Within the construction site / Throughout the construction period	Contractor		✓			-
S5.8.1	• The works should not cause foam, oil, grease, litter or other objectionable matter to be present in the water within and adjacent to the works site.	Within the construction site / Throughout the construction period	Contractor		✓			-
Land-based - Construction Runoff								
S5.8.2	• At the start of site establishment, perimeter cut-off drains to direct off-site water around the site should be constructed and internal drainage works and erosion and sedimentation control facilities implemented. Channels, earth bunds or sand bag barriers should be provided on site to direct stormwater to silt removal facilities. The design of efficient silt removal facilities should be based on the guidelines in *Appendix A1* of *ProPECC PN 1/94*.	Within the construction site / Throughout the construction period	Contractor		✓			*EPD* Practice Note for Professional Persons, Construction Site Drainage *(ProPECC PN 1/94)*
S5.8.2	• All the surface runoff or extracted ground water contaminated by silt and suspended solids should be collected by the on-site drainage system and diverted through the silt traps prior to discharge into storm drain.	Within the construction site / Throughout the construction period	Contractor		✓			*EPD* Practice Note for Professional Persons, Construction Site Drainage *(ProPECC PN 1/94)*

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S5.8.2	• All exposed earth areas should be completed as soon as possible after earthworks have been completed, or alternatively, within 14 days of the cessation of earthworks, where practicable. If excavation of soil cannot be avoided during the rainy season, or at any time of year when rainstorms are likely, exposed slope surfaces should be covered by tarpaulin or by other means.	Within the construction site / Throughout the construction period	Contractor		✓			*EPD* Practice Note for Professional Persons, Construction Site Drainage *(ProPECC PN 1/94)*
S5.8.2	• All drainage facilities and erosion and sediment control structures should be regularly inspected and maintained to ensure proper and efficient operation at all times and particularly following rainstorms. Deposited silt and grit should be removed regularly and disposed of by spreading evenly over stable, vegetated areas.	Within the construction site / Throughout the construction period	Contractor		✓			*EPD* Practice Note for Professional Persons, Construction Site Drainage *(ProPECC PN 1/94)*
S5.8.2	• Measures should be taken to reduce the ingress of site drainage into excavations. If the excavation of trenches in wet periods is necessary, they should be dug and backfilled in short sections wherever practicable. Water pumped out from trenches or foundation excavations should be discharged into storm drains via silt removal facilities.	Within the construction site / Throughout the construction period	Contractor		✓			*EPD* Practice Note for Professional Persons, Construction Site Drainage *(ProPECC PN 1/94)*
S5.8.2	• Open stockpiles of construction materials (for example, aggregates, sand and fill material) of more than 50 m^3 should be covered with tarpaulin or similar fabric during rainstorms. Measures should be taken to prevent the washing away of construction materials, soil, silt or debris into any drainage system.	Within the construction site / Throughout the construction period	Contractor		✓			*EPD* Practice Note for Professional Persons, Construction Site Drainage *(ProPECC PN 1/94)*
S5.8.2	• Manholes (including newly constructed ones) should always be adequately covered and temporarily sealed so as to prevent silt, construction materials or debris being washed into the drainage system.	Within the construction site / Throughout the construction period	Contractor		✓			*EPD* Practice Note for Professional Persons, Construction Site Drainage *(ProPECC PN 1/94)*

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S5.8.2	• Precautions to be taken at any time of year when rainstorms are likely, actions to be taken when a rainstorm is imminent or forecasted, and actions to be taken during or after rainstorms are summarised in *Appendix A2* of *ProPECC PN 1/94*. Particular attention should be paid to the control of silty surface runoff during storm events, especially for areas located near steep slopes.	Within the construction site / Throughout the construction period	Contractor		✓			*EPD* Practice Note for Professional Persons, Construction Site Drainage *(ProPECC PN 1/94)*
S5.8.2	• Oil interceptors should be provided in the drainage system and regularly emptied to prevent the release of oil and grease into the storm water drainage system after accidental spillages. The interceptor should have a bypass to prevent flushing during periods of heavy rain.	Within the construction site / Throughout the construction period	Contractor		✓			*EPD* Practice Note for Professional Persons, Construction Site Drainage *(ProPECC PN 1/94)*
S5.8.2	• All temporary and permanent drainage pipes and culverts provided to facilitate runoff discharge should be adequately designed for the controlled release of storm flows. All sediment traps should be regularly cleaned and maintained. The temporary diverted drainage should be reinstated to the original condition when the construction work has finished or the temporary diversion is no longer required.	Within the construction site / Throughout the construction period	Contractor		✓			*EPD* Practice Note for Professional Persons, Construction Site Drainage *(ProPECC PN 1/94)*
<u>Wastewater from Site Facilities</u>								
S5.8.2	• Sewage from toilets should be collected by a licensed waste collector.	Within the construction site / Throughout the construction period	Contractor		✓			-
S5.8.2	• Vehicle and plant servicing areas, vehicle wash bays and lubrication bays should, as far as possible, be located within roofed areas. The drainage in these covered areas should be connected to foul sewers via a petrol interceptor.	Within the construction site / Throughout the construction period	Contractor		✓			-

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S5.8.2	• Oil leakage or spillage should be contained and cleaned up immediately. Waste oil should be collected and stored for recycling or disposal, in accordance with the *Waste Disposal Ordinance*.	Within the construction site / Throughout the construction period	Contractor		✓			*Waste Disposal Ordinance*
Storage and Handling of Oil, Other Petroleum Products and Chemicals								
S5.8.2	• Waste streams classifiable as chemical wastes should be properly stored, collected and treated for compliance with *Waste Disposal Ordinance* or *Disposal (Chemical Waste) (General) Regulation* requirements.	Within the construction site / Throughout the construction period	Contractor		✓			*Waste Disposal Ordinance* *Disposal (Chemical Waste) (General) Regulation*
S5.8.2	• All fuel tanks and chemical storage areas should be provided with locks and be sited on paved areas.	Within the construction site / Throughout the construction period	Contractor		✓			*Waste Disposal (Chemical Waste) (General) Regulation* *Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes*
S5.8.2	• The storage areas should be surrounded by bunds with a capacity equal to 110% of the storage capacity of the largest tank to prevent spilled oil, fuel and chemicals from reaching the receiving waters.	Within the construction site / Throughout the construction period	Contractor		✓			*Waste Disposal (Chemical Waste) (General) Regulation* *Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes*
S5.8.2	• The Contractors should prepare guidelines and procedures for immediate clean-up actions following any spillages of oil, fuel or chemicals.	Within the construction site / Throughout the construction period	Contractor		✓			-
S5.8.2	• Surface run-off from bunded areas should pass through oil / grease traps prior to discharge to the stormwater system.	Within the construction site / Throughout the construction period	Contractor		✓			*EPD* Practice Note for Professional Persons, Construction Site Drainage *(ProPECC PN 1/94)*

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WATER QUALITY – OPERATIONAL PHASE								
Limestone FGD Absorber Effluent								
S5.9.2	It has predicted that the marine works and structures will have minimal effects on hydrodynamics and water quality. Mitigation measures are not considered to be necessary.	-	-					-
S5.9.2	The high degree of mixing inherent in the coastal margin or coastal zone will result in rapid dilution of the effluent to non-significant concentrations, and therefore mitigation measures are considered unnecessary.	-	-					-
Storage and Handling of Oil, Other Petroleum Products and Chemicals								
S5.9.3	• Waste streams classifiable as chemical wastes should be properly stored, collected and treated for compliance with *Waste Disposal Ordinance* or *Disposal (Chemical Waste) (General) Regulation* requirements.	Within the Project Site / Throughout the operational years	CLP Power (as CAPCO operator)			✓		*Waste Disposal Ordinance* *Disposal (Chemical Waste) (General) Regulation*
S5.9.3	• All fuel tanks and chemical storage areas should be provided with locks and be sited on paved areas.	Within the Project Site / Throughout the operational years	CLP Power (as CAPCO operator)			✓		*Waste Disposal (Chemical Waste) (General) Regulation* *Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes*
S5.9.3	• The storage areas should be surrounded by bunds with a capacity equal to 110% of the storage capacity of the largest tank to prevent spilled oil, fuel and chemicals from reaching the receiving waters.	Within the Project Site / Throughout the operational years	CLP Power (as CAPCO operator)			✓		*Waste Disposal (Chemical Waste) (General) Regulation* *Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes*

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S5.9.3	• The Contractors should prepare guidelines and procedures for immediate clean-up actions following any spillages of oil, fuel or chemicals.	Within the Project Site / Throughout the operational years	CLP Power (as CAPCO operator)			✓		-
S5.9.3	• Surface run-off from bunded areas should pass through oil / grease traps prior to discharge to the stormwater system.	Within the Project Site / Throughout the operational years	CLP Power (as CAPCO operator)			✓		*EPD* Practice Note for Professional Persons, Construction Site Drainage *(ProPECC PN 1/94)*
WASTE MANAGEMENT – CONSTRUCTION PHASE There are no major waste management issues associated with the operation of the new emission control system. This section recommends the mitigation measures to avoid or minimize potential adverse environmental impacts associated with handling, collection and disposal of waste arising from the construction of the new emission control system. It is the Contractor's responsibility to ensure that only licensed chemical waste collectors are used for collection and transportation of chemical waste to the licensed disposal facility and that appropriate measures are taken to minimize adverse environmental impacts, including windblown litter and dust from the transportation of wastes. In addition, the Contractor must ensure that all the necessary waste permits are obtained for the construction and operational phases.								
Dredged Sediments								
S6.6.1	Dredged sediments should be disposed of only at designated disposal sites allocated by the Marine Fill Committee (MFC) based on the findings of further sediment quality tests. A dumping licence should also be obtained from EPD prior to the commencement of the dredging works.	Within designated disposal site / prior to commencement of the dredging works	Contractor		✓			*Dumping at Sea Ordinance*

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S6.6.1	Regardless of the disposal method and site, the Contractor should: • Dredge the sediments using closed grabs; • Use split barges of not less than 750 m^3 capacity when transporting the sediment to the disposal site; • Regularly maintain the barge hoppers to ensure that they are capable of rapid opening and discharge at the designated disposal site; and • Monitor the barge load against loss of materials during transportation.	Within the dredging area /Throughout the dredging works period	Contractor		✓			*Dumping at Sea Ordinance*
C&D Materials								
Management of Waste Disposal								
S6.6.3	• The contractor should open a billing account with EPD in accordance with the *Waste Disposal (Charges for Disposal of Construction Waste) Regulation* for the payment of disposal charges. Every waste load transferred to government waste disposal facilities such as public fill, sorting facilities, landfills or transfer station would required a valid "chit" which contain the information of the account holder to facilitate waste transaction recording and billing to the waste producer. A trip-ticket system should also be established in accordance with *Works Bureau Technical Circular No. 21/2002* to monitor the disposal of solid wastes at transfer station / landfills, and to control fly-tipping. The billing "chit" and trip-ticket system should be included as one of the contractual requirements and implemented by the contractor.	Within the construction site / Throughout the construction period	Contractor		✓			*Waste Disposal (Charges for Disposal of Construction Waste) Regulation, December 2005* *ETWBTC No 31/2004, Trip Ticket System for Disposal of Construction and Demolition Materials*

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S6.6.3	• A recording system for the amount of waste generated, recycled and disposed of (including the disposal sites) should be established during the construction stage.	Within the construction site / Throughout the construction period	Contractor		✓			*ETWBTC No 31/2004, Trip Ticket System for Disposal of Construction and Demolition Materials*
S 6.6.3	*Measures for the Reduction of C&DM Generation during Planning and Design Stages* The various waste management options can be categorized in terms of preference from an environmental viewpoint. The options considered to be more preferable have the least impacts and are more sustainable in the long term. Hence, the waste management hierarchy is as follows: • Avoidance and minimization, that is, reduction of waste generation through changing or improving practices and design; • Reuse of materials, thus avoiding disposal (generally with only limited reprocessing); • Recovery and recycling, thus avoiding disposal (although reprocessing may be required); and • Treatment and disposal, according to relevant law, regulations, guidelines and good practice. This hierarchy should be used to evaluate the waste management options, thus allowing maximum waste reduction and reduced disposal costs. Records of quantities of wastes generated, recycled and disposed (locations) should be kept.	Within the construction site / Throughout the construction period	Contractor		✓			*Waste Disposal Ordinance* *WBTC No. 25/99 Incorporation of Information on Construction and Demolition Material management in PWSC Papers*

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<tr><th rowspan="2">EIA Ref.</th><th rowspan="2">Environmental Protection Measures</th><th rowspan="2">Location/Duration of Measures/Timing of Completion of Measures</th><th rowspan="2">Implementation Agent</th><th colspan="4">Implementation Stage</th><th rowspan="2">Relevant Legislation & Guidelines</th></tr>
<tr><th>Des</th><th>C</th><th>O</th><th>Dec</th></tr>
<tr><td>S6.6.3</td><td>*Measures for the Reduction of C&DM Generation during Construction*
• C&D materials will be reused as far as possible within the Project. Public fill and construction waste should be segregated and stored in different containers or skips to facilitate reuse or recycling of materials and their proper disposal of construction waste. Specific areas of the work site should be designated for such segregation and temporary storage if immediate use is not practicable.
• The construction waste should be collected by Contractor and transported to landfills for disposal.
• The use of wooden hoardings should not be allowed. An alternative material, which can be reused or recycled, for example, metal (aluminium, alloy, etc) should be used.
• To reduce the potential dust impact, C&D materials should be wetted as quickly as possible during excavation works.</td><td>Within the construction site / Throughout the construction period</td><td>Contractor</td><td></td><td>✓</td><td></td><td></td><td>*Waste Disposal Ordinance*
WBTC 32/92, The Use of Tropical Hard Wood on Construction Site
WBTC No. 2/93, Public Dumps</td></tr>
<tr><td colspan="9">Chemical Waste
The Contractor should register as a chemical waste producer with the EPD. Chemical waste, as defined by *Schedule 1* of the *Waste Disposal (Chemical Waste) (General) Regulation*, should be handled in accordance with the *Code of Practice on the Packaging, Handling and Storage of Chemical Wastes* as follows:</td></tr>
<tr><td>S6.6.4</td><td>Containers used for storage of chemical wastes should:
• be suitable for the substance they are holding, resistant to corrosion, maintained in a good condition, and securely closed;
• have a capacity of less than 450 L unless the specifications have been approved by the EPD; and
• display a label in English and Chinese in accordance with instructions prescribed in *Schedule 2* of the *Regulations*</td><td>Within the construction site / Throughout the construction period</td><td>Contractor</td><td></td><td>✓</td><td></td><td></td><td>*Waste Disposal (Chemical Waste) (General) Regulation*
Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes</td></tr>
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S6.6.4	The storage area for chemical wastes should: • be clearly labelled and used solely for the storage of chemical waste; • be enclosed on at least 3 sides; • have an impermeable floor and bunding, of capacity to accommodate 110% of the volume of the largest container or 20% by volume of the chemical waste stored in that area, whichever is the greatest; • have adequate ventilation; • be covered to prevent rainfall entering (water collected within the bund must be tested and disposed of as chemical waste, if necessary); and • be arranged so that incompatible materials are appropriately separated.	Within the construction site / Throughout the construction period	Contractor		✓			*Waste Disposal (Chemical Waste) (General) Regulation* *Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes*
S6.6.4	Disposal of chemical waste should be: • via a licensed waste collector; and • to a facility licensed to receive chemical waste, such as the Chemical Waste Treatment Facility which also offers a chemical waste collection service and can supply the necessary storage containers	Within the construction site / Throughout the construction period	Contractor		✓			*Waste Disposal (Chemical Waste) (General) Regulation* *Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes*
Sewage								
S6.6.5	• The sewage sludge from the portable toilet should be collected by a reputable collector on a regular basic.	Within the construction site / Throughout the construction period	Contractor		✓			-
General Refuse								

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<tr><td>S6.6.6</td><td>• General refuse should be stored in enclosed bins or compaction units separately from construction and chemical wastes.</td><td>Within the construction site / Throughout the construction period</td><td>Contractor</td><td></td><td>✓</td><td></td><td></td><td><i>Waste Disposal Ordinance</i></td></tr>
<tr><td>S6.6.6</td><td>• General refuse should be removed from the site, separately from construction and chemical wastes, on a daily basis to minimise odour, pest and litter impacts.</td><td>Within the construction site / Throughout the construction period</td><td>Contractor</td><td></td><td>✓</td><td></td><td></td><td><i>Waste Disposal Ordinance</i></td></tr>
<tr><td>S6.6.6</td><td>• Burning of refuse on construction site is prohibited by law.</td><td>Within the construction site / Throughout the construction period</td><td>Contractor</td><td></td><td>✓</td><td></td><td></td><td><i>Waste Disposal Ordinance</i></td></tr>
<tr><td>S6.6.6</td><td>• Aluminium cans are often recovered from the waste stream by individual collectors if they are segregated and made easily accessible. As such, separate, labelled bins for their deposit should be provided if feasible. Materials recovered will be re-used on site or sold for recycling.</td><td>Within the construction site / Throughout the construction period</td><td>Contractor</td><td></td><td>✓</td><td></td><td></td><td><i>Waste Disposal Ordinance</i></td></tr>
<tr><td colspan="9"><u>Staff Training</u></td></tr>
<tr><td>S6.6.7</td><td>• Training should be provided to workers on the concepts of site cleanliness and on appropriate waste management procedures, including waste reduction, reuse and recycling at the beginning of the Contract.</td><td>Within the construction site / Throughout the construction period</td><td>Contractor</td><td></td><td>✓</td><td></td><td></td><td>-</td></tr>
<tr><td colspan="9"><i>LAND CONTAMINATION</i>
The following control measures should be implemented during the excavation of potentially contaminated soil and potentially contaminated groundwater:</td></tr>
<tr><td colspan="9"><u>Handling of potentially contaminated soil to be excavated</u></td></tr>
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Annex E	• Potentially contaminated soil should be treated in accordance with the remediation actions specified in the Remediation Action Plan (RAP) of this EIA Report and the treated soil should be reused within the Project Site as far as possible.	Within the contaminated area / Throughout the construction period	Contractor		✓			*EPD's Guidance Notes for Investigation and Remediation of Contaminated Sites of petrol Filling Stations, Boatyards and Car Repairing/Dismantling Workshops*
Annex E	• The temporary stockpile of excavated potentially contaminated materials should be contained in a container covered by HDPE sheet on top	Within the contaminated area / Throughout the construction period	Contractor		✓			*EPD's Guidance Notes for Investigation and Remediation of Contaminated Sites of petrol Filling Stations, Boatyards and Car Repairing/Dismantling Workshops*
Annex E	• Bioremediation by applying nutrient to the soil should be employed for the on-site treatment of excavated materials potentially contaminated by TPH.	Within the contaminated area / Throughout the construction period	Contractor		✓			*EPD's Guidance Notes for Investigation and Remediation of Contaminated Sites of petrol Filling Stations, Boatyards and Car Repairing/Dismantling Workshops*
Annex E	• If disposal of the treated excavated soil to the public fill bank is required, vehicles containing any excavated materials should be suitably covered to limit potential dust emissions or wastewater run-off, and truck bodies and tailgates will be sealed to minimise the risk of a discharge during transportation or during wet conditions.	Within the contaminated area / Throughout the construction period	Contractor		✓			*EPD's Guidance Notes for Investigation and Remediation of Contaminated Sites of petrol Filling Stations, Boatyards and Car Repairing/Dismantling Workshops*

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Annex E	• Records of the quantities of soil generated for off-site disposal will be maintained.	Within the contaminated area / Throughout the construction period	Contractor		✓			*EPD's Guidance Notes for Investigation and Remediation of Contaminated Sites of petrol Filling Stations, Boatyards and Car Repairing/Dismantling Workshops*
Handling of potentially contaminated groundwater								
Annex E	• As groundwater is not used for either domestic or industrial purposes at the site or in the adjacent areas, remediation of groundwater is not considered to be necessary for the Project to proceed. If groundwater is encountered during the construction of foundations, the groundwater abstracted or collected will be recharged back to the site.	Within the contaminated area / Throughout the construction period	Contractor		✓			*Water Pollution Control Ordinance*
Annex E	• The FODT and the oil separator serving it should be cleaned prior to demolition.	Within the contaminated area / Throughout the construction period	Contractor		✓			*Water Pollution Control Ordinance*
Annex E	• Oily water and sludge collected from the cleaning should be treated at the on-site wastewater treatment facility. Oily water and sludge collected from the cleaning should be collected and disposed of as chemical waste at Government chemical waste treatment facility.	Within the contaminated area / Throughout the construction period	Contractor		✓			*Waste Disposal Ordinance (Cap 354) and Waste Disposal (Chemical Waste) (General) Regulation (Cap 354C)*
Annex E	• Only licensed waste contractors should be used to collect and transport any chemical waste. The necessary waste disposal permits will be obtained, as required, from the appropriate authorities, in accordance with the *Waste Disposal Ordinance (Cap 354)* and *Waste Disposal (Chemical Waste) (General) Regulation (Cap 354C)*, as required.	Within the contaminated area / Throughout the construction period	Contractor		✓			*Waste Disposal Ordinance (Cap 354) and Waste Disposal (Chemical Waste) (General) Regulation (Cap 354C)*

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In order to minimise the contacts of the workers with the contaminated materials and to ensure safe work environments during the remediation works, the following safety measures are proposed								
Annex E	• Prior to commence any remediation work, a health and safety risk assessment should be performed for the remediation work to identify potential work related hazards and prepare appropriate control measures.	Within the contaminated area / Throughout the construction period	Contractor		✓			*Heath and safety controls* as stipulated under the *Factories and Undertakings Ordinance and Occupational Safety and Health Regulation*
Annex E	• Appropriate Personal Protective Equipment (PPE) such as safety hat, chemical protective gloves, masks (for both dust and vapour), eye goggles, protective clothing and protective footwear should be provided to staff who would be involved in the tank cleaning and contaminated area (FODT and TP3) remediation works. No works should be allowed without the suitable PPE.	Within the contaminated area / Throughout the construction period	Contractor		✓			*Heath and safety controls* as stipulated under the *Factories and Undertakings Ordinance and Occupational Safety and Health Regulation*
Annex E	• The workers should inspect and check their PPE before, during and after use. In cases where any of the PPE is impaired, the workers should stop work immediately and inform their supervisor. The workers should not be allowed to re-start their work until the impaired PPE is replaced.	Within the contaminated area / Throughout the construction period	Contractor		✓			*Heath and safety controls* as stipulated under the *Factories and Undertakings Ordinance and Occupational Safety and Health Regulation*
Annex E	• The workers should always maintain basic hygiene standard (e.g. hand wash before leaving the contaminated work area). The workers should also be responsible for cleaning and storing their own PPE in a secure place before leaving the site.	Within the contaminated area / Throughout the construction period	Contractor		✓			*Heath and safety controls* as stipulated under the *Factories and Undertakings Ordinance and Occupational Safety and Health Regulation*

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Annex E	• Eating, drinking and smoking should be strictly prohibited within the contaminated site area.	Within the contaminated area / Throughout the construction period	Contractor		✓			*Heath and safety controls* as stipulated under the *Factories and Undertakings Ordinance and Occupational Safety and Health Regulation*
Annex E	• The designated site management representatives must be informed if any workers feel uncomfortable physically or mentally during the remediation works. All workers should leave the work areas and the work should be temporarily suspended until the reason for the uncomfortable feeling has been identified.	Within the contaminated area / Throughout the construction period	Contractor		✓			*Heath and safety controls* as stipulated under the *Factories and Undertakings Ordinance and Occupational Safety and Health Regulation*
Annex E	• The works should be stopped or discontinued when Typhoon Signal No. 3 or Rainstorm Warning signals are hoisted. All stockpile materials (if any) should be covered immediately by tarpaulin or other similar protective and waterproof materials.	Within the contaminated area / Throughout the construction period	Contractor		✓			*Heath and safety controls* as stipulated under the *Factories and Undertakings Ordinance and Occupational Safety and Health Regulation*
Annex E	• Bulk earth-moving excavator equipment should be used to minimise construction workers' potential contact with contaminated materials.	Within the contaminated area / Throughout the construction period	Contractor		✓			*Heath and safety controls* as stipulated under the *Factories and Undertakings Ordinance and Occupational Safety and Health Regulation*
ECOLOGICAL IMPACT – CONSTRUCTION AND OPERATIONAL PHASES In accordance with the guidelines in the *EIAO-TM* on marine ecology impact assessment, the general policy for mitigating impacts to marine ecological resources, in order of priority, are:								
Measures for Marine Mammals								

EIA Ref.	**Environmental Protection Measures**	**Location/Duration of Measures/Timing of Completion of Measures**	**Implementation Agent**	**Implementation Stage**				**Relevant Legislation & Guidelines**
				Des	**C**	**O**	**Dec**	
S8.9	The following recommendations should be considered to minimize potential construction and operation impacts on dolphins and porpoises. • All vessel operators working on the Project construction or operation should be given a briefing, alerting them to the possible presence of dolphins in the area, and the guidelines for safe vessel operation in the presence of cetaceans. If high speed vessels are used, they should be required to slow to 10 knots when passing through a high density dolphin area (west Lantau, Sha Chau and Lung Kwu Chau); • The vessel operators should be required to use predefined and regular routes, as these will become known to dolphins using these waters; • The vessel operators should be required to control and manage all effluent from vessels; • A policy of no dumping of rubbish, food, oil, or chemicals should be strictly enforced. This should also be covered in the contractor briefings; • Every attempt should be made to minimize the effects of construction of the Project on the water quality of the area;	Within the marine works area / Throughout the construction period / Operation of the additional berthing facility	Contractor / CLP Power (as CAPCO operator)		✓	✓		-

EIA Ref.	Environmental Protection Measures	Location/Duration of Measures/Timing of Completion of Measures	Implementation Agent	Implementation Stage				Relevant Legislation & Guidelines
				Des	C	O	Dec	
S8.9	To limit potential impacts to cetaceans from underwater percussive piling, the following steps should be taken: • Quieter hydraulic hammers should be used instead of the noisier diesel hammers; • An exclusion zone of 500 m radius should be scanned around the work area for at least 30 minutes prior to the start of piling. If cetaceans are observed in the exclusion zone, piling should be delayed until they have left the area; and, • Acoustic decoupling of noisy equipment on work barges should be undertaken. These techniques include the use of a soft sling to retain the pile driving hammer, rubber tyred air compressor for bubble jacket/curtain, rubber pads on barge leaders and guides, and an air curtain around the pile barge.	Within the dredging area /Throughout the construction period	Contractor		✓			-
VISUAL – CONSTRUCTION PHASE								
S9.3.5	The new structures associated with the Project, including those of the additional conveyor systems, should be painted in a colour scheme that complements the surrounding industrial setting of the existing CPPS.	New structures associated with the Project	Contractor		✓			-
VISUAL – OPERATIONAL PHASE No mitigation measures are required.								

Des=Design; C=Construction; O=Operation; Dec=Decommissioning

11 SUMMARY OF ENVIRONMENTAL OUTCOMES AND CONCLUSIONS

The Emissions Control Project at CPB will result in significant emission reductions of SO_2 and NO_x. Further reduction in particulate emissions is also anticipated as a result of SO_2 emission control in addition to existing high efficiency ESP.

The construction and operation of the Project could also result in some environmental impacts which have been the subject of a detailed assessment under this Study. They are summarised and discussed in the following sub-sections.

11.1 AIR QUALITY

11.1.1 Construction Phase

Dust from excavation, site formation and construction activities is the only key air quality concern during the construction of the Project. Owing to the small scale of the civil construction requirement and the distance from the ASRs, no adverse dust impact is anticipated. In addition, only a limited number of diesel-powered equipment will be operated on site, and therefore impact from construction equipment is expected to be minimal. With the implementation of the dust control measures stipulated in the *Air Pollution Control (Construction Dust) Regulation*, no adverse air quality impact is envisaged from the construction of the Project.

11.1.2 Operational Phase

Except for a slight increase of emissions associated with marine traffic due to increased reagent and by-product transportation, the operation of the Project will not introduce any additional emissions of air pollutants, while the SO_2 and NO_x emissions will be significantly reduced.

The following reduction efficiencies are used as the basic assumptions for the operational air quality assessment:

- SO_2 emission reduction by up to 90%; and
- NO_x emission reduction by up to 80%.

A comparative air quality assessment was conducted for CPB by scale model testing performed in a Boundary Layer Wind Tunnel to simulate the behaviour of the exhaust plume before and after installation of the proposed emission control equipment.

The modelled percentage reduction in SO_2 and NO_x concentrations at the 36 ASR locations after implementation of the retrofit programme are similar in magnitude to the proposed emission reductions at source. The effects of changes in flue gas characteristics on the dispersion of emissions were minor and insignificant when compared to the corresponding reductions in SO_2 and NO_x emissions from CPB after retrofit.

The comparative study demonstrated that all the identified ASRs will have an improvement in air quality after the retrofit as required in *Section 3.4.1.2* of the *Study Brief*.

11.2 NOISE

11.2.1 Construction Phase

The construction noise assessment conducted for the Project indicates that the predicted noise levels at the noise sensitive receivers (NSRs) are expected to range from 43 to 51 dB(A) and therefore within the noise criteria. This is due mainly to the considerable separation distance and the screening offered by the topography and the existing buildings. In view of the assessment results, the noise generated during the construction phase is not expected to cause any adverse impact and mitigation measures will not be required.

11.2.2 Operational Phase

The noise levels at the identified NSRs (Sha Po Kong village and the planned holiday camp at Siu Lang Shui) from the operation of the Project have been predicted based on the specified maximum sound pressure levels (SPL) for the new equipment to be installed at CPB. The results indicate that the identified NSRs will be subject to noise levels of up to 35 dB(A), which complies with both the stipulated daytime and night-time noise criteria.

The suppliers of the new equipment should guarantee the specified SPL by providing certificate of measurement and verify the SPL during testing and commissioning in accordance with international standard procedures. If necessary, the suppliers should apply attenuation measures to achieve the guaranteed noise levels during the detailed design stage. With the noise specifications in place, further mitigation measures will not be required during the operational phase of the Project.

11.3 WATER QUALITY

11.3.1 Construction Phase

The water quality modelling works, with the assumption of no mitigation measures to be adopted, have indicated that for both the dry and wet seasons, no exceedances of the WQO and the evaluation criterion are predicted to occur during the dredging operations. The impact assessment has also shown that other land-based construction works, if properly controlled, are not expected to cause any adverse impacts to the surrounding waters and the sensitive receivers.

11.3.2 Operational Phase

No effluent is anticipated from the operation of the NO_x control system and water quality impact is not expected.

In the LS-FGD process, the gypsum slurry from the absorber unit is treated, resulting in dewatered gypsum and a small quantity of liquid effluent. The resulting effluent may have a small chemical oxygen demand and/or reduced dissolved oxygen concentrations.

The effluent will be treated to comply with the discharge standards stipulated in the *Technical Memorandum on Standards for Effluents Discharged Into Drainage And Sewerage Systems, Inland And Coastal Waters* issued under the *Water Pollution Control Ordinance*. It will then be added to the cooling water flows and discharged via the existing sub-marine cooling water outfall of CPB, resulting in a small increase (about 0.02%) in the total flows from the outfall. The treated FGD effluent would not be expected to have any adverse effect on the temperature of the cooling water or on the quantities of residual chlorine in the discharge. The high degree of mixing inherent in the coastal margin or coastal zone will result in rapid dilution of the effluent to very low concentrations and no exceedance of the WQO or evaluation criteria for DO, dissolved metals, temperature, SS, salinity and sulphate are expected. As a result, further mitigation measures are considered unnecessary.

11.4 WASTE MANAGEMENT

11.4.1 Construction Phase

The key potential impacts during the construction phase are related to management of dredged sediments, demolition materials, excavated materials and construction waste.

About 80,700 m^3 of uncontaminated sediment will be dredged to be disposed of at an open sea. The final disposal site will be determined by the MFC and a dumping licence will be obtained from EPD prior to the commencement of the dredging works.

An estimated 50 m^3 of potentially contaminated soil within the Project boundary will be treated and disposed of in accordance with the Remediation Action Plan (RAP).

A total of about 835 tonnes of scrap steel will be produced during demolition of oil tanks and the associated fixtures/ appendages. All the scrap steel will be delivered off-site by barge/truck for recycling.

A total of about 30,000 m^3 of excavated soil will be generated from the demolition and construction works. All excavated soil will be reused for the backfilling on-site.

Small quantities of chemical wastes (less than 100 litres per month), sewage (a maximum of 135 m^3 per day) and general refuse (a maximum of 585 kg per day) will be generated during the construction phase.

With the implementation of the mitigation measures recommended, the potential environmental impacts arising from storage, handling, collection, transport and disposal of wastes should be able to meet the criteria specified in the *EIAO-TM*. No adverse waste management impact is anticipated.

11.4.2 Operational Phase

About 240,000 tonnes of commercial grade gypsum will be generated each year from the FGD process and can be commercially recycled in PRD and East Asia region. Similarly the lower grade gypsum (about 17,000 tonnes per year) can also be reused for cement production. About 180 tonnes at 30% dry solids of sludge from FGD wastewater treatment is expected to be generated everyday. Design optimisation of the FGD wastewater treatment system and exploration of additional disposal options, such as off-take by the limestone supplier and gypsum off-taker, are ongoing to further reduce the quantity of sludge to be disposed of at Government landfills.

With the implementation of the recommended mitigation measures, the potential environmental impacts associated with the storage, handling, collection, transport and disposal of a small quantity of industrial waste and general refuse arising from the operation of the Project will meet the criteria specified in the *EIAO-TM* and no adverse waste management impact is anticipated.

11.5 LAND CONTAMINATION

A number of existing facilities at CPB, including the FODT, the DG Store, the IPRS, the LPG compound and the CO_2 tanks, are required to be demolished to accommodate the proposed emissions control equipment. A land contamination assessment was carried out at these areas following the methodology and procedures prescribed in the Contamination Assessment Plan (CAP) approved by the EPD. The land contamination assessment included soil and groundwater sampling, laboratory analyses for target parameters, preparation of Contamination Assessment Report (CAR) and preparation of Remediation Action Plan (RAP).

With the implementation of the remedial measures in the RAP, the hazard and environmental impacts associated with the potential land contamination and handling and treatment of the contaminated soil and groundwater are considered very low.

11.6 *ECOLOGY*

The land-based construction works and operations of the Project will be conducted entirely within the existing industrial site of CPPS and therefore no impact on terrestrial ecology is envisaged.

The literature review of the existing marine ecological resources of the Study Area identified two key sensitive receivers, namely the Sha Chau and Lung Kwu Chau Marine Park and the Indo-pacific humpback dolphin (*Sousa chinensis*) habitat. The assessment of the potential construction and operational phase impacts to marine ecological resources has indicated that no significant adverse effects will impact the sensitive receivers as impacts arising from the proposed construction works are predicted to be confined to the area to be dredged and the area for the construction of the additional berthing facility, both of which have low ecological sensitivity.

The predicted alterations of the water quality parameters attributable to construction and operational activities are not expected to cause exceedances of the WQO, and therefore no impacts to the marine ecological resources or marine mammals are anticipated.

Mitigation measures designed to minimise impacts to the population of Indo-pacific humpback dolphins that use the area include restrictions on vessel speed while adopting local construction practice of using bubble curtains/jacket during percussive piling work for the construction of the additional berthing facility. Other mitigation measures designed to mitigate impacts to water quality to acceptable levels (compliance with WQOs) are also expected to mitigate impacts to marine ecological resources.

11.7 *LANDSCAPE AND VISUAL CONSIDERATIONS*

With the new structures of the emissions control equipment located within the existing industrial setting of CPB, the Project is not expected to result in any negative impact on the surrounding landscape and it will also have a very low visibility.

11.8 *CONCLUSION*

The Emissions Control Project at CPB will result in significant emission reductions of SO_2 and NO_x. Further reduction in particulate emissions is also anticipated as a result of the LS FGD operation.

The detailed impact assessment concluded that no adverse environmental impacts are envisaged in the areas of air and water quality, noise, waste management, land contamination, ecology and visual appearance during both the construction and operational phases.

Annex A

Wind Tunnel Test Methodology and Results

A1 METHODOLOGY

A1.1 INTRODUCTION

In addition to lowering the air pollutant emission levels, the Emission Control Project will also result in lowering the temperature and exit velocity of the gases leaving the CPB stacks. This creates the potential that at some near-field receivers, the ground level concentrations of SO_2 and NO_x may be higher due to the lower plume rise, despite the reductions in emissions. The Study Brief stipulates that "The Applicant may carry out a comparative study to demonstrate if the stack emission impacts of the "B" Units before and after the Project will lead to lower air quality impacts at the Air Sensitive Receivers (ASRs) by using either a simple screening tool such as ISCST3 Gaussian model or a more sophisticated tool, such as wind tunnel test, if necessary". The following sub-sections describe the methodology and results of such comparative assessment, using a Wind Tunnel testing methodology.

A1.2 WIND TUNNEL METHODOLOGY (GENERAL)

The spatially and temporally variable meteorological and atmospheric dispersion conditions associated with complex terrain pose several challenges to assessing the dispersion of airborne pollutants in a coastal, mountainous region such as the Study Area. Physical scale wind tunnel modelling accounts for building wake and complex terrain effects, and is one of the most accurate methods for the simulation of these near-field influences for neutrally stable atmospheric conditions.

In general, wind tunnel air quality studies involve placing a physical model of the emission sources and surrounding terrain in a wind tunnel, emitting a passive tracer from the sources and measuring its concentrations at a number of receivers inside the wind tunnel for different wind speeds and directions. The raw results come in the form of *Concentration Ratios* expressing the dilution of the pollutant from a source to the identified receptor for a given wind speed and direction. The concentration ratios depend on the source and receptor locations and the source characteristics, such as release height and exit temperature and velocity, and on the meteorological conditions tested, but do not depend on the emission levels of particular pollutants. However, the concentration ratios can be easily converted into the predicted concentrations of different pollutants by a simple scaling procedure based on the tracer concentration at the source and the corresponding pollutant concentrations.

A1.3 THE PRESENT STUDY

Wind tunnel tests for this study were conducted by Rowan Williams Davies & Irwin Inc. (RWDI) of Guelph, Ontario, Canada. The RWDI methodology for physical modelling of exhaust dispersion is based on the similitude theory and

USEPA-approved guidance provided by Snyder, W.H. in *Guideline for Fluid Modeling of Atmospheric Diffusion*. In particular, adequate Reynolds numbers were maintained inside the wind tunnel in order to assure the similarity of the wind tunnel modelled turbulent flow to that in the real terrain.

It should be noted that, as discussed by Snyder, it is generally impossible to match all dimensionless parameters (eg Reynolds number, Froude number, Rossby number and Peclet number) at the same time for model scales greater than 10:1. The guidance provided by Snyder and briefly summarized below gives a detailed evaluation of the appropriate criteria for non-dimensional parameters and discusses their limitations and conditions for their relaxing.

The Rossby number is an indicator of how important the Coriolis accelerations are when compared with advective accelerations. A large Rossby number means small Coriolis accelerations, and therefore the enhanced dispersion due to wind shear may be ignored. Published literature and data provide information regarding the length scales considered borderline for consideration of Rossby number. These distances are in the range of 5 to 12 km from the source under neutral or stable atmospheric conditions in flat terrain. The Coriolis forces may also be ignored when modelling rugged terrain, in which case the flow is dominated by the advective forces. As the modelling area for this Study is in line with these criteria, the Coriolis forces may be ignored.

The square of the Froude number represents the ratio of inertial forces to buoyancy forces. A large value of the Froude number means that buoyancy forces are small compared to inertial forces and as such, simulation of the nondimensional parameter is not required and this is the case for this Study. In addition, the dispersion in the study area is dominated by mechanical mixing as a result of the wind interaction with the rugged terrain.

The Peclet and Reynolds-Schmidt numbers are products of Reynolds number and a ratio of molecular transport coefficients. Turbulent diffusion in the atmosphere dominates molecular diffusion in turbulent flows, therefore the effect of not matching the Peclet and Reynolds-Schmidt numbers of the prototype in the model is not significant.

The Reynolds Number is a measure of the turbulence of the flow. The scale reductions typically result in model Reynolds numbers that are three to four orders of magnitude lower than in the atmosphere. Flow modelling is made possible by the Reynolds number independence theory that stipulates that for a specified flow system, in the absence of Coriolis and thermal effects, the turbulent flow structure is similar at all sufficiently high Reynolds numbers. Essentially, geometrically similar flows are similar at all sufficiently high Reynolds numbers. Therefore, rather than reproducing the Reynolds number exactly, it is sufficient to ensure that it remains above a critical threshold, which can be lowered by placing trip wires and flow restrictions inside the model stack. This method was used in this project: the stacks were tripped, and the experimental data confirm that adequate Reynolds numbers were maintained during all wind tunnel tests.

A 1:2000 scale model of the site including the existing plant and all surrounding terrain was constructed and put on a disk (see *Figure A.1*). In order to quantify impacts on regions that cannot be accommodated on the disk, extensions were constructed. Another disk was constructed for some areas where the separation distance between the source and receptor location was greater than 12 km.

The completed model and extensions were placed in RWDI's Boundary layer Wind Tunnel (BLWT) and rotated to simulate any desired wind direction. The diameter of the turning table was 4.87 m corresponding to a full scale value of approximately 9.7 km. Thus, the actual constructed (physical) model was in fact much larger and sections of the model had to be moved during the testing procedures. To facilitate measurements at the receptors located farther away, the exhaust stacks were placed upwind on the disk and ASRs were installed on downwind model extensions.

Similarly, the fan speed was adjusted to simulate a variety of wind speeds. Turbulence generators were placed in the tunnel upwind of the model to simulate the mean and turbulent characteristics of the approaching wind in an open setting.

The actual measurements using carbon monoxide were preceded by flow visualization tests, performed as a qualitative assessment to understand how the exhaust plume was affected by different meteorological conditions and terrain effects.

The wind tunnel simulated the winds approaching the Study Area, the exhaust discharged from the source being tested and the dispersion of the exhaust in the atmosphere. The wind tunnel tests were conducted by emitting a tracer gas at a scaled concentration and flow rate for each of the scenarios tested. Carbon monoxide (CO) was used as the tracer gas in this study and it was mixed with helium to simulate the buoyant characteristics of the exhaust plume. The CO was introduced into each exhaust source at an initial concentration, C_o, of approximately 6% (60,000 ppm). Mean concentrations of CO were measured at identified sensitive receivers by drawing samples through tubes (receptors) leading to a bank of infrared analyzers stationed outside the tunnel. The measured CO concentration at each receptor location was compared to the CO concentration at the stack and the results are presented as concentration ratios. The concentration ratios presented in *Annex A* represent the percentage of the initial source concentration, measured at each receptor, for a wide range of conditions.

Quantitative tracer gas testing was performed for five wind speeds (2.8, 5.1, 7.4, 9.7 and 12 m s^{-1} referenced to 10 m full scale above ground in open terrain) and all wind directions necessary to assess the plume impacts at all receptor locations. Wind directions were adjusted in 5 degree increments. Receptor locations were selected according to the *Study Brief*.

In order to accurately simulate the exhaust plume for each scenario, detailed scaling of the full scale exhaust parameters and approaching wind was performed. A combination of both momentum and buoyant scaling, following the classic approach of Snyder [1]was implemented for the modelled exhaust.

A1.4 *EXHAUST PARAMETERS STUDIED*

The exhaust parameters for the modelled exhaust source before and after the retrofit are summarized in *Table A.1*. Scenario 1 is representative of operating conditions before the implementation of the retrofit programme. All four flues have the same exhaust parameters for this scenario. Scenario 2 is representative of operating conditions after the implementation of the retrofit programme. For this scenario, there was a decrease in the exhaust flow rate, temperature and exit velocity, as shown in *Table A.1*. All four flues have the same exhaust parameters for Scenario 2.

Table A.1 Source Exhaust Parameters

Scenario	**Number of Stacks**	**Chimney Height (m)**	**Inside Flue Diameter (m)**	**Flow Rate (m^3s^{-1})**	**Efflux Temp. (^oC)**	**Efflux Velocity ($m\ s^{-1}$)**
Scenario 1 - Before Retrofit	4 flues in one chimney	250 above ground	6.6 each flue	821 each flue	110 each flue	24.0 each flue
Scenario 2 - After Retrofit	4 flues in one chimney	250 above ground	6.6 each flue	756 each flue	80 each flue	22.1 each flue

The stack exit concentrations of SO_2, NO_x and particulates before and after the retrofit were assumed according to the current licence limits[2] and the anticipated emission reduction efficiencies of 90%, 80% and 60% respectively.

A1.5 *AIR SENSITIVE RECEIVERS IN THE WIND TUNNEL*

A total of 36 ground level and elevated receptors, were installed on the scale model to represent 23 locations of Air Sensitive Receivers (ASRs) at which the comparison between Scenario 1 and 2 was measured. Thirteen of these locations are represented by two receptors installed at different levels above the ground. The ASRs are listed in *Table 3.3* of the main report; their locations shown in *Figure A.2*. Note that the location of the exhaust source as well as the two modelling disks configuration is also shown in *Figure A.2.*

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[1] Snyder, W.H., ***Guideline for Fluid modeling of Atmospheric Diffusion***, US EPA Report, 600/8-81-009, 1981

[2] Current licence limits for SO_2, NO_x and particulates are 2,100, 1,500 and 125 mg Nm^{-3} respectively.

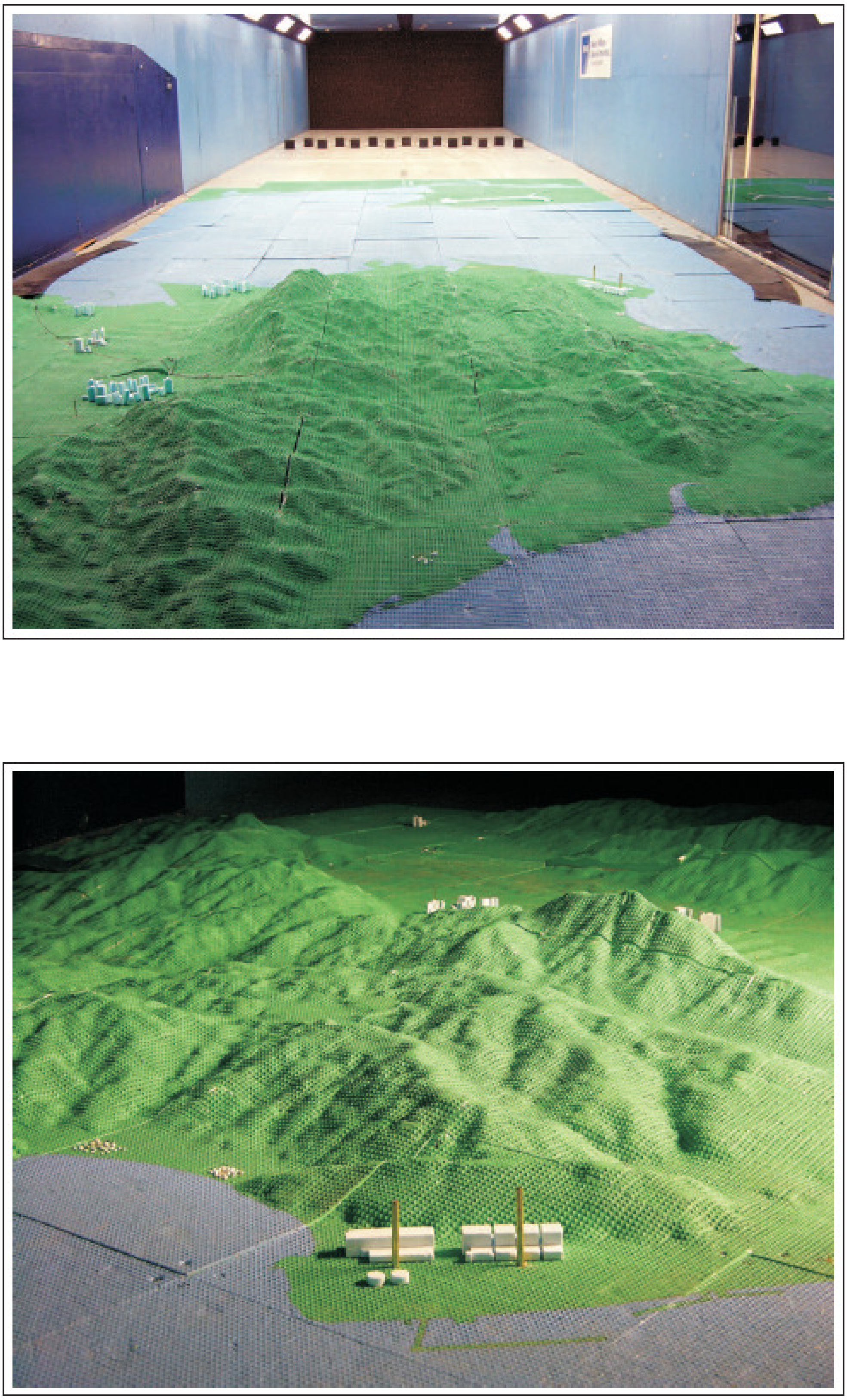

Figure A.1 Physical Model inside the Wind Tunnel

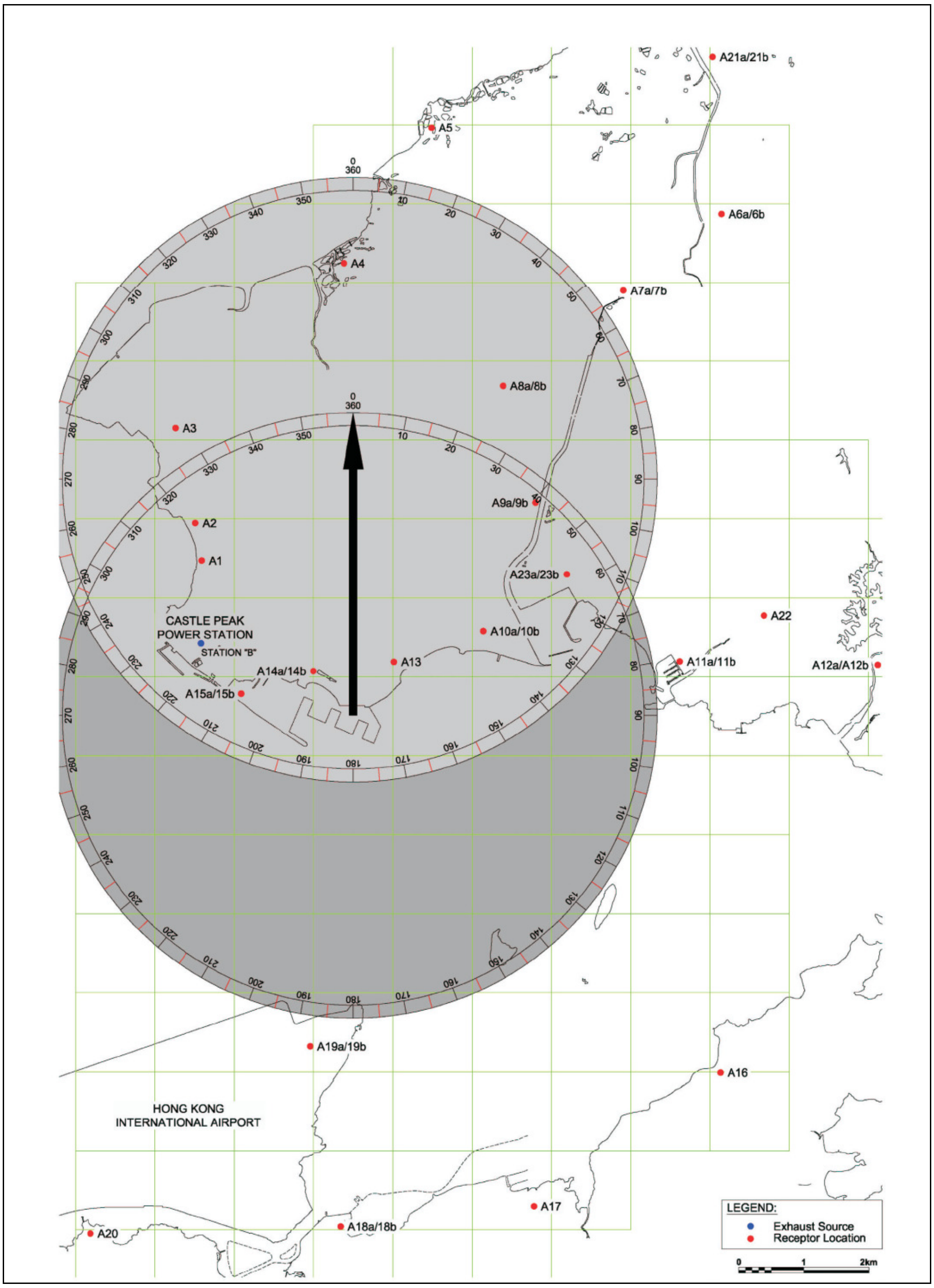

Figure A.2 *Exhaust Source and Locations of Wind Tunnel Air Sensitive Receivers (ASRs)*

A2 RESULTS

A2.1 MEASURED CONCENTRATION RATIOS

Measured concentration ratios (%) for each of the tracer gas tests performed before and after the retrofit are presented in *Tables A2* and *A3* below. These tables summarize concentration ratios (presented as a percent) for each receptor location and for each scenario tested. The meteorological conditions of wind speed and wind direction at which each measurement was made are also identified. The concentration ratios, together with the assumed source concentrations of each pollutant form the basis for predicting of pollutant concentrations at each receptor before and after the retrofit.

Table A.2: Concentration Ratios (%) - Before Retrofit

RECPTR LABEL	WIND m/s	165	170	175	180	185	190	195	200	205	210	215	220	225	230	235	240
1	2.8	***	***	***	***	***	***										
1	5.1	***	***	***	***	***	***										
1	7.4	***	***	***	***	***	***										
1	9.7	***	***	***	***	***	***										
1	12.0	***	***	***	***	***	***										
2	2.8	***	***	***	***	***	***										
2	5.1	***	***	***	***	***	***										
2	7.4	***	***	0.0006	0.000733333	***	***										
2	9.7	***	***	0.001666667	0.0021	0.0012	***										
2	12.0	***	0.0009	0.003266667	0.0057	0.0034	0.0013										
3	2.8	***	***	***	***	***	***										
3	5.1	***	0.002733333	0.003866667	0.0025	0.0008	***										
3	7.4	0.0006	0.004366667	0.011033333	0.007966667	0.0013	***										
3	9.7	0.0016	0.0083	0.020166667	0.014133333	0.00375	***										
3	12.0	0.0012	0.0103	0.025666667	0.020466667	0.0071	***										
4	2.8							0.0009231	0.0022147	0.001116867	***	***					
4	5.1							0.0035964	0.015717333	0.012775	0.004385	***					
4	7.4							0.006556	0.026803333	0.023063333	0.00778	***					
4	9.7							0.007469333	0.030983333	0.028156667	0.009571333	***					
4	12.0							0.007397333	0.030883333	0.029696667	0.010900667	***					
5	2.8							***	0.002901	0.004955667	***	***					
5	5.1							***	0.00855	0.018206667	0.00461	***					
5	7.4							***	0.011383333	0.02629	0.014774	***					
5	9.7							***	0.011288	0.025443333	0.01442	***					
5	12.0							***	0.009972	0.024613333	0.01528	***					
6a	2.8											***	***	0.0012	0.0037	0.003766667	0.0013
6a	5.1											***	***	0.0027	0.0106	0.012666667	0.003733333
6a	7.4											***	***	0.0018	0.009266667	0.013533333	0.0048
6a	9.7											***	***	0.0016	0.007333333	0.011533333	0.004966667
6a	12.0											***	***	0.0014	0.006333333	0.010233333	0.004633333
6b	2.8											***	***	0.0011	0.003233333	0.003166667	0.0009
6b	5.1											***	***	0.0027	0.010566667	0.012	0.003266667
6b	7.4											***	***	0.0016	0.009266667	0.013	0.004066667
6b	9.7											***	***	0.0015	0.007	0.0109	0.0044
6b	12.0											***	***	0.0014	0.0061	0.009566667	0.003933333
7a	2.8											***	***	***	0.003166667	0.003766667	0.0023
7a	5.1											***	***	0.0019	0.009833333	0.0138	0.006333333
7a	7.4											***	***	0.0007	0.009166667	0.016466667	0.008266667
7a	9.7											***	***	0.0015	0.008266667	0.014966667	0.0096
7a	12.0											***	***	0.0009	0.0071	0.0137	0.008033333
7b	2.8											***	***	***	0.0028	0.0031	0.0018
7b	5.1											***	***	0.0021	0.008866667	0.012033333	0.005366667
7b	7.4											***	***	0.0008	0.0084	0.0146	0.0072
7b	9.7											***	***	0.0013	0.0074	0.013233333	0.008166667
7b	12.0											***	***	0.0009	0.0063	0.011966667	0.006866667

Table A.2 (continued): Concentration Ratios (%) - Before Retrofit

RECPTR LABEL	WIND m/s	165	170	175	180	185	190	195	200	205	210	215	220	225	230	235	240
8a	2.8											***	***	0.0007	0.0007	***	***
8a	5.1											***	0.0007	0.0026	0.003133333	0.001466667	0.0012
8a	7.4											***	0.0009	0.0047	0.0066	0.003266667	0.001266667
8a	9.7											***	0.0008	0.004566667	0.007433333	0.004	0.001733333
8a	12.0											***	***	0.005233333	0.0073	0.0043	0.001666667
8b	2.8											***	***	***	0.0007	***	***
8b	5.1											***	***	0.0018	0.004366667	0.004133333	0.002666667
8b	7.4											***	***	0.002233333	0.006166667	0.0065	0.003733333
8b	9.7											***	***	0.0021	0.006733333	0.007066667	0.004833333
8b	12.0											***	***	0.0019	0.006466667	0.0074	0.004466667

Table A.2 (continued): Concentration Ratios (%) - Before Retrofit

RECPTR LABEL	WIND m/s	245	250	255	260	265	270	275	280	285	290	310	315	320	325	330
9a	2.8	0.0028	0.008133333	0.004466667	0.0009	***	***	***								
9a	5.1	0.0113	0.039266667	0.0231	0.004666667	0.0018	***	***								
9a	7.4	0.017266667	0.0448	0.0273	0.0076	0.0014	***	***								
9a	9.7	0.017833333	0.041333333	0.027266667	0.008333333	0.0017	***	***								
9a	12.0	0.015233333	0.036333333	0.0244	0.007733333	0.001833333	***	***								
9b	2.8	0.005266667	0.010066667	0.003866667	0.0009	***	***	***								
9b	5.1	0.021066667	0.0433	0.021266667	0.0045	0.0016	***	***								
9b	7.4	0.0275	0.048366667	0.025866667	0.0077	0.0014	***	***								
9b	9.7	0.0256	0.0421	0.025066667	0.0082	0.001633333	***	***								
9b	12.0	0.021966667	0.037333333	0.022566667	0.007566667	0.001833333	***	***								
10a	2.8	***	***	***	***	0.0013	0.0018	0.0016								
10a	5.1	***	***	***	0.001733333	0.007766667	0.0125	0.003966667								
10a	7.4	***	***	***	0.005	0.0218	0.0293	0.0101								
10a	9.7	***	***	0.0012	0.006266667	0.029633333	0.038066667	0.013233333								
10a	12.0	***	***	0.0019	0.008466667	0.034	0.0388	0.010933333								
10b	2.8	***	***	***	0.0007	0.001	0.001433333	0.001								
10b	5.1	***	***	***	0.002666667	0.010033333	0.0116	0.0055								
10b	7.4	***	***	***	0.006433333	0.027333333	0.0275	0.005333333								
10b	9.7	***	***	0.0011	0.0076	0.0349	0.035533333	0.007166667								
10b	12.0	***	***	0.0018	0.009766667	0.039033333	0.0347	0.0054								
11a	2.8					0.0006	0.002366667	0.0042	***	***	***					
11a	5.1					0.003966667	0.016333333	0.009133333	0.0009	***	***					
11a	7.4					0.012366667	0.032033333	0.0153	0.0014	***	***					
11a	9.7					0.010933333	0.0327	0.017133333	0.0012	***	***					
11a	12.0					0.0113	0.030666667	0.0141	0.0013	***	***					
11b	2.8					***	0.00455	0.0045	***	***	***					
11b	5.1					0.0036	0.0177	0.0142	0.0028	***	***					
11b	7.4					0.010833333	0.0339	0.020633333	0.0034	***	***					
11b	9.7					0.0097	0.032933333	0.022133333	0.0028	***	***					
11b	12.0					0.009733333	0.030833333	0.018866667	0.0027	***	***					
12a	2.8					***	0.0069	0.00465	***	***	***					
12a	5.1					***	0.0149	0.0131	0.001	***	***					
12a	7.4					0.0008	0.014433333	0.0169	0.0022	***	***					
12a	9.7					***	0.0205	0.016566667	0.0016	***	***					
12a	12.0					0.001	0.01815	0.014566667	0.0012	***	***					
12b	2.8					***	***	0.00445	***	***	***					
12b	5.1					***	0.01505	0.0127	0.0011	***	***					
12b	7.4					0.0012	0.0146	0.016433333	0.0023	***	***					
12b	9.7					0.0008	0.013866667	0.015966667	0.0016	***	***					
12b	12.0					0.00105	0.012333333	0.014133333	0.0013	***	***					

Table A.2 (continued): Concentration Ratios (%) - Before Retrofit

RECPTR LABEL	WIND m/s	245	250	255	260	265	270	275	280	285	290	310	315	320	325	330
13	2.8					***	***	***	***	***	***					
13	5.1					0.00145	0.003466667	0.002433333	0.0009	***	***					
13	7.4					0.006233333	0.0124	0.0093	0.0032	***	***					
13	9.7					0.009333333	0.019266667	0.0139	0.0023	***	***					
13	12.0					0.0152	0.026933333	0.011866667	0.0044	***	***					
14a	2.8					***	***	***	***	***	***					
14a	5.1					***	***	***	0.0008	***	***					
14a	7.4					***	***	***	0.0018	0.0009	***					
14a	9.7					***	***	0.001266667	0.0019	0.001333333	***					
14a	12.0					***	0.0015	0.0034	0.0064	0.003533333	0.0009					
14b	2.8					***	***	***	***	***	***					
14b	5.1					***	***	***	0.001033333	0.000833333	***					
14b	7.4					***	***	0.000933333	0.001466667	0.001333333	0.0009					
14b	9.7					***	0.0008	0.0017	0.003333333	0.002633333	***					
14b	12.0					***	0.0022	0.004666667	0.009366667	0.005633333	0.0014					
15a	2.8											***	***	***	***	***
15a	5.1											***	***	***	***	***
15a	7.4											***	***	***	***	***
15a	9.7											***	***	***	***	***
15a	12.0											0.0007	0.0007	***	***	***
15b	2.8											***	***	***	***	***
15b	5.1											***	***	***	***	***
15b	7.4											0.0121	0.0121	***	***	***
15b	9.7											0.0101	0.0101	***	***	***
15b	12.0											0.012	0.012	***	***	***

Table A.2 (continued): Concentration Ratios (%) - Before Retrofit

RECPTR LABEL	WIND m/s	305	310	315	325	330	335	340	345	350
16	2.8	0.0042	0.009133333	0.002						
16	5.1	0.0121	0.028233333	0.0066						
16	7.4	0.013333333	0.032366667	0.006633333						
16	9.7	0.0107	0.028533333	0.0059						
16	12.0	0.009633333	0.0267	0.006466667						
17	2.8				0.0012	0.004666667	0.0014	***	***	***
17	5.1				0.009433333	0.018266667	0.0127	***	***	***
17	7.4				0.015566667	0.028633333	0.0178	***	***	***
17	9.7				0.018666667	0.031533333	0.0206	***	***	***
17	12.0				0.015966667	0.027533333	0.0192	***	***	***
18a	2.8				***	***	***	0.003666667	0.009633333	0.004033333
18a	5.1				***	***	***	0.013266667	0.035966667	0.016366667
18a	7.4				***	***	***	0.010466667	0.034333333	0.0151
18a	9.7				***	***	***	0.010766667	0.029666667	0.011866667
18a	12.0				***	***	***	0.008633333	0.024	0.008366667
18b	2.8				***	***	***	0.0075	0.007233333	0.002766667
18b	5.1				***	***	***	0.010366667	0.031666667	0.014733333
18b	7.4				***	***	***	0.008633333	0.034133333	0.015966667
18b	9.7				***	***	***	0.010466667	0.0315	0.0135
18b	12.0				***	***	***	0.008466667	0.0267	0.010266667
19a	2.8				***	***	***	0.0041	0.003566667	0.0027
19a	5.1				***	***	***	0.018366667	0.028733333	0.008866667
19a	7.4				***	***	***	0.0227	0.043633333	0.014566667
19a	9.7				***	***	***	0.027266667	0.045633333	0.013633333
19a	12.0				***	***	***	0.0229	0.039266667	0.0103
19b	2.8				***	***	***	0.003533333	0.005633333	0.0043
19b	5.1				***	***	***	0.0232	0.030133333	0.009366667
19b	7.4				***	***	0.0007	0.020966667	0.041133333	0.0135
19b	9.7				***	***	***	0.0341	0.045266667	0.012333333
19b	12.0				***	***	0.0013	0.022633333	0.040233333	0.0101

Table A.2 (continued): Concentration Ratios (%) - Before Retrofit

RECPTR LABEL	WIND m/s	5	10	15	215	220	225	230	235	240	245	250	255	260	265	270	275
20	2.8	0.008033333	0.011566667	0.0012													
20	5.1	0.015466667	0.035	0.005													
20	7.4	0.014133333	0.031233333	0.0047													
20	9.7	0.012466667	0.028433333	0.004													
20	12.0	0.0107	0.023033333	0.0034													
21a	2.8				***	0.003433333	0.0029	***	***	***							
21a	5.1				***	0.0182	0.010466667	***	***	***							
21a	7.4				***	0.0163	0.011366667	0.001	***	***							
21a	9.7				***	0.016666667	0.012333333	0.0008	***	***							
21a	12.0				***	0.0136	0.0104	0.0011	***	***							
21b	2.8				0.0009	0.002833333	0.0018	***	***	***							
21b	5.1				0.0012	0.013066667	0.010733333	***	***	***							
21b	7.4				0.0011	0.012466667	0.011833333	0.0014	***	***							
21b	9.7				0.0006	0.012633333	0.0124	0.001	***	***							
21b	12.0				0.0007	0.010233333	0.010466667	0.0013	***	***							
22	2.8										***	***	***	0.0025	0.003966667	0.0031	***
22	5.1										***	***	***	0.0167	0.021166667	0.013533333	0.0031
22	7.4										***	***	0.0008	0.0082	0.033066667	0.020633333	0.0046
22	9.7										***	***	***	0.008466667	0.0308	0.019133333	0.0038
22	12.0										***	***	***	0.008166667	0.028933333	0.016266667	0.0018
23a	2.8										***	***	0.0015	0.002066667	0.0014	***	***
23a	5.1										***	***	0.012366667	0.022666667	0.010966667	0.0012	***
23a	7.4										***	0.0014	0.018033333	0.039833333	0.019366667	0.002633333	***
23a	9.7										***	0.0032	0.021933333	0.040966667	0.0198	0.003066667	***
23a	12.0										***	0.0026	0.021333333	0.041566667	0.0199	0.003466667	***
23b	2.8										***	***	0.0025	0.003366667	0.002166667	***	***
23b	5.1										***	0.0008	0.013166667	0.029533333	0.013333333	0.0011	***
23b	7.4										***	0.0019	0.0226	0.045666667	0.019433333	0.002	***
23b	9.7										***	0.0028	0.025166667	0.045666667	0.020466667	0.002633333	***
23b	12.0										***	0.0025	0.0227	0.042666667	0.018633333	0.0027	***

Table A.3: Concentration Ratios (%) - After Retrofit

RECPTR LABEL	WIND m/s	165	170	175	180	185	190	195	200	205	210	215	220	225	230	235	240
1	2.8	***	***	***	***	***	***										
1	5.1	***	***	***	***	***	***										
1	7.4	***	***	***	***	***	***										
1	9.7	***	***	***	***	***	***										
1	12.0	***	***	***	***	0.0008	***										
2	2.8	***	***	***	***	***	***										
2	5.1	***	***	***	***	***	***										
2	7.4	***	***	0.000966667	0.001366667	0.0008	***										
2	9.7	***	0.001	0.001966667	0.004266667	0.002966667	0.0014										
2	12.0	***	0.0009	0.0042	0.007466667	0.005266667	0.0019										
3	2.8	***	0.0011	0.00165	***	***	***										
3	5.1	0.0007	0.001233333	0.003233333	0.002466667	0.0008	***										
3	7.4	0.0009	0.006133333	0.015933333	0.011766667	0.0046	***										
3	9.7	0.0012	0.008533333	0.023366667	0.0193	0.005166667	***										
3	12.0	0.0022	0.0108	0.029766667	0.0229	0.006533333	***										
4	2.8							0.0007	0.0019	0.001533333	***	***					
4	5.1							0.0047	0.017033333	0.0122	0.002566667	***					
4	7.4							0.0052	0.027966667	0.0264	0.009066667	***					
4	9.7							0.0068	0.029966667	0.029333333	0.011133333	***					
4	12.0							0.007033333	0.0314	0.031066667	0.012333333	***					
5	2.8							***	0.0052	0.004	0.0011	***					
5	5.1							0.0008	0.0082	0.021	0.009066667	***					
5	7.4							***	0.012466667	0.027233333	0.015333333	***					
5	9.7							***	0.013333333	0.0283	0.0159	***					
5	12.0							***	0.011	0.025233333	0.011833333	0.0007					
6a	2.8											***	***	0.0009	0.0036	0.003566667	0.001
6a	5.1											***	***	0.0025	0.009966667	0.0122	0.003366667
6a	7.4											***	***	0.0023	0.009366667	0.0131	0.004333333
6a	9.7											***	***	0.0011	0.006566667	0.0109	0.004466667
6a	12.0											***	***	0.001	0.005666667	0.009533333	0.004433333
6b	2.8											***	***	0.0008	0.003266667	0.0043	***
6b	5.1											***	***	0.0027	0.009733333	0.011633333	0.002866667
6b	7.4											***	***	0.0022	0.0092	0.0126	0.003733333
6b	9.7											***	***	0.001	0.0064	0.010333333	0.003833333
6b	12.0											***	***	0.0008	0.0054	0.0089	0.0038
7a	2.8											***	***	***	0.002333333	0.002766667	0.0014
7a	5.1											***	***	0.0019	0.009133333	0.014866667	0.005866667
7a	7.4											***	***	0.0012	0.008933333	0.015233333	0.007433333
7a	9.7											***	***	0.0008	0.007066667	0.0142	0.008
7a	12.0											***	***	***	0.007833333	0.012166667	0.0076
7b	2.8											***	***	***	0.002266667	0.002433333	0.0013
7b	5.1											***	***	0.0019	0.008333333	0.013033333	0.004966667
7b	7.4											***	***	0.0014	0.0082	0.0135	0.006466667
7b	9.7											***	***	0.0008	0.0064	0.012466667	0.0069
7b	12.0											***	***	***	0.007133333	0.010766667	0.0066

Table A.3 (continued): Concentration Ratios (%) - After Retrofit

RECPTR	WIND																
LABEL	m/s	165	170	175	180	185	190	195	200	205	210	215	220	225	230	235	240
8a	2.8											***	***	***	***	***	***
8a	5.1											***	***	0.0036	0.004066667	0.001466667	0.001
8a	7.4											***	***	0.005166667	0.0062	0.003066667	0.001133333
8a	9.7											***	0.0007	0.004133333	0.006933333	0.003866667	0.001733333
8a	12.0											***	***	0.004266667	0.007066667	0.004333333	0.001666667
8b	2.8											***	***	***	0.0009	***	***
8b	5.1											***	***	0.0016	0.0045	0.004066667	0.002433333
8b	7.4											***	***	0.002566667	0.0069	0.0065	0.0034
8b	9.7											***	***	0.0021	0.006433333	0.007	0.0046
8b	12.0											***	***	0.001533333	0.006066667	0.0071	0.004366667

Table A.3 (continued): Concentration Ratios (%) - After Retrofit

RECPTR LABEL	WIND m/s	245	250	255	260	265	270	275	280	285	290	310	315	320	325	330
9a	2.8	0.003033333	0.0095	0.0062	0.0013	***	***	***								
9a	5.1	0.014366667	0.042166667	0.026566667	0.0068	0.001066667	***	***								
9a	7.4	0.016833333	0.044166667	0.0288	0.007233333	0.0015	***	***								
9a	9.7	0.016133333	0.038066667	0.0244	0.0066	0.001466667	***	***								
9a	12.0	0.013266667	0.032766667	0.022133333	0.007733333	0.0017	***	***								
9b	2.8	0.0077	0.011133333	0.0058	0.0013	***	***	***								
9b	5.1	0.024233333	0.046366667	0.024133333	0.006633333	0.001133333	***	***								
9b	7.4	0.026133333	0.045066667	0.0267	0.007333333	0.001466667	***	***								
9b	9.7	0.023733333	0.0392	0.022566667	0.006833333	0.001433333	***	***								
9b	12.0	0.019666667	0.033866667	0.0207	0.007633333	0.001666667	***	***								
10a	2.8	***	***	***	***	0.0013	0.001433333	0.0012								
10a	5.1	***	***	***	0.0022	0.0099	0.013466667	0.003866667								
10a	7.4	***	***	***	0.004066667	0.0212	0.0281	0.0105								
10a	9.7	***	***	0.0007	0.005566667	0.028033333	0.035733333	0.009366667								
10a	12.0	***	***	0.002	0.008766667	0.034233333	0.037966667	0.012033333								
10b	2.8	***	***	***	***	0.001733333	0.0018	***								
10b	5.1	***	***	***	0.003366667	0.0128	0.012933333	0.0048								
10b	7.4	***	***	***	0.005866667	0.027	0.026566667	0.005833333								
10b	9.7	***	***	***	0.0081	0.032533333	0.032533333	0.0047								
10b	12.0	***	***	0.0018	0.010433333	0.037733333	0.0322	0.006266667								
11a	2.8					0.0013	0.003033333	0.002433333	***	***	***					
11a	5.1					0.005833333	0.0204	0.011166667	0.0016	***	***					
11a	7.4					0.0093	0.030433333	0.0151	0.0009	***	***					
11a	9.7					0.012166667	0.030666667	0.013533333	0.0013	***	***					
11a	12.0					0.011366667	0.029333333	0.012066667	0.0009	***	***					
11b	2.8					0.0007	0.003666667	0.004	***	***	***					
11b	5.1					0.004966667	0.022233333	0.016566667	0.004	***	***					
11b	7.4					0.007566667	0.030266667	0.0201	0.0019	***	***					
11b	9.7					0.010333333	0.03	0.018533333	0.004	***	***					
11b	12.0					0.009766667	0.0293	0.016466667	0.002	***	***					
12a	2.8					***	0.0023	0.004433333	***	***	***					
12a	5.1					***	0.0145	0.014333333	0.0023	***	***					
12a	7.4					0.0008	0.016166667	0.0161	0.0012	***	***					
12a	9.7					0.001033333	0.0123	0.0145	0.0019	***	***					
12a	12.0					0.0011	0.013733333	0.013	0.0011	***	***					
12b	2.8					***	0.002666667	0.004333333	***	***	***					
12b	5.1					0.000666667	0.012166667	0.013966667	0.0023	***	***					
12b	7.4					0.0011	0.014133333	0.015733333	0.0014	***	***					
12b	9.7					0.001466667	0.012466667	0.014066667	0.0018	***	***					
12b	12.0					0.0013	0.0114	0.012566667	0.0012	***	***					

Table A.3 (continued): Concentration Ratios (%) - After Retrofit

RECPTR	WIND	245	250	255	260	265	270	275	280	285	290	310	315	320	325	330
LABEL	m/s															
13	2.8					***	***	***	***	***	***					
13	5.1					0.001866667	0.0042	0.003833333	0.0016	***	***					
13	7.4					0.0059	0.012	0.008466667	0.000933333	***	***					
13	9.7					0.011166667	0.019766667	0.012266667	0.0037	***	***					
13	12.0					0.015333333	0.027966667	0.017666667	0.002633333	***	***					
14a	2.8					***	***	***	***	***	***					
14a	5.1					***	***	***	***	***	***					
14a	7.4					***	0.0007	0.00065	0.001166667	0.001133333	***					
14a	9.7					***	***	0.001966667	0.0035	0.002066667	***					
14a	12.0					***	0.002	0.004433333	0.007766667	0.004566667	0.0021					
14b	2.8					***	***	***	***	***	***					
14b	5.1					***	***	***	0.0007	0.001166667	***					
14b	7.4					***	0.0011	0.001066667	0.0021	0.002066667	***					
14b	9.7					***	0.001	0.0028	0.0057	0.003866667	***					
14b	12.0					***	0.003	0.006266667	0.011566667	0.007133333	0.001566667					
15a	2.8											***	***	***	***	***
15a	5.1											***	***	***	***	***
15a	7.4											***	***	***	***	***
15a	9.7											***	***	***	***	***
15a	12.0											***	***	***	***	***
15b	2.8											***	***	***	***	***
15b	5.1											***	***	***	***	***
15b	7.4											***	***	***	***	***
15b	9.7											***	***	***	***	***
15b	12.0											***	***	***	***	***

Table A.3 (continued): Concentration Ratios (%) - After Retrofit

RECPTR LABEL	WIND m/s	305	310	315	325	330	335	340	345	350
16	2.8	0.005266667	0.0118	0.0054						
16	5.1	0.0126	0.0268	0.0057						
16	7.4	0.012766667	0.031233333	0.0073						
16	9.7	0.011666667	0.027566667	0.005433333						
16	12.0	0.0098	0.025133333	0.005633333						
17	2.8				0.0025	0.003933333	0.0014	***	***	***
17	5.1				0.0107	0.021133333	0.0157	***	***	***
17	7.4				0.016866667	0.029333333	0.006633333	***	***	***
17	9.7				0.018933333	0.03	0.0199	***	***	***
17	12.0				0.0173	0.028933333	0.0187	***	***	***
18a	2.8				***	***	***	0.003366667	0.012633333	0.006166667
18a	5.1				***	***	***	0.010833333	0.033233333	0.013666667
18a	7.4				***	***	***	0.010933333	0.032233333	0.013366667
18a	9.7				***	***	***	0.0088	0.0273	0.010633333
18a	12.0				***	***	***	0.008566667	0.0243	0.0086
18b	2.8				***	***	***	0.0054	0.007966667	0.004366667
18b	5.1				***	***	***	0.007666667	0.028033333	0.0125
18b	7.4				***	***	***	0.0097	0.032533333	0.014766667
18b	9.7				***	***	***	0.007866667	0.029666667	0.012433333
18b	12.0				***	***	***	0.0083	0.0267	0.010633333
19a	2.8				***	***	***	0.002766667	0.004766667	0.0026
19a	5.1				***	***	***	0.015	0.0281	0.008133333
19a	7.4				***	***	***	0.024933333	0.042366667	0.0123
19a	9.7				***	***	***	0.0235	0.0431	0.0119
19a	12.0				***	***	***	0.021633333	0.039166667	0.011
19b	2.8				***	***	***	0.005333333	0.006433333	0.0028
19b	5.1				***	***	***	0.019866667	0.032566667	0.008466667
19b	7.4				***	***	0.0009	0.0246	0.042666667	0.012366667
19b	9.7				***	***	***	0.028466667	0.041366667	0.011366667
19b	12.0				***	***	***	0.026166667	0.039266667	0.010533333

Table A.3 (continued): Concentration Ratios (%) - After Retrofit

RECPTR LABEL	WIND m/s	5	10	15	215	220	225	230	235	240	245	250	255	260	265	270	275
20	2.8	0.006833333	0.0137	0.0011													
20	5.1	0.018166667	0.036133333	0.0047													
20	7.4	0.014466667	0.030533333	0.0041													
20	9.7	0.0111	0.026833333	0.005													
20	12.0	0.0092	0.021866667	0.0033													
21a	2.8				***	0.004933333	0.001933333	***	***	***							
21a	5.1				0.001	0.0118	0.008266667	0.0006	***	***							
21a	7.4				***	0.0186	0.0124	0.0009	***	***							
21a	9.7				***	0.015066667	0.011933333	0.0013	***	***							
21a	12.0				***	0.012033333	0.009866667	0.001	***	***							
21b	2.8				0.0009	0.003633333	0.002433333	***	***	***							
21b	5.1				0.0018	0.012533333	0.008833333	0.0009	***	***							
21b	7.4				0.0006	0.0139	0.012666667	0.0014	***	***							
21b	9.7				0.0007	0.011733333	0.012	0.0017	***	***							
21b	12.0				***	0.012066667	0.01	0.0013	***	***							
22	2.8										***	***	***	0.0023	0.005166667	0.004533333	***
22	5.1										***	***	***	0.009233333	0.0275	0.015266667	0.0014
22	7.4										***	***	***	0.010866667	0.030533333	0.017366667	0.0024
22	9.7										***	***	***	0.0099	0.027966667	0.0163	0.0025
22	12.0										***	***	***	0.0109	0.026366667	0.014266667	0.002
23a	2.8										***	***	0.001333333	0.003466667	0.0051	***	***
23a	5.1										***	0.0019	0.012433333	0.026933333	0.012733333	0.0011	***
23a	7.4										***	0.0016	0.016566667	0.035566667	0.016766667	0.002266667	***
23a	9.7										***	0.0029	0.0195	0.0373	0.0174	0.0024	***
23a	12.0										***	0.0019	0.0192	0.0389	0.0201	0.0025	***
23b	2.8										***	***	0.003	0.005266667	0.002833333	***	***
23b	5.1										***	0.0026	0.017266667	0.0342	0.0152	0.001133333	***
23b	7.4										***	0.0029	0.021433333	0.0409	0.0169	0.0021	***
23b	9.7										***	0.0035	0.021833333	0.0411	0.0172	0.002	***
23b	12.0										***	0.0026	0.020866667	0.040266667	0.018333333	0.002033333	***

A2.2 *AIR QUALITY IMPROVEMENTS UNDER WORST-CASE MEASURED CONCENTRATION RATIOS*

The estimated relative reductions in concentrations of SO_2, NO_x and particulates after the retrofit for the worst-case meteorological conditions (ie those for which the highest concentration ratios were measured) are presented in *Table A.4*. The wind speeds shown in the table are referenced to 10 m above grade, in open terrain. The concentration estimates are based on pollutant concentrations obtained for each receptor by multiplying the assumed stack exit concentrations corrected for the actual efflux temperature, by the worst-case concentration ratios before and after the retrofit obtained from *Tables A.2* and *A.3*. The calculation steps are as follows:

Step 1

The stack exit concentration before the retrofit expressed in mg Nm^{-3} shown in *Table A.1* is first converted to concentration expressed in mg m^{-3}:

$e_1' = e_1 \quad x \quad 273/383$

where e_1 = stack exit concentration in mg Nm^{-3} before the retrofit

e_1' = stack exit concentration in mg m^{-3} before the retrofit

Step 2

The worst-case concentration before the retrofit at a given sensitive receiver is obtained by multiplying the stack exit concentration before the retrofit by the highest concentration ratio at the same sensitive receiver (from *Table A.2*):

$c_1 = e_1' \ x \quad r_1$

where c_1 = worst-case concentration before the retrofit at receiver in mg m^{-3}

r_1 = highest concentration ratio for the same receiver before the retrofit

Step 3

The stack exit concentrations after the retrofit expressed in mg Nm^{-3} shown in *Table A.1* are first converted to concentrations expressed in mg m^{-3}

$e_2' = e_2 \quad x \quad 273/353$

where e_2 = stack exit concentration in mg Nm^{-3} after the retrofit

e_2' = stack exit concentration in mg m^{-3} after the retrofit

Step 4

The worst-case concentration after the retrofit at the same sensitive receiver considered in *Step 2* is obtained by multiplying the stack exit concentration after the retrofit by the highest concentration ratio at the same sensitive receiver (from *Table A.3*):

$$c_2 = e_2' \text{ x } r_2$$

where c_2 = worst-case concentration after the retrofit at receiver in mg m^{-3}

r_2 = highest concentration ratio for the same receiver after the retrofit

Step 5

The relative reduction in concentration of an air pollutant at the sensitive receiver given above is obtained as follows:

$$R = (c_1 - c_2) / c_1$$

where R = relative reduction in concentration at the given receiver

Table A.4 Modelled Air Quality Improvement at ASR under Worst-Case Concentration Ratios

ASR	Wind Speed (m s^{-1})	Wind Direction (deg)	Modelled Change in SO_2 Concentration (%)	Modelled Change in NO_x Concentration (%)	Modelled Change in Particulate Concentration (%)
A1	NA[(a)]	NA[(a)]	NA[(b)]	NA[(b)]	NA[(b)]
A2	12	180	-85.9	-71.8	-43.7
A3	12	175	-87.4	-74.8	-49.7
A4	12	200	-89.0	-78.0	-56.0
A5	9.7	205	-88.3	-76.7	-53.3
A6a	7.4	235	-89.5	-78.9	-57.9
A6b	7.4	235	-89.5	-79.0	-57.9
A7a	7.4	235	-90.0	-80.0	-60.0
A7b	7.4	235	-90.3	-80.7	-61.4
A8a	12	230	-89.6	-79.2	-58.3
A8b	12	235	-89.6	-79.2	-58.3
A9a	7.4	250	-89.3	-78.6	-57.2
A9b	5.1	250	-89.6	-79.2	-58.4
A10a	12	270	-89.4	-78.8	-57.5
A10b	12	265	-89.5	-79.0	-58.0
A11a	9.7	270	-89.8	-79.6	-59.3
A11b	7.4	270	-90.3	-80.6	-61.2
A12a	7.4	270	-91.4	-82.6	-65.7
A12b	7.4	275	-89.6	-79.2	-58.4
A13	12	270	-88.7	-77.4	-54.8
A14a	12	280	-86.9	-73.9	-47.8
A14b	12	280	-86.6	-73.2	-46.5
A15a	NA[(a)]	NA[(a)]	NA[(b)]	NA[(b)]	NA[(b)]
A15b	NA[(a)]	NA[(a)]	NA[(b)]	NA[(b)]	NA[(b)]
A16	7.4	310	-89.6	-79.1	-58.2
A17	9.7	330	-89.7	-79.3	-58.7

ASR	Wind Speed ($m\ s^{-1}$)	Wind Direction (deg)	Modelled Change in SO_2 Concentration (%)	Modelled Change in NO_x Concentration (%)	Modelled Change in Particulate Concentration (%)
A18a	5.1	345	-90.0	-80.0	-60.0
A18b	7.4	345	-89.7	-78.2	-58.6
A19a	9.7	345	-89.7	-79.5	-59.0
A19b	7.4	345	-89.8	-79.5	-59.1
A20	5.1	10	-88.8	-77.6	-55.2
A21a	7.4	220	-88.9	-77.8	-55.7
A21b	7.4	220	-88.5	-77.0	-53.9
A22	7.4	265	-90.0	-80.0	-60.0
A23a	12	260	-89.9	-79.7	-59.4
A23b	9.7	260	-90.2	-80.5	-61.0

Notes:

(a) 0.0010 is the lowest detection limit for concentration ratios. When all the readings in the wind tunnel test measurements are below the detection limit, establishing which wind speed and direction results in the highest concentration is not possible.

(b) With concentration ratios below the detection limits, changes in concentrations cannot be estimated.

The results shown in *Table A.4* represent the resultant reduction of SO_2, NO_x and particulate concentrations, hence air quality improvements at the ASRs, under the worst-case concentration ratios measured in the wind tunnel for each of the two scenarios tested. The results demonstrate that the percentage reductions in the measured SO_2, NO_x and particulate concentrations at the ASRs are very similar to the corresponding reductions of SO_2 (90%), NO_x (80%) and particulate (60%) emissions from the CPB units after retrofit. The slight changes in the percentage reduction of the measured concentrations can be explained by the changes in the plume characteristics (i.e. a lower exit velocity and a lower efflux temperature after implementation of the retrofit programme) and the effects of the complex terrain on the exhaust dispersion.

In conclusion, the effects of changes in dispersion characteristics (due to changes in flue gas physical properties) on the pollutant concentrations at ASRs after the retrofit are much lower in magnitude when compared with those of the expected emission reductions of SO_2, NO_x and particulates. As can be seen in *Table A.4*, the combined effects of the emission reductions and the changes in physical characteristics of the plume result in air quality improvements at all the identified ASRs ranging from 86% to 91% for SO_2, 72% to 83% for NO_x. Similarly, assuming a 60% reduction of particulate emissions, corresponding reductions in particulate concentrations ranging from 44% to 66% at ASRs are expected.

It should be noted that the above reductions in predicted worst-case concentrations are related to the Castle Peak Station "B" emissions only and do not include cumulative effects. While the assessment of cumulative impacts is not the focus of this EIA Study, it is anticipated that (with all other emissions assumed constant) the Project will result in an improvement in SO_2, NO_x and particulates levels in the vicinity of the Castle Peak Power Station. The magnitude of such improvements will of course be lower for sensitive receivers located further away from the CPPS.

Annex B

Noise Assessment Supporting Information

Annex B-1

Measured Prevailing Noise Levels at NSRs

Measured Prevailing Noise Levels at N1 (Village House at Sha Po Kong)
(15 - 16 March 2006)

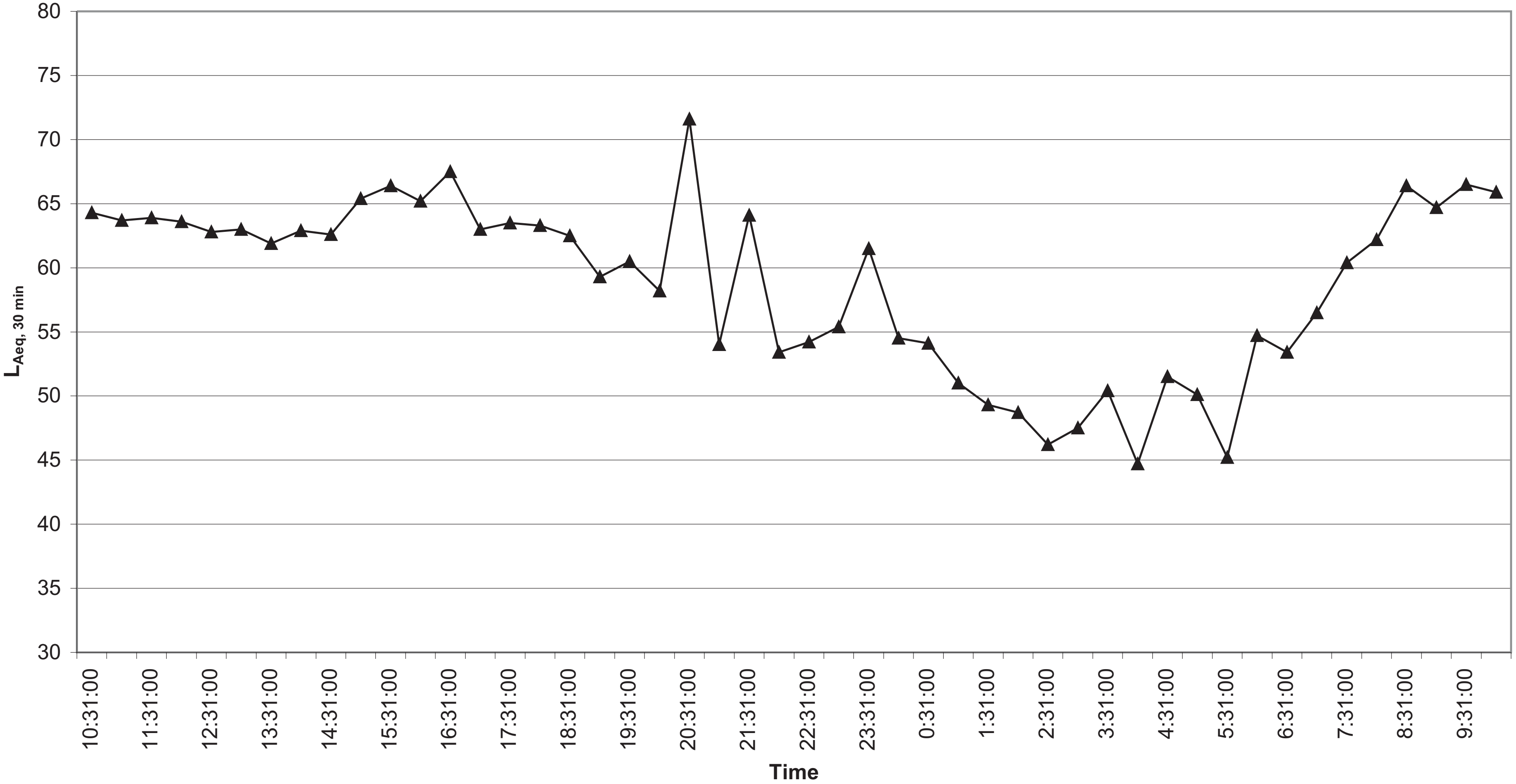

Figure B1

Measured Prevailing Noise Levels at NSR

FILE: 0024405m
DATE: 21/04/2006

Environmental
Resources
Management

ERM

Annex B-2

Construction Programme for Noise Assessment

Annex B-2 - Preliminary Construction Programme

	2006												2007												2008												2009												2010											
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Construction Item																																																												
Demolition of Oil Tank													■	■	■	■	■	■	■	■	■	■																																						
Site formation																					■	■	■	■	■							■	■	■	■	■	■	■	■	■	■	■																		
Foundation																■	■	■	■							■	■	■	■	■	■																													
M&E Installation																										■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
Dredging Work															■	■																																												

Annex B-3

Construction Plant Inventory

Annex B-3 Construction Plant Inventory

Stage	Activities	Plant	CNP/BS5228 ref.	No. of PME	Basic SWL	SWL
1	Demolition of Oil Tank	Crane Lorry	CNP 141	1	112	112
		Excavator	CNP 081	2	112	115
		Air Compressor <= $10m^3min^{-1}$	CNP 001	2	100	103
		Breaker, hand-held >35kg	CNP 026	1	114	114
		Concrete Lorry Mixer	CNP 044	2	109	112
		Vibratory Poker	CNP 170	3	113	118
		Generator, standard	CNP 101	2	108	111
		Dump Truck	CNP 067	2	117	120
				Total SWL =		***124***
2	Site formation	Excavator	CNP 081	4	112	118
		Bulldozer	CNP 030	4	115	121
		Lorry	CNP 141	2	112	115
				Total SWL =		***123***
3	Foundation	Bored Pile, RCD	CNP 166	4	100	106
		Concrete Lorry Mixer	CNP 044	2	109	112
				Total SWL =		***113***
4	M&E Installation	Mobile Crane	CNP 048	2	112	115
		Crane, Tower	CNP 049	4	95	101
		Generator	CNP 103	2	95	98
		Poker	CNP 170	2	113	116
		Concrete Lorry Mixer	CNP 044	2	109	112
				Total SWL =		***120***
5	Dredging Work	Dredger, grab	CNP 063	1	112	112
				Total SWL =		***112***

Annex B-4

Construction Noise Assessment

Annex B-4 - Construction Noise Assessment

NSR: Village House at Sha Po Kong

Correction Factor

Distance from NSR to Sources 1100 *m* to the nearest site boundary — ***Distance Attenuation*** -69 dB(A) — *Barrier attenuation* -10 dB(A) *for land based works* & 0 dB(A) *for dredgeing work*

Distance from NSR to Dredging Area 1100 *m* to the nearest site boundary — ***Distance Attenuation*** -69 — *Facade* 3 dB(A)

	2006							2007												2008												2009												2010											
	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Construction Item																																																							
Demolition of Oil Tank	0	0	0	0	0	0	0	124	124	124	124	124	124	124	124	124	124	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total SWL	0	0	0	0	0	0	0	124	124	124	124	124	124	124	124	124	124	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Noise Level at NSR (dB(A))	0	0	0	0	0	0	0	48	48	48	48	48	48	48	48	48	48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Site formation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	123	123	123	123	123	0	0	0	0	0	0	123	123	123	123	123	123	123	123	123	123	123	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total SWL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	123	123	123	123	123	0	0	0	0	0	0	123	123	123	123	123	123	123	123	123	123	123	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Noise Level at NSR (dB(A))	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	48	48	48	48	48	0	0	0	0	0	0	48	48	48	48	48	48	48	48	48	48	48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Foundation	0	0	0	0	0	0	0	0	0	0	113	113	113	113	0	0	0	0	0	0	113	113	113	113	113	113	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total SWL	0	0	0	0	0	0	0	0	0	0	113	113	113	113	0	0	0	0	0	0	113	113	113	113	113	113	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Noise Level at NSR (dB(A))	0	0	0	0	0	0	0	0	0	0	37	37	37	37	0	0	0	0	0	0	37	37	37	37	37	37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
M&E Installation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	0
Total SWL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	0
Noise Level at NSR (dB(A))	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	0
Dredging Work	0	0	0	0	0	0	0	0	0	112	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total SWL	0	0	0	0	0	0	0	0	0	112	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Noise Level at NSR (dB(A))	0	0	0	0	0	0	0	0	0	46	46	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ALL NOISE LEVEL AT NSR (dB(A))	0	0	0	0	0	0	0	48	48	50	51	49	49	49	48	51	51	48	48	48	45	45	45	45	45	45	49	49	49	49	49	49	49	49	49	49	49	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	0

Note:

(1) With the construction activities will be screened by the existing building structures at Castle Peak Power Station and topography, a negative correction factor of 10dB(A) has been applied in the assessment.

NSR: Planned Holiday Camp

Correction Factor

Distance from NSR to Sources 1200 *m* to the nearest site boundary — ***Distance Attenuation*** -70 dB(A) — *Barrier attenuation* -10 dB(A) *for land based works* & -10 dB(A) *for dredgeing work* (1)

Distance from NSR to Dredging Area 2000 *m* to the nearest site boundary — ***Distance Attenuation*** -74 — *Facade* 3 dB(A)

	2006							2007												2008												2009												2010											
	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Construction Item																																																							
Demolition of Oil Tank	0	0	0	0	0	0	0	124	124	124	124	124	124	124	124	124	124	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total SWL	0	0	0	0	0	0	0	124	124	124	124	124	124	124	124	124	124	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Noise Level at NSR (dB(A))	0	0	0	0	0	0	0	48	48	48	48	48	48	48	48	48	48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Site formation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	123	123	123	123	123	0	0	0	0	0	0	123	123	123	123	123	123	123	123	123	123	123	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total SWL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	123	123	123	123	123	0	0	0	0	0	0	123	123	123	123	123	123	123	123	123	123	123	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Noise Level at NSR (dB(A))	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	47	47	47	47	47	0	0	0	0	0	0	47	47	47	47	47	47	47	47	47	47	47	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Foundation	0	0	0	0	0	0	0	0	0	0	113	113	113	113	0	0	0	0	0	0	113	113	113	113	113	113	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total SWL	0	0	0	0	0	0	0	0	0	0	113	113	113	113	0	0	0	0	0	0	113	113	113	113	113	113	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Noise Level at NSR (dB(A))	0	0	0	0	0	0	0	0	0	0	36	36	36	36	0	0	0	0	0	0	36	36	36	36	36	36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
M&E Installation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	0
Total SWL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	0
Noise Level at NSR (dB(A))	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	0
Dredging Work	0	0	0	0	0	0	0	0	0	112	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total SWL	0	0	0	0	0	0	0	0	0	112	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Noise Level at NSR (dB(A))	0	0	0	0	0	0	0	0	0	31	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ALL NOISE LEVEL AT NSR (dB(A))	0	0	0	0	0	0	0	48	48	48	48	48	48	48	48	50	50	47	47	47	44	44	44	44	44	44	48	48	48	48	48	48	48	48	48	48	48	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	43	0

Note:

(1) With the construction activities will be screened by the existing building structures at Castle Peak Power Station and topography, a negative correction factor of 10dB(A) has been applied in the assessment.

Annex B-5

Equipment Inventory during Operational Phase

Annex B-5 - Equipment Inventory during Operational Phase

Group No(1).	Plant Inventory	Specified Maximum Sound Pressure Level	Total No. of Emission Group
ABSORBER ISLAND			
1	Booster fans	85 dBA, feee-field at 3 ft	4
	Gas-Gas heater	85 dBA, feee-field at 3 ft	
2	Oxidation air compressors	90dBA, free-field at 3 ft	4
3	Absorber vessel	85 dBA, free-field at 3 ft	4
	Recycle pumps	85 dBA, free-field at 3 ft	
	Absorber bleed pumps	85 dBA, free-field at 3 ft	
	Makeup water transfer pump	85 dBA, free-field at 3 ft	
	Absorber drain tank transfer pumps	85 dBA, free-field at 3 ft	
	Absorber island sump pumps	85 dBA, free-field at 3 ft	
	Absorber island sump agitators	85 dBA, free-field at 3 ft	
LIMESTONE PREPARATION ISLAND			
4	Limestone ball mill	90dBA, free-field at 3 ft	1
5	Reagent slurry feed pumps	85 dBA, free-field at 3 ft	1
	Limestone prep sump pumps	85 dBA, free-field at 3 ft	
	Limestone prep sump agitators	85 dBA, free-field at 3 ft	
GYPSUM DEWATERING ISLAND			
6	Hydrocyclone overflow return pumps	85 dBA, free-field at 3 ft	1
	Secondary hydracyclone feed tank pumps	85 dBA, free-field at 3 ft	
	Chloride purge transfer pumps	85 dBA, free-field at 3 ft	
	Reclaim water pumps	85 dBA, free-field at 3 ft	
	Gypsum dewatering island sump pumps	85 dBA, free-field at 3 ft	
	Instrument & Service Air Compressors	85 dBA, free-field at 3 ft	
	Belt filters	85 dBA, free-field at 3 ft	
WASTEWATER TREATMENT FACILITY			
7	Mixers	85 dBA, free-field at 3 ft	1
	Centrifugal pumps	85 dBA, free-field at 3 ft	
	Progressive cavity pumps	85 dBA, free-field at 3 ft	
	Aeration blowers	85 dBA, free-field at 3 ft	
	Chemical dosing pumps	85 dBA, free-field at 3 ft	
	Clarifier sludge recycle pumps	85 dBA, free-field at 3 ft	
MATERIAL HANDLING			
8	Limestione silos- full time opeation	85 dBA, free-field at 3 ft	1
	Conveyors	85 dBA, free-field at 3 ft	
	Two dust collection systems	85 dBA, free-field at 3 ft	
	Bin discharge vibrators	85 dBA, free-field at 3 ft	
	Electro-magnet	85 dBA, free-field at 3 ft	
GYPSUM TRANSFER			
9	Conveyors	85 dBA, free-field at 3 ft	1
LIMESTONE TRANSFER			
10	Conveyors	85 dBA, free-field at 3 ft	1
	Dust collector	85 dBA, free-field at 3 ft	
	Electro-magnet	85 dBA, free-field at 3 ft	
	Barge unloader	85 dBA, free-field at 3 ft	
GYPSUM TRANSFER TO BARGE LOADER			
11	Conveyor	85 dBA, free-field at 3 ft	1
	Electro magnet	85 dBA, free-field at 3 ft	
	Barge loader	85 dBA, free-field at 3 ft	

Note:

The SCR reactors do not have machinery / equipment that are major noise sources and the location of the SCR reactors will be largely shielded by the boiler house structure. The SCR reactors are therefore not required to be included in the EIA noise assessment.

Annex B-6

Operational Noise Assessment

Annex B-6 - Operational Noise Assessment

NSR: Village House at Sha Po Kong
Distance from NSR to Source *1100* *m* *to the nearest site boundary*

Emission Group		No. of plant	SPL at 1m dB(A)	Correction, dB(A)				SPL at NSR dB(A)
				No. of Plant	Distance(1)	Barrier(2)	Facade	
ABSORBER ISLAND								
1	Booster fans Gas-Gas heater	4	85	6.0	-60.8	-10	3	23
2	Oxidation air compressors	4	90	6.0	-60.8	-10	3	28
3	Absorber vessel Recycle pumps Absorber bleed pumps Makeup water transfer pump Absorber drain tank transfer Absorber island sump pumps Absorber island sump	4	85	6.0	-60.8	-10	3	23
LIMESTONE PREPARATION ISLAND								
4	Limestone ball mill	1	90	0.0	-60.8	-10	3	22
5	Reagent slurry feed pumps Limestone prep sump pumps Limestone prep sump agitators	1	85	0.0	-60.8	-10	3	17
GYPSUM DEWATERING ISLAND								
6	Hydrocyclone overflow return pumps Secondary hydracyclone feed tank pumps Chloride purge transfer pumps Reclaim water pumps Gypsum dewatering island sump pumps Instrument & Service Air Compressors Belt filters	1	85	0.0	-60.8	-10	3	17
WASTEWATER TREATMENT FACILITY								
7	Mixers Centrifugal pumps Progressive cavity pumps Aeration blowers Chemical dosing pumps Clarifier sludge recycle pumps	1	85	0.0	-60.8	-10	3	17
MATERIAL HANDLING								
8	Limestione silos- full time opeation Conveyors Two dust collection systems Bin discharge vibrators Electro-magnet	1	85	0.0	-60.8	-10	3	17
GYPSUM TRANSFER								
9	Conveyors	1	85	0.0	-60.8	0	3	27
LIMESTONE TRANSFER								
10	Conveyors Dust collector Electro-magnet Barge unloader	1	85	0	-61	0	3	27
GYPSUM TRANSFER TO BARGE LOADER								
11	Conveyor Electro magnet Barge loader	1	85	0.0	-60.8	0	3	27
							TOTAL SPL at NSR, dB(A) =	**35**

Note:

(1) Given the considerable distance between the noise sources and the NSR, the distance correction has been considered as attenuation due to spherical wave propagation.

(2) With the equipment will be screened by the existing building structures at Castle Peak Power Station and topography, a negative correction factor of 10dB(A) has been applied in the assessment.

(3) The SCR reactors do not have machinery / equipment that are major noise sources and the location of the SCR reactors will be largely shielded by the boiler house structure. The SCR reactors are therefore not required to be included in the EIA noise assessment.

Annex B-6 - Operational Noise Assessment

NSR: Planned Holiday Camp

Distance from NSR to Source *1200* *m* *to the nearest site boundary*

Emission Group		No. of plant	SPL at 1m dB(A)	Correction, dB(A)				SPL at NSR dB(A)
				No. of Plant	Distance(1)	Barrier(2)	Facade	
ABSORBER ISLAND								
1	Booster fans Gas-Gas heater	4	85	6.0	-61.6	-10	3	22
2	Oxidation air compressors	4	90	6.0	-61.6	-10	3	27
3	Absorber vessel Recycle pumps Absorber bleed pumps Makeup water transfer pump Absorber drain tank transfer Absorber island sump pumps Absorber island sump	4	85	6.0	-61.6	-10	3	22
LIMESTONE PREPARATION ISLAND								
4	Limestone ball mill	1	90	0.0	-61.6	-10	3	21
5	Reagent slurry feed pumps Limestone prep sump pumps Limestone prep sump agitators	1	85	0.0	-61.6	-10	3	16
GYPSUM DEWATERING ISLAND								
6	Hydrocyclone overflow return pumps Secondary hydracyclone feed tank pumps Chloride purge transfer pumps Reclaim water pumps Gypsum dewatering island sump pumps Instrument & Service Air Compressors Belt filters	1	85	0.0	-61.6	-10	3	16
WASTEWATER TREATMENT FACILITY								
7	Mixers Centrifugal pumps Progressive cavity pumps Aeration blowers Chemical dosing pumps Clarifier sludge recycle pumps	1	85	0.0	-61.6	-10	3	16
MATERIAL HANDLING								
8	Limestione silos- full time opeation Conveyors Two dust collection systems Bin discharge vibrators Electro-magnet	1	85	0.0	-61.6	-10	3	16
GYPSUM TRASFER								
9	Conveyors	1	85	0.0	-61.6	-10	3	16
LIMESTONE TRANSFER								
10	Conveyors Dust collector Electro-magnet Barge unloader	1	85	0	-62	-10	3	16
GYPSUM TRASFER TO BARGE LOADER								
11	Conveyor Electro magnet Barge loader	1	85	0.0	-61.6	-10	3	16
					TOTAL SPL at NSR, dB(A) =			**31**

Note:

(1) Given the considerable distance between the noise sources and the NSR, the distance correction has been considered as attenuation due to spherical wave propagation.

(2) With the equipment will be screened by the existing building structures at Castle Peak Power Station and topography, a negative correction factor of 10dB(A) has been applied in the assessment.

(3) The SCR reactors do not have machinery / equipment that are major noise sources and the location of the SCR reactors will be largely shielded by the boiler house structure. The SCR reactors are therefore not required to be included in the EIA noise assessment.

Annex C

Supplementary Information to Water Quality Impact Assessment

Annex C1

Results of Elutriate Test

Lam Environmental Services
Test Specialists & Environmental Analysts

SUMMARY REPORT

Project: **Emission Control Project at Castle Peak Power Station 'B' Units**
Client: **CLP Power Hong Kong Limited**
Address: Commercial Project
G/F, 147 Argyle Street
Kowloon
Hong Kong
Lab. Job No. : J446

Matrix : Water

Laboratory Sample ID	**Sample Reference**		**Heavy Metals**									**TKN**	**Nitrate**	**Nitrite**	**Ammoniacal Nitrogen**	**Ortho-Phosphate**	**Total Phosphorous**
	Drillhole No.	**Type**	Cadmium (Cd)	Chromium (Cr)	Copper (Cu)	Nickel (Ni)	Lead (Pb)	Zinc (Zn)	Mercury (Hg)	Arsenic (As)	Silver (Ag)						
			ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	mg-N/L	mg-N/L	mg-N/L	mg-NH_4-N/L	mg-P/L	mg-P/L
			0.5	5	1	2	2	10	0.2	1	1	0.1	0.05	0.05	0.1	0.05	0.1
16995 / 1	V1 1m	Marine Water	<0.5	<5	5.1	<2	<2	<10	<0.2	<1	<1	2.1	0.52	0.03	0.20	0.08	<0.1
16995 / 2	V1 3.7m	Marine Water	<0.5	<5	3.9	<2	<2	<10	<0.2	<1	<1	2.2	0.68	0.04	0.32	0.09	<0.1
16995 / 3	V1 6.5m	Marine Water	<0.5	<5	4.9	<2	<2	<10	<0.2	<1	<1	1.5	0.88	0.03	0.31	0.09	<0.1
16995 / 5	V2 1m	Marine Water	<0.5	<5	4.4	<2	<2	<10	<0.2	<1	<1	2.2	0.6	0.02	0.18	0.08	<0.1
16995 / 6	V2 3.5m	Marine Water	<0.5	<5	4.5	<2	<2	<10	<0.2	<1	<1	1.2	0.28	0.05	0.15	0.07	<0.1
16995 / 7	V2 6m	Marine Water	<0.5	<5	4.5	<2	<2	<10	<0.2	<1	<1	1.9	0.34	0.02	0.18	0.08	<0.1
16995 / 9	V3 1m	Marine Water	<0.5	<5	4.7	<2	<2	<10	<0.2	<1	<1	1.6	0.74	0.03	0.27	0.08	<0.1
16995 / 10	V3 4m	Marine Water	<0.5	<5	4.4	<2	<2	<10	<0.2	<1	<1	1.9	0.82	0.05	0.38	0.08	<0.1
16995 / 11	V3 7m	Marine Water	<0.5	<5	4.8	<2	<2	<10	<0.2	<1	<1	1.2	0.34	0.09	0.22	0.07	<0.1
17017 / 1	V1 0.00-0.90 (V1)	Elutriate	<0.5	<5	2.0	<2	<2	<10	<0.2	<1	<1	4.3	0.21	0.25	3.5	0.16	0.17
17017 / 2	V1 0.90-1.70 (V1)	Elutriate	<0.5	<5	1.8	<2	<2	<10	<0.2	<1	<1	4.5	0.18	0.05	3.9	0.18	0.23
17017 / 3	V2 0.20-0.90 (V2)	Elutriate	<0.5	<5	2.1	<2	<2	<10	<0.2	<1	<1	3.4	0.14	0.15	3.4	0.15	0.18
17017 / 4	V2 0.90-2.20 (V2)	Elutriate	<0.5	<5	2.0	<2	<2	<10	<0.2	<1	<1	4.3	0.10	0.03	3.9	0.17	0.21
17017 / 5	V3 0.05-1.10 (V3)	Elutriate	<0.5	<5	2.0	<2	<2	<10	<0.2	<1	<1	2.5	0.16	0.04	0.68	0.06	<0.1

Lam Environmental Services
Test Specialists & Environmental Analysts

SUMMARY REPORT

Project: **Emission Control Project at Castle Peak Power Station 'B' Units**
Client: **CLP Power Hong Kong Limited**
Address: Commercial Project
G/F, 147 Argyle Street
Kowloon
Hong Kong
Lab. Job No. : J446

Matrix : Water

Laboratory Sample ID	Sample Reference		PAHs (Low Molecular Weight)						PAHs (High Molecular Weight)									
	Drillhole No.	Type	Naphthalene	Acenaphtylene	Acenaphtene	Fluorene	Phenanthrene	Anthracene	Benzo(a)anthracene	Benzo(a)pyrene	Chrysene	Dibenz(ah)anthracene	Fluoranthene	Pyrene	Benzo(b)fluoranthene	Benzo(k)fluoranthene	Indeno(1,2,3-cd)pyrene	Benzo(ghi)perylene
			ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
			0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
16995 / 1	V1 1m	Marine Water	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
16995 / 2	V1 3.7m	Marine Water	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
16995 / 3	V1 6.5m	Marine Water	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
16995 / 5	V2 1m	Marine Water	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
16995 / 6	V2 3.5m	Marine Water	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
16995 / 7	V2 6m	Marine Water	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
16995 / 9	V3 1m	Marine Water	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
16995 / 10	V3 4m	Marine Water	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
16995 / 11	V3 7m	Marine Water	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
17017 / 1	V1 0.00-0.90 (V1)	Elutriate	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
17017 / 2	V1 0.90-1.70 (V1)	Elutriate	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
17017 / 3	V2 0.20-0.90 (V2)	Elutriate	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
17017 / 4	V2 0.90-2.20 (V2)	Elutriate	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
17017 / 5	V3 0.05-1.10 (V3)	Elutriate	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Lam Environmental Services
Test Specialists & Environmental Analysts

SUMMARY REPORT

Project: **Emission Control Project at Castle Peak Power Station 'B' Units**
Client: **CLP Power Hong Kong Limited**
Address: Commercial Project
G/F, 147 Argyle Street
Kowloon
Hong Kong
Lab. Job No. : J446

Matrix : Water

Laboratory Sample ID	Sample Reference		PCB																		
	Drillhole No.	Type	PCB 8	PCB 18	PCB 28	PCB 44	PCB 52	PCB 66	PCB 77	PCB 101	PCB 105	PCB 118	PCB 126	PCB 128	PCB 138	PCB 153	PCB 169	PCB 170	PCB 180	PCB 187	Total PCB
			ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
			0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
16995 / 1	V1 1m	Marine Water	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
16995 / 2	V1 3.7m	Marine Water	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
16995 / 3	V1 6.5m	Marine Water	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
16995 / 5	V2 1m	Marine Water	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
16995 / 6	V2 3.5m	Marine Water	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
16995 / 7	V2 6m	Marine Water	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
16995 / 9	V3 1m	Marine Water	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
16995 / 10	V3 4m	Marine Water	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
16995 / 11	V3 7m	Marine Water	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
17017 / 1	V1 0.00-0.90 (V1)	Elutriate	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
17017 / 2	V1 0.90-1.70 (V1)	Elutriate	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
17017 / 3	V2 0.20-0.90 (V2)	Elutriate	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
17017 / 4	V2 0.90-2.20 (V2)	Elutriate	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
17017 / 5	V3 0.05-1.10 (V3)	Elutriate	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

SUMMARY REPORT

Project: **Emission Control Project at Castle Peak Power Station 'B' Units**
Client: **CLP Power Hong Kong Limited**
Address: Commercial Project
G/F, 147 Argyle Street
Kowloon
Hong Kong
Lab. Job No. : J446

Matrix : Water

Laboratory Sample ID	Sample Reference			Chlorinated Pesticides											
	Drillhole No.	Type	Tributyltin (TBT)	Alpha-BHC	Beta BHC	Gamma BHC	Delta-BHC	Heptachlor	Aldrin	Heptachlor epoxide	Endosulfan 1	p, p'-DDT	p, p'-DDD	p, p'-DDE	Endosulfan sulfate
			ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
			0.015	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
16995 / 1	V1 1m	Marine Water	<0.015	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
16995 / 2	V1 3.7m	Marine Water	<0.015	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
16995 / 3	V1 6.5m	Marine Water	<0.015	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
16995 / 5	V2 1m	Marine Water	<0.015	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
16995 / 6	V2 3.5m	Marine Water	<0.015	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
16995 / 7	V2 6m	Marine Water	<0.015	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
16995 / 9	V3 1m	Marine Water	<0.015	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
16995 / 10	V3 4m	Marine Water	<0.015	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
16995 / 11	V3 7m	Marine Water	<0.015	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
17017 / 1	V1 0.00-0.90 (V1)	Elutriate	<0.015	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
17017 / 2	V1 0.90-1.70 (V1)	Elutriate	<0.015	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
17017 / 3	V2 0.20-0.90 (V2)	Elutriate	<0.015	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
17017 / 4	V2 0.90-2.20 (V2)	Elutriate	<0.015	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
17017 / 5	V3 0.05-1.10 (V3)	Elutriate	<0.015	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Annex C2

Details of Model Refinement

C2 MODELLING DETAILS

C2.1 INTRODUCTION

The refinement of grid has been applied in the Delft-WAQ model in the EIA Study. This enhanced the resolution of the model at the sensitive receivers in the vicinity of the project area. The refined model grid mesh adopted in the EIA Study is shown in *Figure C2.1*. As shown, the grid size of the refined grid mesh is less than 75 m.

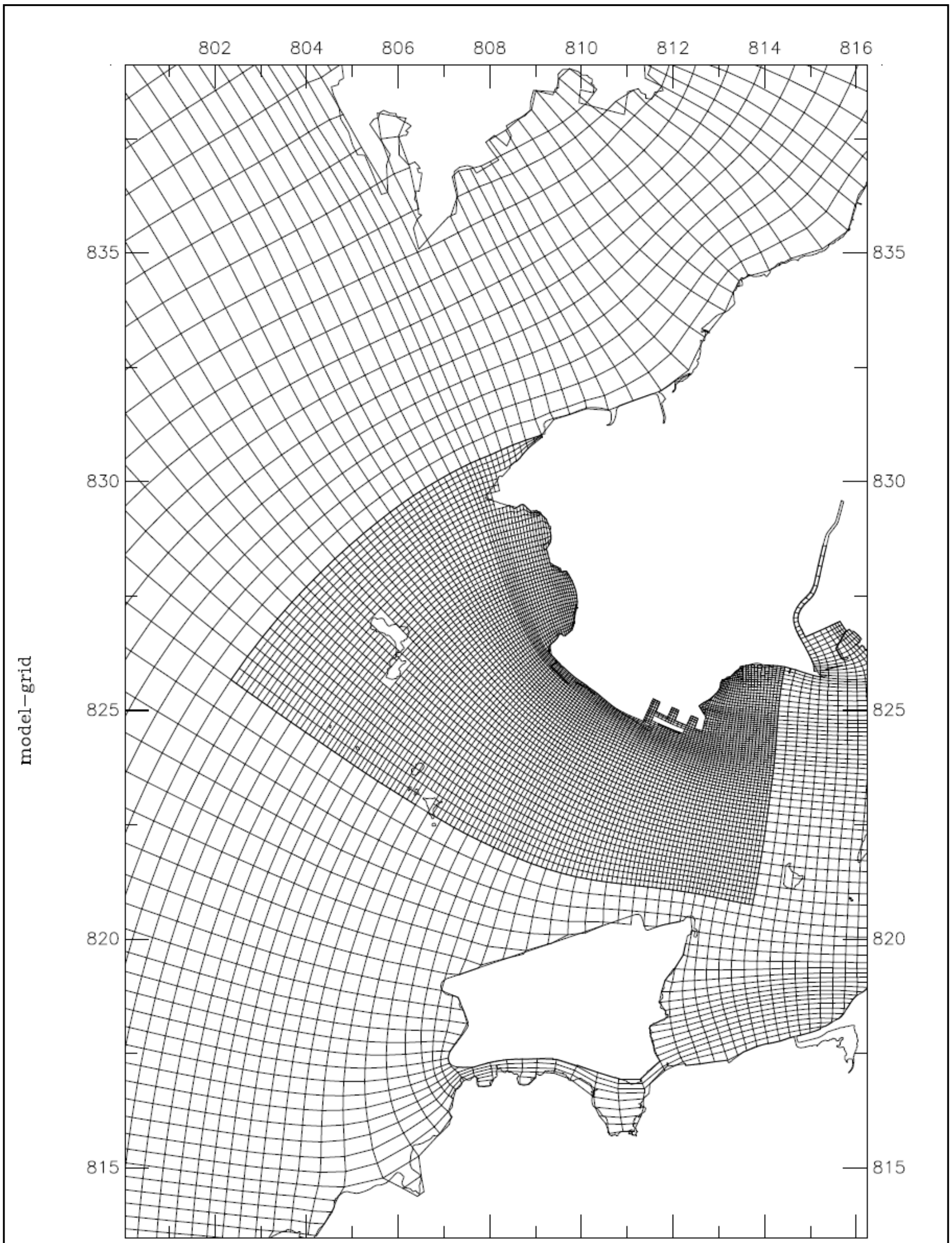

Figure C2.1 Refined Water Quality Model Grid used in the EIA

C2.2 THEORY OF THE GRID REFINEMENT

C2.2.1 Mass Conserving Properties of the Refinement

The refinement of the water quality grid is carried out at the level of the *finite volumes* used by the computational core of the Delft3D-WAQ programme. The text below assumes that the model is 3D. The finite water volume is given by V(t), while there are 6 flows Q(t) through the surfaces of the finite volume (see *Figure C2.2*). Note that in the surface and the bottom layer one of the two vertical flows is zero by definition.

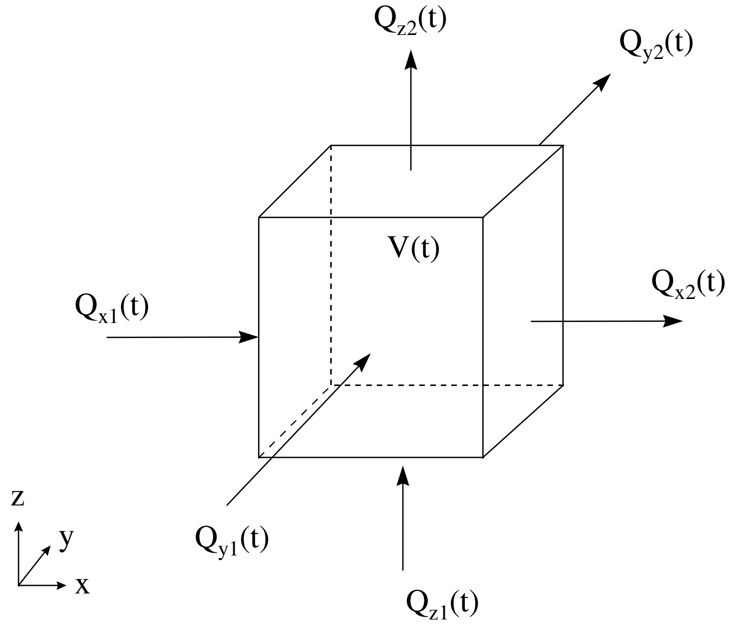

Figure 2.2 ***Definition of the Water Balance of a Finite Volume***

The water balance of the finite volume is defined as follows:

$$\frac{dV(t)}{dt} = Q_{x1}(t) + Q_{y1}(t) + Q_{z1}(t) - Q_{x2}(t) - Q_{y2}(t) - Q_{z2}(t)$$

The demonstration of mass conservancy for the refinement of the grid is based on the assumption that the mass balance for one finite volume (expressed by the equation above) is valid.

The refinement is carried out in the horizontal plane only (in the x and y directions). In x-direction the finite volume is sliced in M parts ($M \geq 1$), and in the y-direction the volume is sliced in N parts ($N \geq 1$).

We assume that the bottom surfaces as well as the top surfaces are plane: this implies that the bottom depth and the water level within one vertical column of finite volumes are assumed constant.

First, we present the water balance terms of one of the sub-volumes. Next we will demonstrate that the conservancy of mass for the whole volume implies the conservancy of mass for each of the subvolumes. The subvolumes are indicated by indices:

i, i = 1,M
j, j = 1,N

Each of the sub-volumes (i,j) is given an equal share of the total volume:

$$V_{i,j}(t) = \frac{V(t)}{N \times M}$$

In a similar way the vertical flows are simply divided homogeneously over each of the N x M sub-volumes:

$$Qz1_{i,j}(t) = \frac{Qz1(t)}{N \times M}$$
$$Qz2_{i,j}(t) = \frac{Qz2(t)}{N \times M}$$

The horizontal flows are first interpolated from one side to the other side of the total volume, and afterwards sliced in the necessary number of equal parts:

$$Qx1_{i,j}(t) = \frac{1}{N}\left\{\left(1 - \frac{i-1}{M}\right) \times Qx1(t) + \left(\frac{i-1}{M}\right) \times Qx2(t)\right\}$$
$$Qx2_{i,j}(t) = \frac{1}{N}\left\{\left(1 - \frac{i}{M}\right) \times Qx1(t) + \left(\frac{i}{M}\right) \times Qx2(t)\right\}$$
$$Qy1_{i,j}(t) = \frac{1}{M}\left\{\left(1 - \frac{j-1}{N}\right) \times Qy1(t) + \left(\frac{j-1}{N}\right) \times Qy2(t)\right\}$$
$$Qy2_{i,j}(t) = \frac{1}{M}\left\{\left(1 - \frac{j}{N}\right) \times Qy1(t) + \left(\frac{j}{N}\right) \times Qy2(t)\right\}$$

The water balance of one sub-volume (i,j) is defined as follows:

$$\frac{dV_{i,j}(t)}{dt} = Qx1_{i,j}(t) + Qy1_{i,j}(t) + Qz1_{i,j}(t) - Qx2_{i,j}(t) - Qy2_{i,j}(t) - Qz2_{i,j}(t)$$

If we substitute all expressions above in the water balance equation for one sub-volume, it is easily demonstrated that the water balance equation for the total volume remains. Thus, if the water balance for the total finite volume is correct, also the water balance for each of the sub-volumes is correct.

C2.3 ACCEPTABILITY OF UNREFINED FLOW MODEL

C2.3.1 Introduction

The results submitted to the draft EIA have been obtained by using a local grid refinement in the water quality model. This refinement technique uses the flow data from the unrefined FLOW model. The refinement (*Figure C2.1*) is intended to provide resolution of concentration gradients on spatial scales smaller than that of the FLOW model grid (similar results could have been obtained e.g. by a particle tracking approach).

It is recognised that the grid refinement method does not provide higher resolution flow patterns. However, in this specific case, it will show in the following section that the results submitted can be an acceptable basis for the impact assessment.

C2.3.2 Comparison between Unrefined and Refined Flow Model

From the results obtained it has been derived that the area where a significant impact from the construction or the operation of the project can possibly be expected is the area immediately adjacent to the project construction site and the Castle Peak B discharge location respectively.

A domain decomposition model was used to assess the small scale velocity variations and to compare them with the unrefined flow field calculated by the Western Harbour Model (*Figure C2.3*).

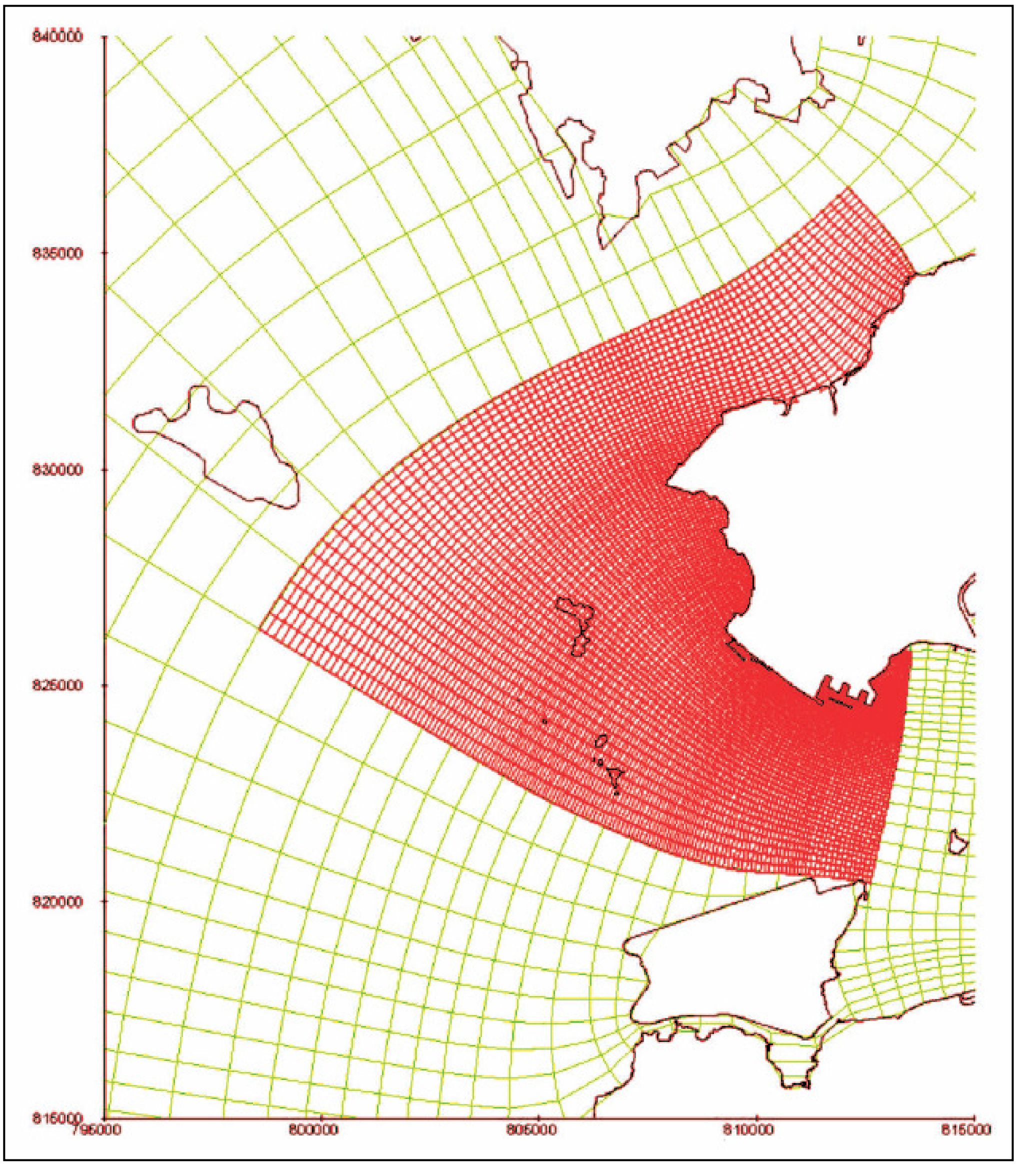

Figure C2.3 Refined Domain (red) and Unrefined Domain (green) of the DD-FLOW Model

From the simulation results (wet season) available at present, we have produced velocity vector snapshots for the ebb and the flood currents near the project area (spring tide conditions); see *Figures C2.4* and *C2.5*.

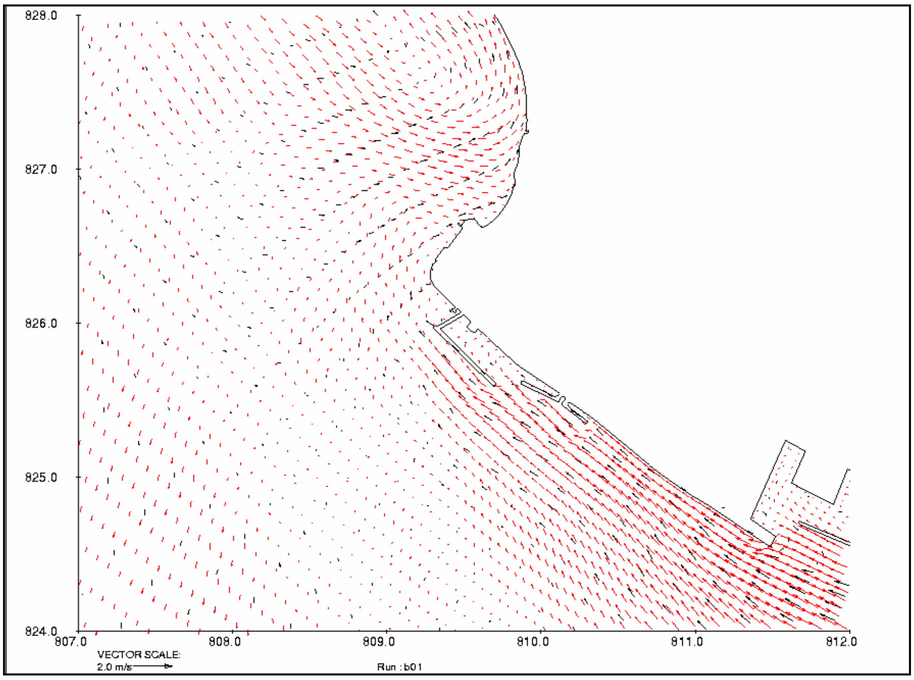

***Figure C2.4** Comparison of flood currents in the wet season calculated by the Western Harbour Model (in black) and by the DD-FLOW model (in red) shown by Figure C2.3*

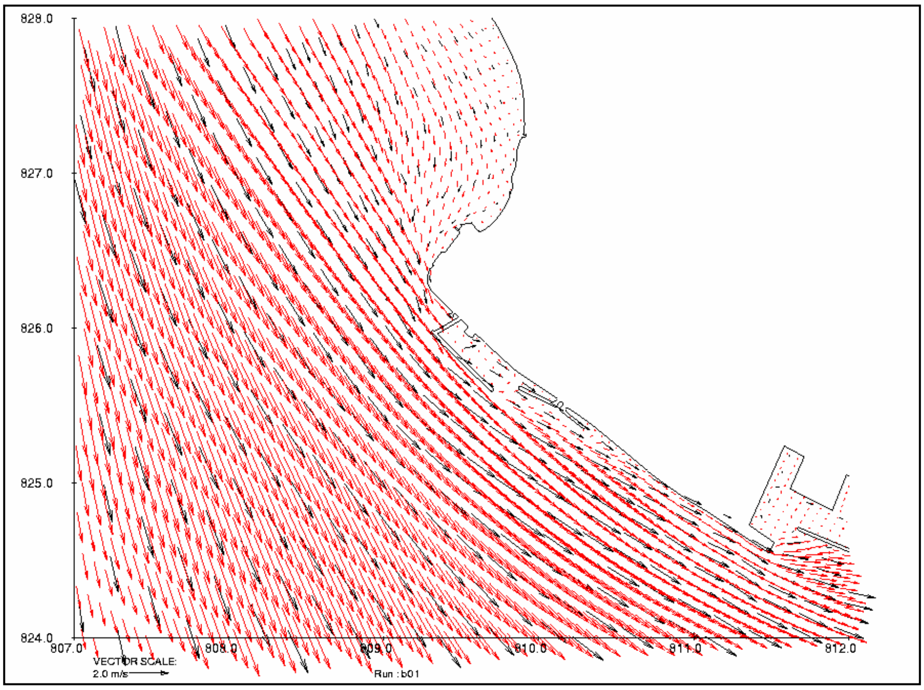

***Figure C2.5** Comparison of ebb currents in the wet season calculated by the Western Harbour Model (in black) and by the DD-FLOW model (in red) shown by Figure C2.3*

From the comparative velocity vector fields, it can be derived that there are no major differences between the overall features of the currents in and around the project area calculated by both models. On theoretical grounds we may assume that the unrefined model misses some smaller scale currents patterns which are resolved by the DD-FLOW model with the locally refined model.

This phenomenon is not likely to affect the dispersion of the operational discharges through outfall B of Castle Peak Power Station, since this discharge is in the area with high currents parallel to the coast.

The sediments released during the construction of the project may reach the area with smaller currents velocities north of the site. In this area, the unrefined model may underestimate the dispersion of sediments by small scale currents. This will lead to overestimated impacts close to the project site. From the most conservative perspective, this does not affect the reliability of the assessment, as long as no water quality objectives are violated in the simulation results. Farther away from the project site, e.g. at sensitive receivers B1, I5 and I3, the impacts may be underestimated. However, the impacts are well below the applicable objectives, and therefore this extra degree of uncertainty does not affect the results of the EIA.

The approach of interpolation of the flow results onto the refined water quality model has been used in recent EIA studies, among those the modelled areas in the EIA for the Permanent Aviation Fuel Facility (1) and the EIA for New Contaminated Mud Pits (2) are the adjacencies to the modelled area for this Study. Hence, it is believed that the approach is likewise suitable for this Study.

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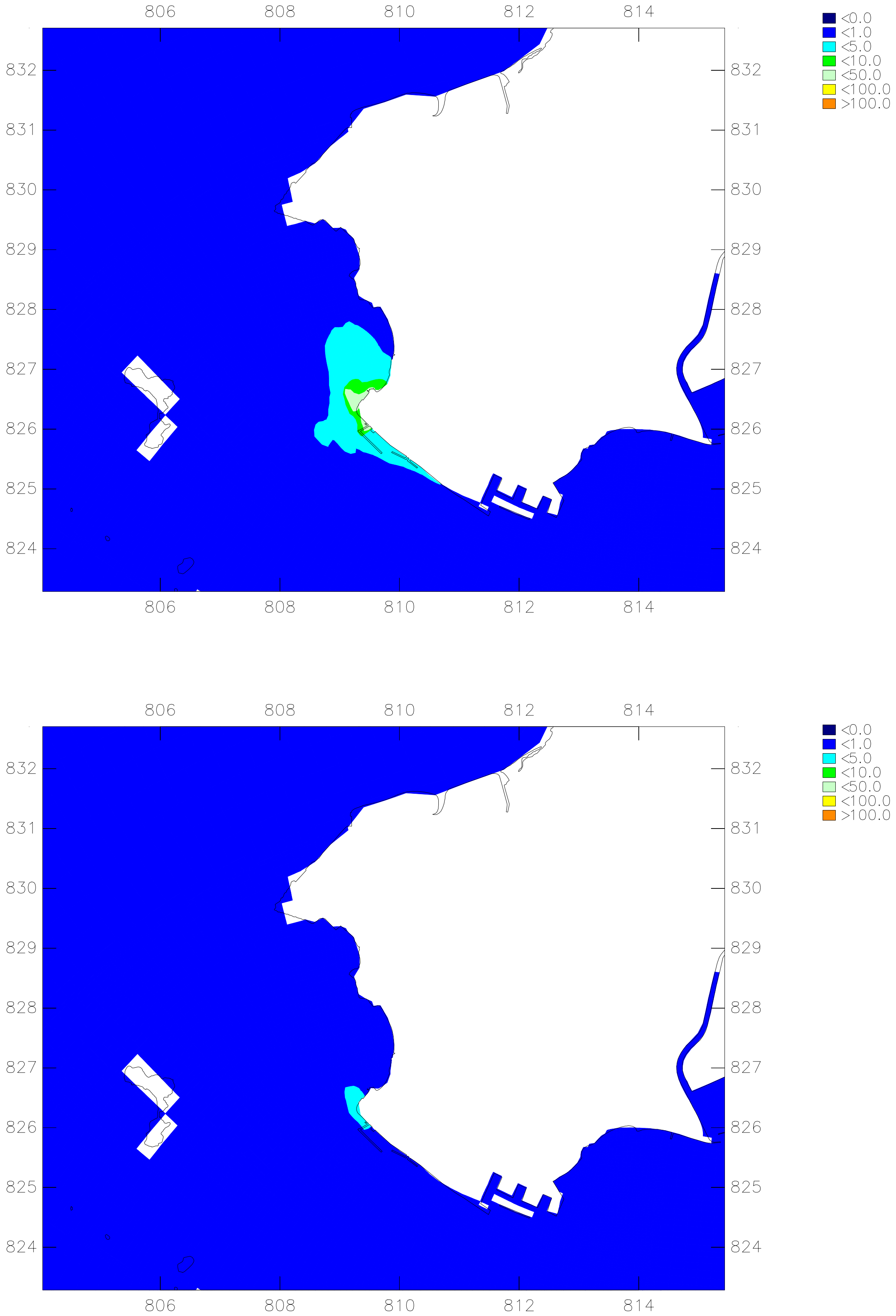
(1) Mouchel (2002). EIA for Permanent Aviation Fuel Facility.

(2) ERM - Hong Kong Ltd (2005). EIA for New Contaminated Mud Disposal Facility within the Airport East / East of Sha Chau Area

Annex C3

Results of Water Quality Model



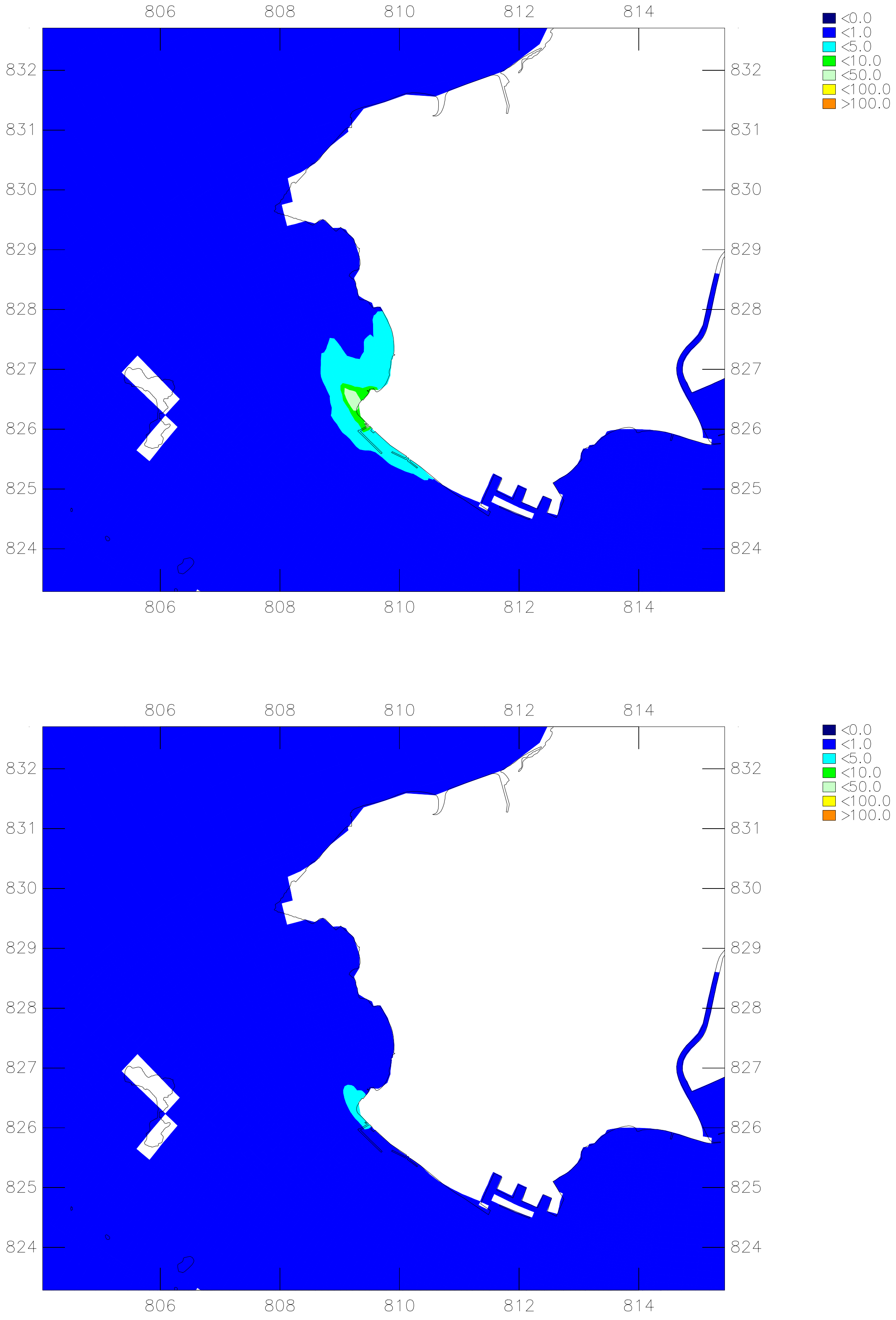
Discharge of SS from FGD construction

Top: max depth average, Bottom: mean depth average

Dry Season

WL | Delft Hydraulics — ERM

Figure C1



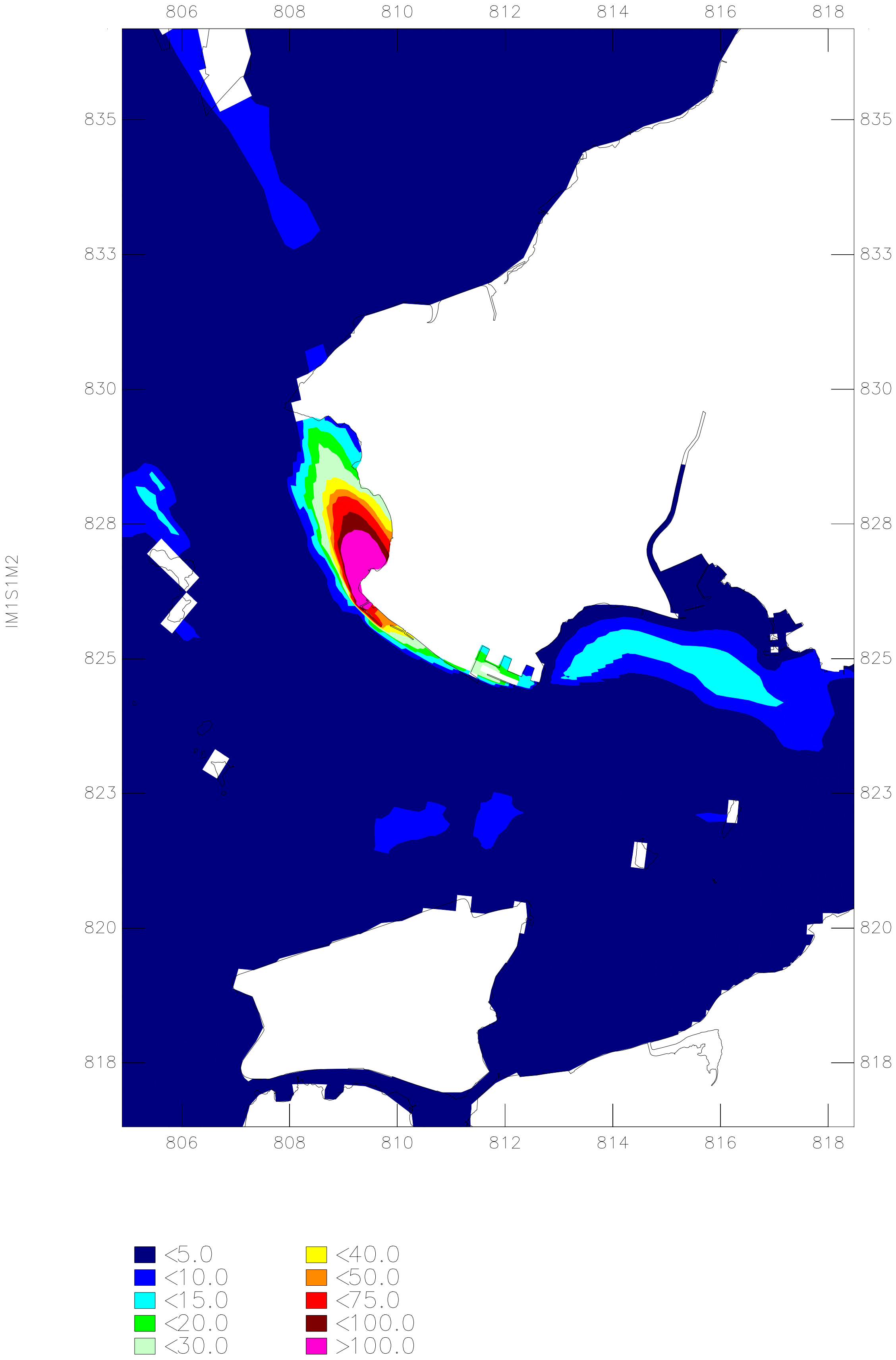
Discharge of SS from FGD construction

Top: max depth average, Bottom: mean depth average

Wet Season

WL | Delft Hydraulics — ERM

Figure C2

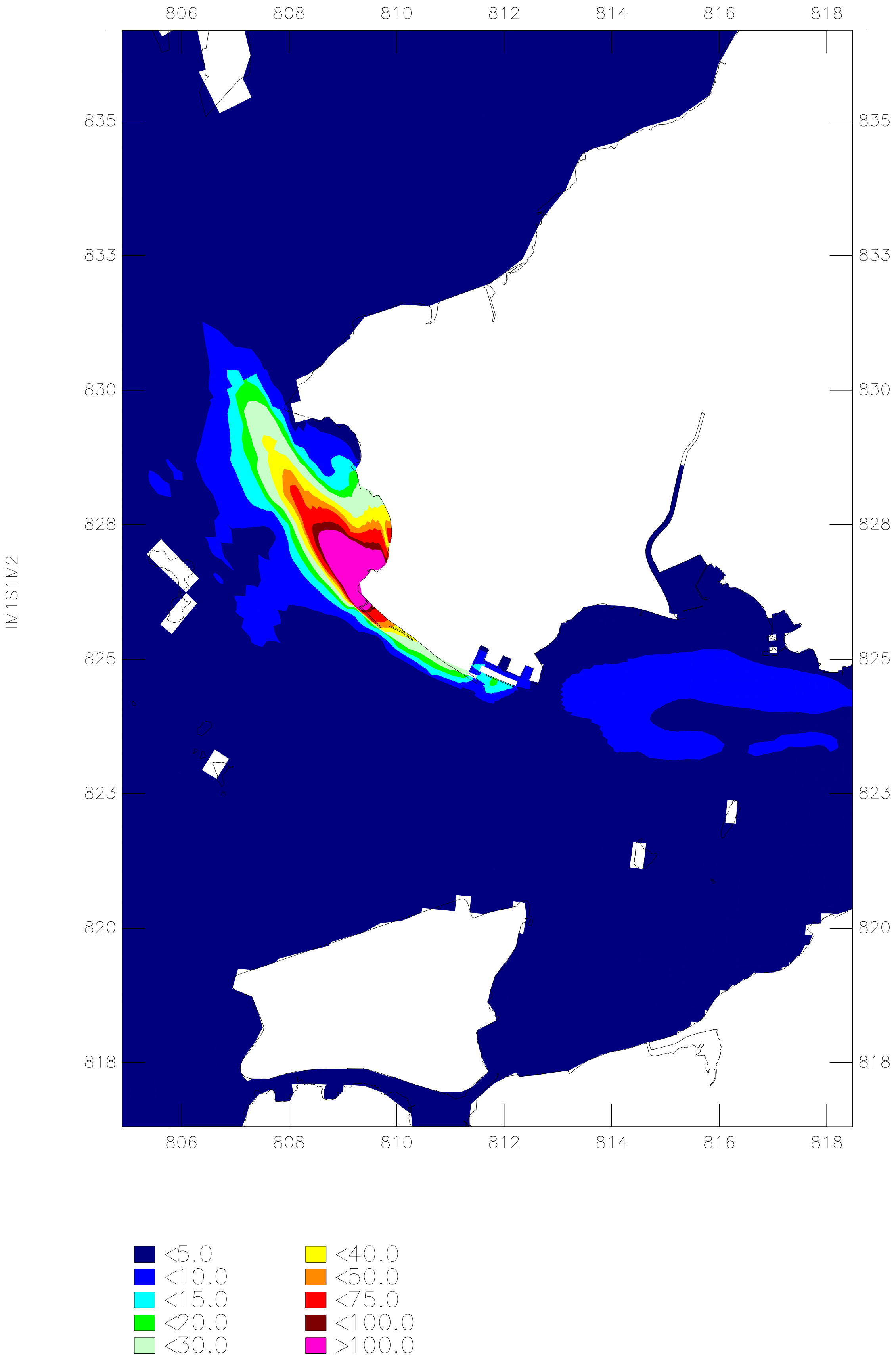


Discharge of SS from FGD construction
Maximum deposition (g/m2)

Dry Season

WL | Delft Hydraulics — ERM

Figure C3



Discharge of SS from FGD construction
Maximum deposition (g/m2)

Wet Season

WL | Delft Hydraulics – ERM

Figure C4

Annex D

Marine Sediment Quality Documents

Annex D1

Marine Sediment Quality Plan

EMISSIONS CONTROL PROJECT AT CASTLE PEAK POWER STATION "B" UNITS SEDIMENT SAMPLING AND TESTING PROGRAMME

1. Background Information

The operations of the Emissions Control Project at Castle Peak Power Station "B" Units will involve the use of reagents and the production of process by-products. The reagents and by-product are expected to be transported via marine transport and new berthing facilities are expected to be required for the loading and unloading of these materials.

The existing Heavy Load Berth along the north-western waterfront of the Castle Peak Power Station will be extended to form a multi-purpose wharf and to provide the additional berthing facilities required. Dredging will be required for the development of the new berthing facilities. The exact extent and boundary of the dredging works is still being streamlined but the total area required to be dredged is currently estimated to be approximately 30,000 m^2. The dredged level is expected to be up to a depth of –8.2 mPD with the total dredged volume is estimated at 80,700 m^3. The preliminary proposed dredge area is presented in Sketch No. 24443/HLB/SK/007 in *Annex D1a*.

2. Sampling Arrangement

Vibrocore of sediment materials for testing of potential contaminants in the sediment is proposed within the proposed dredging area for the new berthing facilities (1). Based on the existing sediment quality data published by EPD for the monitoring stations at Pillar Point and Urmston Road (NS3 and NS4), the sediment quality in the area is considered to be not contaminated.

Based on the total area expected to be dredged, vibrocore samples of sediments are proposed to be taken at three locations evenly distributed within the area to be dredged. The proposed sampling locations are presented in Sketch No. 24443/HLB/SK/007 in *Annex D1a*.

3. Sampling

CAPCO's site investigation contractor will carry out the sampling and provide all necessary equipment. Equipment will be located onto barges and the barges will be towed to the Site prior to sampling.

The contractor will ensure that adequate sediment samples are collected for chemical testing as well as the next Tier of biological testing, based on the laboratory requirement. If one vibrocore recovery is deemed not adequate for conducting all proposed laboratory testing, the contractor's supervisor will be responsible to carry out additional sampling immediately to ensure adequate sediment samples are recovered. Vibrocore sampling will be conducted to the end of the proposed dredging level or at refusal (ie end of sediment layer). The vibrocores will be cut on-site at proposed sampling depths at the existing seabed surface, -0.9m, -1.9m, -2.9m and every 3m thereafter. They will then be inventoried and logged on chain-of-custody forms as described above.

---

(1) This sampling plan is based on the fact that no reclamation is required for the proposed development.

All sediment and water samples will be stored at 4°C during transportation and at the laboratory prior to testing.

The proposed sample container for each test is described in *Annex D1b*.

Sediment samples will be extracted in the laboratory and placed in the appropriate containers directly after the sampling. All samples will be double-bagged and labelled internally and externally with indelible ink. CAPCO contractor's Standard Operating Procedure (SOP) for Extrusion & Homogenization of Sediment Samples is attached in *Annex D1c*.
Each sub-sample for chemical testing will be analysed for parameters as presented in *Section 5* below.

Samples will be extracted and analysed within 14 days. The laboratory will ensure that the chemical screening results are ready as soon as possible after the sampling finished so that a Tier III biological testing programme (where required) can be developed and commenced within 8 weeks from the date of sampling.

The sub-samples for biological testing will also be stored in the same manner as described above (including for ancillary parameters). The composite samples for biological testing, where required, will comprise of composite samples prepared from up-to 5 sub-samples of the same category (ie sediment classified under *ETWBTCW 34/2002* as (category M or H), which are continuous in vertical or horizontal profile. The composite samples for biological testing will also be tested for ancillary parameters, including moisture content, grain size distribution, pH, TOC, ammonia and salinity of pore water.

4. Reference Sample

If Tier III biological testing programme is anticipated, samples for reference sediment will be taken, prior to the initiation of the biological testing programme. The site for collecting reference sediment is in Port Shelter at PS6 (E850234, N820057).

5. Sediment Chemistry Tests

All samples will be tested for all the contaminants stated in *Table 1 - Analytical Methodology* in *Appendix B* of *ETWBTCW 34/2002* and other proposed parameters including: metals (Cd, Cr, Cu, Hg, Ni, Pb, Ag, Zn), metalloid (As), organic-PAHs (low molecular weight PAHs (including Naphthalene, Acenaphtylene, Acenaphtene, Fluorene, Phenanthrene, Anthracene) and high molecular weight PAHs (including Benzo(a)anthracene, Benzo(a)pyrene, Chrysene, Dibenz(ah)anthracene, Fluoranthene, Pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, Benzo(ghi)perylene)), PCBs (including 2,4' dichlorobiphenyl (PCB 8), 2,2',5 trichlorobiphenyl (PCB 18), 2,4,4' trichlorobiphenyl (PCB 28), 2,2',3,5' tetrachlorobiphenyl (PCB 44), 2,2',5,5' tetrachlorobiphenyl (PCB 52), 2,3',4,4' tetrachlorobiphenyl (PCB 66), 3,3',4,4' tetrachlorobiphenyl (PCB 77), 2,2',4,5,5' pentachlorobiphenyl (PCB 101), 2,3,3',4,4' pentachlorobiphenyl (PCB 105), 2,3',4,4',5 pentachlorobiphenyl (PCB 118), 3,3',4,4,5 pentachlorobiphenyl (PCB 126), 2,2',3,3',4,4' hexachlorobiphenyl (PCB 128), 2,2',3,4,4',5' hexachlorobiphenyl (PCB 138), 2,2',4,4',5,5' hexachlorobiphenyl (PCB 153), 3,3',4,4',5,5' hexachlorobiphenyl (PCB 169), 2,2',3,3',4,4',5 heptachlorobiphenyl (PCB 170), 2,2',3,4,4',5,5' heptachlorobiphenyl (PCB 180), 2,2',3,4',5,5',6 heptachlorobiphenyl (PCB 187) and Total PCBs (as sum of the 18 congenors)), chlorinated pesticides (including, Alpha-BHC, Beta BHC, Gamma BHC Delta-BHC, Heptachlor, Aldrin, Heptachlor epoxide, Endosulfan 1, p, p'-DDT, p, p'-DDD, p, p'-DDE and Endosulfan sulphate), TBT in interstitial water and other parameters relating to water quality impact assessment (particle size, redox potential, TOC, TKN, nitrate, nitrite, ammonia nitrogen, ortho-phosphate, total phosphorus).

Elutriate samples will be analysed for metals (Cd, Cr, Cu, Hg, Ni, Pb, Ag, Zn), metalloid (As), organic-PAHs (low molecular weight and high molecular weight PAHs), PCBs, chlorinated pesticides, TBT, and other parameters relating to water quality impact assessment (ammonia, TKN, nitrate, nitrite, ammonia nitrogen, ortho-phosphate, total phosphorus, biological and chemical oxygen demand).

Water samples will be taken at 3 depths, ie 1m below surface, mid-depth and 1m above the seabed level. If the seabed level is less than 6m but more than 3m, samples will be taken at 1m below surface and mid-depth. If the seabed level is less than 3m, samples will be taken at 1m below surface.

Water samples will be tested for metals, ammonia, TKN, nitrate, nitrite, ammoniacal nitrogen, ammonia nitrogen, orthophosphate, total phosphorus, PAHs, PCBs, chlorinated pesticides and TBT.

List of the instrumentation, analytical methods and reporting limit of individual parameters for sediment, elutriate, interstitial water and water samples are summarized in *Annex D1d*.

6. Quality Assurance/Quality Control

The laboratory should ensure that all equipment and instruments to be used for analysis meet the requirements and specifications of the reference method procedures. The laboratory will set upper and lower control limits based on statistical analysis of historical performance data to monitor the acceptability of the QA/QC sample data. All instruments will be calibrated prior to analysis to monitor sensitivity and precision.

The following QA/QC samples will be analysed.

- *Laboratory blanks* - an analyte free matrix to which all reagents are added in the same volumes or proportions as used in the standard sample preparation to monitor contamination introduced in the laboratory (inorganics and organics).

- *Field blanks* – a control standard solution to be used for monitoring of potential contamination of samples from the environmental suring the on-site sample handling. A field blank shall be collected for each set of samples for analysis of organic contents (PAHs).

- *Batch duplicates* - an intra laboratory split sample randomly selected from the sample batch to monitor method precision (intra batch) in a given sample matrix (inorganics only). It is proposed that duplicate samples of 5% from each batch will be analysed.

- *Reference Materials* - analysis of a material with a known concentration of contamination to determine the accuracy of results in a given matrix (inorganics only) (eg CASS 3).

- *Single Control Samples* - a known, interference-free matrix spiked with target analytes used to monitor laboratory preparation techniques (organics only).

- *Duplicate Control Samples* - multiple single control samples designed to monitor preparation technique reproducibility (organics only).

- *Matrix Spike* - An intra laboratory split sample spiked with the target analytes prior to sample preparation and analysis to determine method bias in a given sample matrix (organics only).

A laboratory blank, a batch duplicate (5% of each batch) and a suitable reference material will be analysed with batch of samples. For organics, a method spike will also be analysed with each batch of samples. Each batch will contain a maximum of 20 samples. Results of instrument calibration checks and QA/QC results will be included in each laboratory report. Data Quality Objectives (DQOs) have been developed to address precision, accuracy and analyte recovery, as described below.

Precision

Duplicates (1 in every 10 samples) will be used to monitor the precision of the analysis. Results will be flagged for reference when:

- For all analytes, except metals, with concentration >4x Method Detection Limit (MDL), the duplicate results have more than a 20% Relative Percentage Deviation (RPD);

- For metals with a concentration >4x MDL, the duplicate results have more than a 25% RPD; and

- For all analytes with concentration <4x MDL, the duplicate results will be reported as analysed and no bounds will be quoted.

Accuracy

Standard and certified reference material (CRM) are used to monitor accuracy and precision within and between batches: Results should be flagged for reference if:

- The variation of the standard from its true value is more than 15% (for mercury: 20%).

Recovery

Post digest spikes are used to determine the recovery of determinants in complex sample matrices. Results should be rejected if:

Spike recoveries are more than 25% from the theoretical recovery for waters, sediment and marine biota. An exceptional case would be if the sample concentration is greater than four times the spike value, the spike may be disregarded.

7. Sediment Classification

The tested sediment samples will be classified according to their level of contamination of metals (eight priority metals, including Cd, Cr, Cu, Hg, Ni, Pb, Ag and Zn), metalloid (arsenic), organic–PAHs (low molecular and high molecular weight PAHs), organic-non-PAHs (total polychlorinated biphenyls) and organometallics (tributyltin in interstitial water) as stipulated in *ETWBTCW 34/2002*. The Chemical Exceedance Levels (CEL) specified in Appendix A of *ETWBTCW 34/2002* serve as criteria for determining the testing and disposal requirements of marine dredged sediments. These include:

Category L: Sediment with all contaminant levels not exceeding the Lower Chemical Exceedance Level (LCEL). The material must be dredged, transported and disposed of in a manner, which minimizes the loss of contaminants either into solution or by resuspension.

Category M: Sediment with any one or more contaminant levels exceeding the Lower Chemical Exceedance Level (LCEL) and none exceeding the Upper Chemical Exceedance Level (UCEL). The material must be dredged and transported with care, and must be effectively isolated from the environment upon final disposal unless appropriate biological tests demonstrate that the material will not adversely affect the marine environment.

Category H: Sediment with any one or more contaminant levels exceeding the Upper Chemical Exceedance Level (UCEL). The material must be dredged and transported with great care, and must be effectively isolated from the environment upon final disposal.

8. Necessity to Proceed to Tier III Biological Screening

There is no need to proceed to Tier III for Category L sediment. However, the Tier III biological testing must be implemented for further analysis of Category M and certain Category H sediment. For the latter, Tier III screening is only required if one or more contaminant levels exceed 10 times the LCEL.

9. Sediment Toxicity Testing

In order to determine whether sediment with contaminant concentrations exceeding LCEL and over 10 times LCEL present a toxicological risk to biota inhabiting areas adjacent to the contaminated mud disposal site during their disposal, ecotoxicological evaluations (bioassays) will be performed on these sediment samples. The ecotoxicological testing programme featured a suite of tests that include three phylogenetically distinct species which interact with bedded sediments in different ways. The objective of the bioassays is to determine if there are any potential risks of toxicological impacts from the sediment to the marine biota and whether there is any difference in the toxicity of the sediments samples and the reference sediment (collected from clean areas).

Sediment ecotoxicity testing will be conducted using three bioassays (using amphipod, polychaete and bivalve larvae) defined in the *ETWBTCW34/2002.* The species used in the bioassays are listed in Table 1. All tests will be initiated within the allowable holding period for the sediments as recommended by both international testing and programmes adopted locally (ie eight weeks) (1).

Table 1 **Sediment Toxicity Test Species**

Test	Species
Amphipod (Solid-phase)	*Leptocheirus plumulosus*
Polychaete (Solid-phase)	*Neanthes arenaceodentata*
Bivalve Larvae (Water-soluble phase)	*Crassostrea gigas*

10. Control Sediment

The control sediment will be used to evaluate background behaviour of the test organism such as mortality, behaviour and development. The results from the control sediment will be used to assess the condition (health) of the test organisms and verify the acceptability of the sediment bioassay using pre-defined criteria (eg should > 10% mean mortality occur in the control sediment in the amphipod test then the test must be repeated as the result indicates that the batch of test organisms were in poor health and may not provide a true indication of the potential for toxicity in the Impact sediment).

11. Statistical Methodology and Interpretation of Test Results

The null hypothesis examined for this project is:

H_0 There are no differences between toxicity of the contaminated sediments and the Reference sediments.

One-way ANOVA will be performed to examine any differences in test organism response when exposed to the sediment in the six treatments. Statistically significant differences is determined at a probability, $p \leq 0.05$.

Amphipod Test - a biologically significant toxic response is considered to be: amphipod mortality that is significantly different ($p \leq 0.05$) between the Reference sediment and the sample, **and**, mean survival in the test sediment <80% of mean survival in Reference sediment (2).

Bivalve Larval Test - a biologically significant toxic response is defined as: corrected abnormality or combined mortality that is statistically different ($p \leq 0.05$) between the Reference Sediment and the sample**, and,** mean normality survival in the test sediment <80% of mean survival in reference sediment (3)(1).

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(1) ETWBTCW (2002) Works Bureau Technical Circular No. 34/2002. Management of Dredged/Excavated Sediment.

(2) Environment, Transport and Works Bureau (2002), Technical Circular (Works) No.34/2002 – Management of Dredged/Excavated Sediment, Appendix B – Test End Points and Decision Criteria do Tier III Biological Screening, Environment, Transport and Works Bureau, Technical Circular (Works) No.34/2002.

(3) Environment, Transport and Works Bureau (2002) *Op cit.*

Polychaete Test - a biologically significant toxic response is an individual growth rate that is recorded when: Mean dry weight in test sediments is significantly different ($p \leq 0.05$) from mean dry weight in Reference sediment , **and**, mean dry weight in test sediments <90% of mean dry weight in Reference sediment (2)(3).

12. Final Classification and Disposal

The final classification decision and selection of appropriate disposal options, routing and the allocation of a permit to dispose at the designated disposal site will be made by the EPD, in consultation with the Marine Fill Committee (MFC) in accordance with *WBTC 12/2000* (4).

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(1) Normality Survival integrates the normality and survival end points, and measures survival of only the normal larvae relative to the starting number.

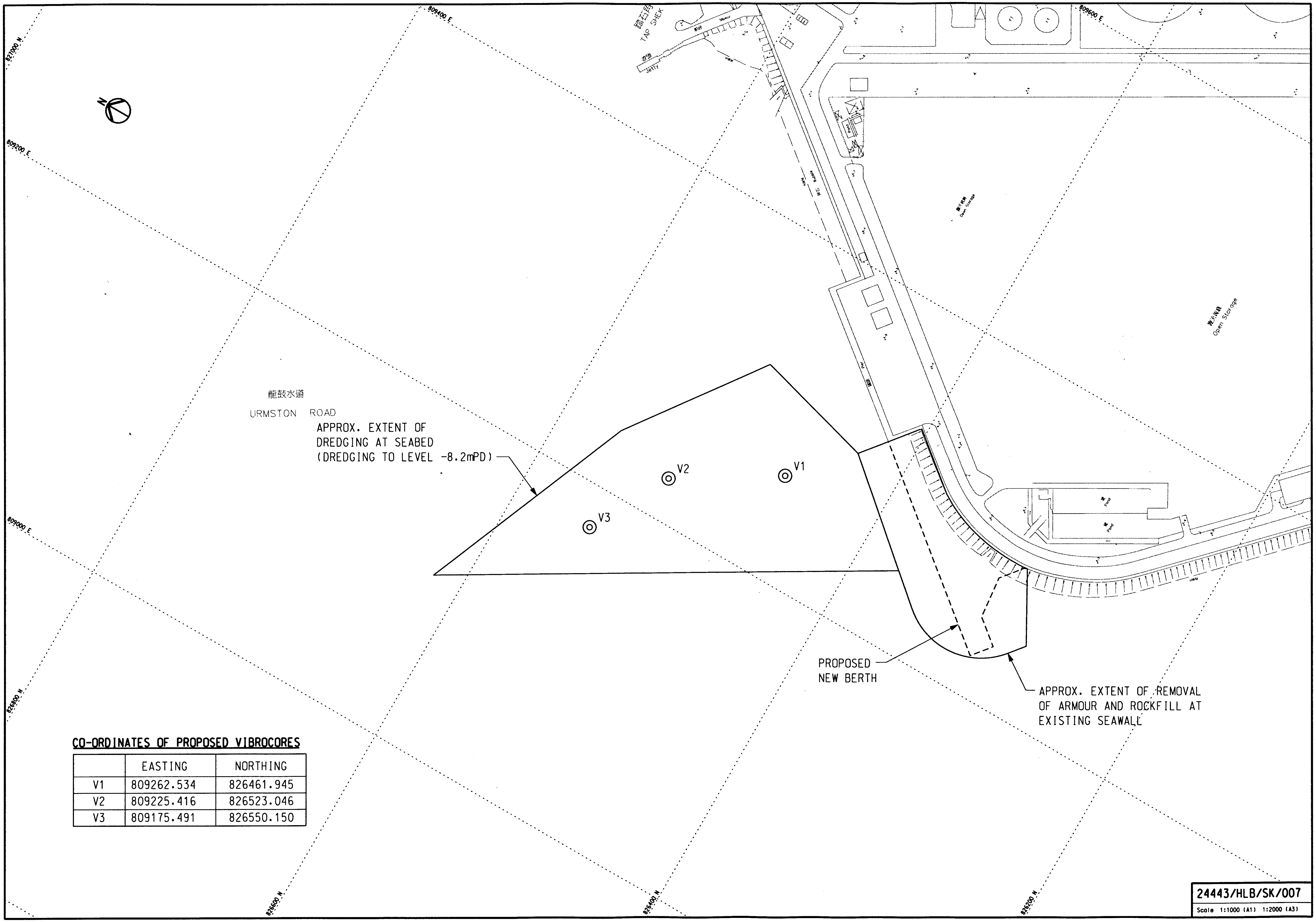
(2) Dry weight means total dry weight after deducing dead and missing worms.

(3) Environment, Transport and Works Bureau (2002) *Op cit.*

(4) *Work Bureau Technical Circular No. 12/2000 - Fill Management*, ETWB.

Annex D1a

Drawings



APPROX. EXTENT OF DREDGING AT SEABED (DREDGING TO LEVEL -8.2mPD)

PROPOSED NEW BERTH

APPROX. EXTENT OF REMOVAL OF ARMOUR AND ROCKFILL AT EXISTING SEAWALL

CO-ORDINATES OF PROPOSED VIBROCORES

	EASTING	NORTHING
V1	809262.534	826461.945
V2	809225.416	826523.046
V3	809175.491	826550.150

24443/HLB/SK/007

Scale 1:1000 (A1) 1:2000 (A3)

Annex D1c

Standard Operating Procedure (SOP) for Extrusion & Homogenization of Sediment Samples

CLP Contract No. 4500219450
Emission Control Project at Castle Peak Power Station “B” Units
Standard Operating Procedure (SOP) for Extrusion & Homogenization of Sediment Samples

1.0 Scope and Application

The purpose of this standard operation procedure (SOP) is to describe the procedures for the extrusion and homogenization of sediment samples from vibrocore.

2.0 Method Summary

Sediment sample is extruded from vibrocore and put onto a stainless steel tray covered by aluminum foil. After the sediment sample is homogenized, sub-samples are put into amber glass bottle for chemical analysis and the remaining samples are put into a plastic bag for chemical and biological analysis.

Sampling and analysis procedures are not covered in this SOP.

3.0 Sample Size

Test Parameters	Sample Container
1. Metals 2. Metalloids 3. PCBs 4. PAHs	One 250mL amber glass bottle
5. Biological Testing	One 6L Plastic Bag

4.0 Sample Preservation, Containers, Handling and Storage

Chemical preservation of solids is not generally recommended. Samples should, however, be cooled at 4 ^{o}C and protected from sunlight to minimize any potential reaction and loss of analyte.

5.0 Procedure

5.1 Carefully remove the caps of the vibrocore and put into sample extruder.

5.2 Turn on the sample extruder and receive the extruded sample from the top carefully.

5.3 Reject the Last 10mm of the sample touching the extruder plunger.

5.4 Put the extruded sample onto a stainless steel tray covered with clean aluminum foil.

4.4 Homogenize the sample inside the tray

5.5 Put the sub-sample into an amber glass bottle and store in a refrigerator at 4^{o}C prior to chemical analysis.

5.6 Put the remaining sample into a heavy duty plastic bag and store in a refrigerator at 4^{o}C prior to biological analysis.

5.7 Dispose of the aluminum foil and the sediment residue and use a new and clean aluminum foil for next sample.

Annex D1b

Proposed Sample Containers

Lam Environmental Services
Test Specialists & Environmental Analysts

Project:	**CLP Contract No. 4500219450** **Emissions Control Project at Castle Peak Power Station “B” Units**
Job No.	***J494***
Subject:	**Sample Container Information**

Sediment (After Extrusion from Vibrocore)

Container per sample			**Parameters**	**Preservation**
Quantity	**Size (mL)**	**Type**		
1	6000	Plastic Bag	Biological Testing*	4°C
1	500	Amber Glass	Metals, PAH, PCB, TOC	
1	1000	Plastic	TBT for immediate centrifuge	
1	125	Amber Glass	OCP	
1	2000	Plastic Bag	Ammonia, Redox Potential, TKN, Nitrate, Nitrite, Ortho-phosphate, Total Phosphorous, Particle Size.	

Seawater for preparation of Elutriate Samples

Container per sample			**Parameters**	**Preservation**
Quantity	**Size (mL)**	**Type**		
1	5000	Plastic Container	Metals, Ammonia, TKN, Nitrate, Nitrite, Ammonical Nitrogen, Ortho-phosphate, Total Phosphorous, PAH, PCB, OCP and TBT	4°C

Elutriate (After Preparation of Elutriate before Analysis)

Container per sample			**Parameters**	**Preservation**
Quantity	**Size (mL)**	**Type**		
1	230	Plastic	Metals	HNO_3, 4°C
1	500	Amber Glass	OCP	4°C
1	3000	Amber Glass	PAH, PCB and TBT	4°C
1	500	Plastic	TKN, Ammonia, Total Phosphorous, COD	H_2SO_4, 4°C
1	500	Plastic	Nitrate, Nitrite, Ortho-phosphate, BOD	4°C

Seawater

Container per sample			**Parameters**	**Preservation**
Quantity	**Size (mL)**	**Type**		
1	230	Plastic	Metals	HNO_3, 4°C
1	500	Amber Glass	OCP	4°C
1	3000	Amber Glass	PAH, PCB and TBT	4°C
1	500	Plastic	TKN, Ammonia, Total Phosphorous, COD	H_2SO_4, 4°C
1	500	Plastic	Nitrate, Nitrite, Ortho-phosphate, BOD	4°C

NOTES:
*Double plastic bags to be used to prevent leakage of samples.

Annex D1d

Analytical Methods

Project : **Emissions Control Project at Castle Peak Power Station "B" Units**
Subject: **Analytical Deliverables**

Chemical Tests (Sediment)

Item No.	Contaminant of Concern	SEDIMENT							INTERSTITIAL WATER / ELUTRIATE / MARINE WATER						
		Methodology Offered	**Reporting Limit Offered**	**Unit**	**Accreditation Status**	**Minimum Sample Size^3**	**Remarks**	**QA/QC Procedures^5**	**Methodology Offered**	**Reporting Limit Offered**	**Unit**	**Accreditation Status$^{\text{Note 8}}$**	**Minimum Sample Size^3**	**Remarks**	**QA/QC Procedures^5**
1	**Metals**					50 g							250 mL		
1a	Cadmium (Cd)	USEPA3050B/6020A	0.1	mg/kg	HOKLAS			Method Blank	USEPA3050B/6020A	0.5	ug/L	HOKLAS			Method Blank
1b	Chromium (Cr)	USEPA3050B/6020A	1	mg/kg	HOKLAS			Sample Duplicate	USEPA3050B/6020A	5	ug/L	HOKLAS			Sample Duplicate
1c	Copper (Cu)	USEPA3050B/6020A	1	mg/kg	HOKLAS			Sample Spike	USEPA3050B/6020A	1	ug/L	HOKLAS			Sample Spike
1d	Mercury (Hg)	USEPA3050B/6020A	0.05	mg/kg	HOKLAS		Note 1	ISE (proficiency)	USEPA3050B/6020A	0.2	ug/L	HOKLAS			Blank Spike
1e	Nickel (Ni)	USEPA3050B/6020A	1	mg/kg	HOKLAS				USEPA3050B/6020A	2	ug/L	HOKLAS			
1f	Lead (Pb)	USEPA3050B/6020A	1	mg/kg	HOKLAS				USEPA3050B/6020A	2	ug/L	HOKLAS			
1g	Silver (Ag)	USEPA3050B/6020A	0.1	mg/kg	HOKLAS				USEPA3050B/6020A	1	ug/L	HOKLAS			
1h	Zinc (Zn)	USEPA3050B/6020A	10	mg/kg	HOKLAS				USEPA3050B/6020A	10	ug/L	HOKLAS			
1i	Arsenic (As)	USEPA3050B/6020A	1	mg/kg	HOKLAS				USEPA3050B/6020A	1	ug/L	HOKLAS			
2	**Particle Size**	Geospec 3, Test 8.1	NA	NA	HOKLAS	500 g		NA							
3	**Redox Potential**	APHA 2580 B mod	1	mV	NA$^{\text{Note 7}}$	500 g		NA							
4	**TOC**	APHA 5310 B	0.1	%	HOKLAS	50 g		Method Blank, Check Sample and Blank Spike							
5	**TKN**	APHA 4500-N_{org} + NH_3 C mod	50	mg-N/kg	NA$^{\text{Note 7}}$	50 g		Method Blank, Sample Duplicate, Sample Spike, QC Standard	APHA 4500-N_{org} + NH_3 C	0.1	mg-N/L	HOKLAS	100 mL		Method Blank, Sample Duplicate, Sample Spike, QC Standard
6	**Nitrate**	APHA 4500-NO_3 I mod	1	mg-N/kg	NA$^{\text{Note 7}}$	50 g			APHA 4500-NO_3 I	0.05	mg-N/L	HOKLAS	100 mL		
7	**Nitrite**	APHA 4500-NO_3 I mod	1	mg-N/kg	NA$^{\text{Note 7}}$	50 g			APHA 4500-NO_3 I	0.05	mg-N/L	HOKLAS	100 mL		
8	**Ammoniacal Nitrogen**	APHA 4500-NH_3 H mod	1	mg-NH_4-N/kg	NA$^{\text{Note 7}}$	50 g			APHA 4500-NH_3 H	0.1	mg-NH_4-N/L	HOKLAS	100 mL		
9	**Ortho-Phosphate**	APHA 4500-P F mod	1	mg-P/kg	NA$^{\text{Note 7}}$	50 g		Method Blank, Sample Duplicate, Sample Spike	APHA 4500-P F	0.05	mg-P/L	HOKLAS	100 mL		Method Blank, Sample Duplicate, Sample Spike
10	**Total Phosphorous**	APHA 4500-P B&E mod	10	mg-P/kg	NA$^{\text{Note 7}}$	50 g			APHA 4500-P B&E	0.1	mg-P/L	HOKLAS	100 mL		
11	**PAHs**					100 g							1L		
	Low Molecular Weight PAHs		55	ug/kg	NA$^{\text{Note 7}}$			Method Blank		0.1	ug/L	NA$^{\text{Note 7}}$			Method Blank
11a	Naphthalene	USEPA3550B/8270C	55	ug/kg	HOKLAS			Sample Duplicate	USEPA3550B/8270C	0.1	ug/L	HOKLAS			Sample Duplicate
11b	Acenaphtylene		55	ug/kg	HOKLAS			Matrix Spike		0.1	ug/L	HOKLAS			Matrix Spike
11c	Acenaphtene		55	ug/kg	HOKLAS			SETOC		0.1	ug/L	HOKLAS			Blank Spike
11d	Fluorene		55	ug/kg	HOKLAS					0.1	ug/L	HOKLAS			
11e	Phenanthrene		55	ug/kg	HOKLAS					0.1	ug/L	HOKLAS			
11f	Anthracene		55	ug/kg	HOKLAS					0.1	ug/L	HOKLAS			
	High Molecular Weight PAHs		170	ug/kg	NA$^{\text{Note 7}}$					0.1	ug/L	NA$^{\text{Note 7}}$			
11g	Benzo(a)anthracene	USEPA3550B/8270C	170	ug/kg	HOKLAS				USEPA3550B/8270C	0.1	ug/L	HOKLAS			
11h	Benzo(a)pyrene		170	ug/kg	HOKLAS					0.1	ug/L	HOKLAS			
11i	Chrysene		170	ug/kg	HOKLAS					0.1	ug/L	HOKLAS			
11j	Dibenz(ah)anthracene		170	ug/kg	HOKLAS					0.1	ug/L	HOKLAS			
11k	Fluoranthene		170	ug/kg	HOKLAS					0.1	ug/L	HOKLAS			
11l	Pyrene		170	ug/kg	HOKLAS					0.1	ug/L	HOKLAS			
11m	Benzo(b)fluoranthene		170	ug/kg	HOKLAS					0.1	ug/L	HOKLAS			
11n	Benzo(k)fluoranthene		170	ug/kg	HOKLAS					0.1	ug/L	HOKLAS			
11o	Indeno(1,2,3-cd)pyrene		170	ug/kg	HOKLAS					0.1	ug/L	HOKLAS			
11o	Benzo(ghi)perylene		170	ug/kg	HOKLAS					0.1	ug/L	HOKLAS			
12	**PCBs**	USEPA3550B, 3620B, 3660B & 3665A/8270C				100 g			USEPA3550B, 3620B, 3660B & 3665A/8270C				1L		
12a	2,4' dichlorobiphenyl (PCB 8)		2	ug/kg	HOKLAS			Method Blank		0.01	ug/L	HOKLAS			Method Blank
12b	2,2',5 trichlorobiphenyl (PCB 18)		2	ug/kg	HOKLAS			Sample Duplicate		0.01	ug/L	HOKLAS			Sample Duplicate
12c	2,4,4' trichlorobiphenyl (PCB 28)		2	ug/kg	HOKLAS			Matrix Spike		0.01	ug/L	HOKLAS			Matrix Spike
12d	2,2',3,5' tetrachlorobiphenyl (PCB 44)		2	ug/kg	HOKLAS			SETOC		0.01	ug/L	HOKLAS			Blank Spike
12e	2,2',5,5' tetrachlorobiphenyl (PCB 52)		2	ug/kg	HOKLAS					0.01	ug/L	HOKLAS			
12f	2,3',4,4' tetrachlorobiphenyl (PCB 66)		2	ug/kg	HOKLAS					0.01	ug/L	HOKLAS			
12g	3,3',4,4' tetrachlorobiphenyl PCB 77)		2	ug/kg	HOKLAS					0.01	ug/L	HOKLAS			
12h	2,2',4,5,5' pentachlorobiphenyl (PCB 101)		2	ug/kg	HOKLAS					0.01	ug/L	HOKLAS			
12i	2,3,3',4,4' pentachlorobiphenyl (PCB 105)		2	ug/kg	HOKLAS					0.01	ug/L	HOKLAS			
12j	2,3',4,4',5 pentachlorobiphenyl (PCB 118)		2	ug/kg	HOKLAS					0.01	ug/L	HOKLAS			
12k	3,3',4,4,5 pentachlorobiphenyl (PCB 126)		2	ug/kg	HOKLAS					0.01	ug/L	HOKLAS			
12l	2,2',3,3',4,4' hexachlorobiphenyl (PCB 128)		2	ug/kg	HOKLAS					0.01	ug/L	HOKLAS			
12m	2,2',3,4,4',5' hexachlorobiphenyl (PCB 138)		2	ug/kg	HOKLAS					0.01	ug/L	HOKLAS			
12n	2,2',4,4',5,5' hexachlorobiphenyl (PCB 153)		2	ug/kg	HOKLAS					0.01	ug/L	HOKLAS			
12o	3,3',4,4',5,5' hexachlorobiphenyl (PCB 169)		2	ug/kg	HOKLAS					0.01	ug/L	HOKLAS			
12p	2,2',3,3',4,4',5 heptachlorobiphenyl (PCB 170)		2	ug/kg	HOKLAS					0.01	ug/L	HOKLAS			
12q	2,2',3,4,4',5,5' heptachlorobiphenyl (PCB 180)		2	ug/kg	HOKLAS					0.01	ug/L	HOKLAS			
12r	2,2',3,4',5,5',6 heptachlorobiphenyl (PCB 187)		2	ug/kg	HOKLAS					0.01	ug/L	HOKLAS			
12s	Total PCBs (as sum of the 18 congenors)		2	ug/kg	HOKLAS					0.01	ug/L	HOKLAS			
13	**Tributyltin (TBT)**								UNEP/IOC/IAEA	0.015	ug/L	HOKLAS	100 mL	Note 2	Method Blank, Sample Duplicate, Method Spike, Blank Spike
14	**Chlorinated Pesticides**					200g									
	Alpha-BHC	GC-ECD/GC-MSD/USEPA8081A/USEPA827	0.01	mg/kg	NATA		Note 6	Blank, Recovery	GC-ECD/GC-MSD/USEPA8081A/USEPA8270C	0.02	ug/L	NATA	500 mL	Note 6	Blank, Recovery
	Beta BHC		0.01	mg/kg	NATA					0.02	ug/L	NATA			
	Gamma BHC		0.01	mg/kg	NATA					0.02	ug/L	NATA			
	Delta-BHC		0.01	mg/kg	NATA					0.02	ug/L	NATA			
	Heptachlor		0.01	mg/kg	NATA					0.02	ug/L	NATA			
	Aldrin		0.01	mg/kg	NATA					0.02	ug/L	NATA			
	Heptachlor epoxide		0.01	mg/kg	NATA					0.02	ug/L	NATA			
	Endosulfan 1		0.01	mg/kg	NATA					0.02	ug/L	NATA			
	p, p'-DDT		0.01	mg/kg	NATA					0.02	ug/L	NATA			
	p, p'-DDD		0.01	mg/kg	NATA					0.02	ug/L	NATA			
	p, p'-DDE		0.01	mg/kg	NATA					0.02	ug/L	NATA			
	Endosulfan sulfate		0.01	mg/kg	NATA					0.02	ug/L	NATA			
15	**Biological Oxygen Demand**								APHA 5210B	2	mg/L	HOKLAS	500 mL	Note 8	Dilution Blank, Seed Blank, Sample Duplicate, Control Sample
16	**Chemcial Oxygen Demand**								APHA 5220D	50	mg/L	HOKLAS	100 mL	Note 8	Sample Duplicate, Method Spike, Control Sample

Note:
1. Hg reported to MDL level.
2. TBT reported to MDL (Method Detection Limit) based on 100 mL sample volume.
3. Extra sample is required for sample duplicate & matrix spike
4. Turnaround time: 14 days from sample receipt.
5. For a batch of 20 or less samples.
6. NATA - National Association of Testing Authorities of Australia
7. NA denotes not applicable.
8. Accreditation is in water and wastewater.
9. Item 4 subcontracted to ALS. Item 14 subcontracted to National Measurement Institute.
10. TBT in interstitial water will be analysed for all sediment samples.
11. USEPA and US Army Corps of Engineers, EPA 823-B-98/004, 1998 will be used for elutriate sample preparation.
12. All sediment samples will be tested for metals (Cd, Cr, Cu, Hg, Ni, Pb, Ag, Zn),metalloid (As), organic-PAHs (low molecular weight PAHs and high molecular weight PAHs, PCBs, chlorinated pesticides, TBT in interstitial water, particle size, redox potential, TOC, TKN, nitrate, nitrite, ammonia nitrogen, ortho-phosphate and total phosphorus.
13. Elutriate samples will be analysed for metals (Cd, Cr, Cu, Hg, Ni, Pb, Ag, Zn), metalloid (As), organic-PAHs (low molecular weight and high molecular weight PAHs), PCBs, chlorinated pesticides, TBT, ammonia, TKN, nitrate,nitrite, ammonia nitrogen, ortho-phosphate, total phosphorus and biological and chemical oxygen demand.
14. Water samples will be tested for metals, ammonia, TKN, nitrate, nitrite, ammoniacal nitrogen, ammonia nitrogen, orthophosphate, total phosphorus, PAHs, PCBs, chlorinated pesticides and TBT.

Annex D2

Marine Sediment Testing Results

Lam Environmental Services
Test Specialists & Environmental Analysts

SUMMARY REPORT

Project: **Emission Control Project at Castle Peak Power Station 'B' Units**
Client: **CLP Power Hong Kong Limited**
Address: Commercial Project
G/F, 147 Argyle Street
Kowloon
Hong Kong
Lab. Job No. : J494

Matrix : Sediment

Laboratory Sample ID	**Sample Reference**		**Heavy Metals**								
	Drillhole No.	**Depth (m)**	Cadmium (Cd)	Chromium (Cr)	Copper (Cu)	Nickel (Ni)	Lead (Pb)	Zinc (Zn)	Mercury (Hg)	Arsenic (As)	Silver (Ag)
		From To	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
			0.1	1	1	1	1	10	0.05	1	0.1
16960 / 1	V1	0.00-0.90	0.2	35	18	21	54	83	0.13	12	0.1
16960 / 2	V1	0.90-1.70	0.1	28	15	18	36	72	0.10	12	<0.1
16960 / 3	V2	0.20-0.90	0.2	35	63	22	55	110	<0.05	12	0.4
16960 / 4	V2	0.90-2.20	0.1	35	46	20	45	97	0.17	12	0.2
16960 / 5	V3	0.05-1.10	0.2	30	37	19	46	110	0.14	10	0.4

Lam Environmental Services
Test Specialists & Environmental Analysts

SUMMARY REPORT

Project: **Emission Control Project at Castle Peak Powe Station 'B' Units**
Client: **CLP Power Hong Kong Limited**
Address: Commercial Project
G/F, 147 Argyle Street
Kowloon
Hong Kong
Lab. Job No. : J494

Matrix : Sediment

Laboratory Sample ID	Sample Reference		Redox Potential	TOC	TKN	Nitrate	Nitrite	Ammoniacal Nitrogen	Ortho-Phosphate	Total Phosphorous
	Drillhole No.	Depth (m) From To	mV	%	mg-N/kg	mg-N/kg	mg-N/kg	mg-NH_4-N/kg	mg-P/kg	mg-P/kg
			1	0.1	50	1	1	1	1	10
16960 / 1	V1	0.00-0.90	450	0.78	170	5.2	1.7	23	3.5	410
16960 / 2	V1	0.90-1.70	450	1.1	100	6.7	1.5	33	3.7	410
16960 / 3	V2	0.20-0.90	430	0.89	120	8.3	2.8	21	5.3	700
16960 / 4	V2	0.90-2.20	450	1.4	110	4.4	1.8	31	9.6	660
16960 / 5	V3	0.05-1.10	460	1.2	130	5.3	1.9	6.7	2.0	520

SUMMARY REPORT

Project: **Emission Control Project at Castle Peak Powe**
Station 'B' Units
Client: **CLP Power Hong Kong Limited**
Address: Commercial Project
G/F, 147 Argyle Street
Kowloon
Hong Kong
Lab. Job No. : J494

Matrix : Sediment

Laboratory Sample ID	Sample Reference		PAHs (Low Molecular Weight)						PAHs (High Molecular Weight)									
	Drillhole No.	Depth (m) From To	Naphthalene ug/kg	Acenaphtylene ug/kg	Acenaphtene ug/kg	Fluorene ug/kg	Phenanthrene ug/kg	Anthracene ug/kg	Benzo(a)anthracene ug/kg	Benzo(a)pyrene ug/kg	Chrysene ug/kg	Dibenz(ah)anthracene ug/kg	Fluoranthene ug/kg	Pyrene ug/kg	Benzo(b)fluoranthene ug/kg	Benzo(k)fluoranthene ug/kg	Indeno(1,2,3-cd)pyrene ug/kg	Benzo(ghi)perylene ug/kg
			55	55	55	55	55	55	170	170	170	170	170	170	170	170	170	170
16960 / 1	V1	0.00-0.90	<55	<55	<55	<55	<55	<55	<170	<170	<170	<170	<170	<170	<170	<170	<170	<170
16960 / 2	V1	0.90-1.70	<55	<55	<55	<55	<55	<55	<170	<170	<170	<170	<170	<170	<170	<170	<170	<170
16960 / 3	V2	0.20-0.90	<55	<55	<55	<55	<55	<55	<170	<170	<170	<170	<170	<170	<170	<170	<170	<170
16960 / 4	V2	0.90-2.20	<55	<55	<55	<55	<55	<55	<170	<170	<170	<170	<170	<170	<170	<170	<170	<170
16960 / 5	V3	0.05-1.10	<55	<55	<55	<55	<55	<55	<170	<170	<170	<170	<170	<170	<170	<170	<170	<170

SUMMARY REPORT

Project: **Emission Control Project at Castle Peak Powe**
Station 'B' Units
Client: **CLP Power Hong Kong Limited**
Address: Commercial Project
G/F, 147 Argyle Street
Kowloon
Hong Kong
Lab. Job No. : J494

Matrix : Sediment

Laboratory Sample ID	Sample Reference		PCB																		
	Drillhole No.	Depth (m) From To	PCB 8	PCB 18	PCB 28	PCB 44	PCB 52	PCB 66	PCB 77	PCB 101	PCB 105	PCB 118	PCB 126	PCB 128	PCB 138	PCB 153	PCB 169	PCB 170	PCB 180	PCB 187	Total PCB
			ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
			2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
16960 / 1	V1	0.00-0.90	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
16960 / 2	V1	0.90-1.70	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
16960 / 3	V2	0.20-0.90	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
16960 / 4	V2	0.90-2.20	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
16960 / 5	V3	0.05-1.10	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2

Lam Environmental Services
Test Specialists & Environmental Analysts

SUMMARY REPORT

Project: **Emission Control Project at Castle Peak Powe**
Station 'B' Units
Client: **CLP Power Hong Kong Limited**
Address: Commercial Project
G/F, 147 Argyle Street
Kowloon
Hong Kong
Lab. Job No. : J494

Matrix : Sediment

Laboratory	Sample Reference			Chlorinated Pesticides												Particle Size		
Sample ID	Drillhole No.	Depth (m) From To	TBT	Alpha-BHC	Beta BHC	Gamma BHC	Delta-BHC	Heptachlor	Aldrin	Heptachlor epoxide	Endosulfan 1	p, p'-DDT	p, p'-DDD	p, p'-DDE	Endosulfan sulfate	Gravel	Sand	Silt & Clay
			ug/L	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	%	%	%
			0.015	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	NA	NA	NA
16960 / 1	V1	0.00-0.90	<0.015	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	1	20	79
16960 / 2	V1	0.90-1.70	<0.015	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0	2	98
16960 / 3	V2	0.20-0.90	<0.015	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	2	15	83
16960 / 4	V2	0.90-2.20	<0.015	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0	6	94
16960 / 5	V3	0.05-1.10	<0.015	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0	28	72

Annex E

Land Contamination Assessment Documents

Emissions Control Project at Castle Peak Power Station "B" Units

Environmental Impact Assessment

Remediation Action Plan

June 2006

Environmental Resources Management
21/F Lincoln House
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CONTENTS

1 INTRODUCTION

1.1 BACKGROUND TO THE STUDY

The Castle Peak Power Company (CAPCO) has initiated a project for emission control at the Castle Peak Power Station "B" units (CPB) ("Project"), in response to the Hong Kong SAR Government (HKSARG)'s stated intent to reduce emissions in Hong Kong. An Environmental Impact Assessment (EIA) Study Brief was issued for the Project by the Environmental Protection Department (EPD) in October 2005 (EIA Study Brief No. ESB-134/2005). In compliance with one of the Study Brief requirements, a land contamination assessment will be carried out for the Project Areas ("the site"). To accommodate the new development, extensive demolition works are required to relocate a number of existing facilities, including:

- CPB Fuel Oil Day Tank (FODT, hereafter referred to as the aboveground fuel oil day tank) and associated pipe works connecting with fuel oil pump house (FOPH) and oil interceptor;
- Dangerous Goods (DG) stores; and
- Intermediate Pressure Reduction Station (IPRS), LPG compound and CO_2 storage tanks.

Environmental Resources Management (ERM) was commissioned by CAPCO to conduct a land contamination assessment of the site, in accordance with the Study Brief requirements. A Contamination Assessment Plan (CAP) was prepared, submitted to and was approved by the EPD and forms a basis of this assessment.

The preliminary Project Areas are shown in *Figure 1.1a* of the approved CAP.

Site inspection including soil and groundwater sampling and analysis was conducted to identify potential sources of contamination from historical and on-going operations in this area, in accordance with the CAP.

A Contamination Assessment Report (CAR) summarising the results of the investigation works and recommending further investigation was prepared (*Annex E1*).

1.2 OBJECTIVES OF THE ACTION PLAN

This Remediation Action Plan (RAP) presents the results obtained during the contamination investigation at the Project Areas and proposes remediation actions. The objective of the plan is to reduce the opportunity for exposure to contaminants during the construction of the Project.

1.3 SCOPE OF THE REMEDIATION

The scope of the remediation will include:

- Sampling and testing and, where applicable, treatment and handling/management of the excavated contaminated soils; and
- Preparation of a decontamination verification report upon completion of the demolition, construction and any necessary decontamination works.

1.4 STRUCTURE OF THE RAP

The remainder of this document is structured as follows:

Section 2	summarises the site investigation results; and
Section 3	presents contamination remediation action plan for the Project Areas.

The document is accompanied by the CAR in *Annex E1*.

2 CONTAMINATION ASSESSMENT BACKGROUND INFORMATION

This *Section* presents the summary of the results of the site investigation works. The full details of the methodology used for the soil and groundwater sampling works, details of field observations such as visual observations made during the investigation programme and the analytical results from soil and groundwater analyses are provided in the CAR, *Annex E1*.

2.1 SITE INVESTIGATION PROGRAMME

The Site Investigation (SI) was conducted as described in the CAR and consisted of drilling of eight boreholes (DH1 to DH8) and four trial pits (TP1 to TP4), the installation groundwater sampling wells where groundwater was encountered (ie DH1 to DH8), soil and groundwater sampling, laboratory sample analysis and a field QA/QC programme. The locations of the boreholes and trial pits are presented in *Figure 3.1a* of the approved CAP.

The SI programme was designed and carried out in accordance with the EPD's *Practice Notes for Professional Persons: Contaminated Land Assessment and Remediation ProPECC PN 3/94* and the *Guidance Notes for Investigation and Remediation of Contaminated Sites of Petrol Stations, Boatyards, and Car Repair/Dismantling Workshops, 1999*.

2.1.1 Field Observations

The underground soil profiles observed during the exploration were recorded using boring logs (see *Annex E1b* of the CAR). No obvious sign of hydrocarbon staining, discoloration or odour was observed in any underlying soil samples and/or groundwater. No free oil product was observed on the groundwater surface.

2.1.2 Soil Sample Results

A soil sample taken from TP3 at a depth 0.9 m below ground level (m bgl), had a reported total TPH concentration of 1,858 mg/kg (1). This level exceeds the Dutch "B" level for mineral oil (1,000 mg/kg). The concentration was below the Dutch "C" value for mineral oil of 5,000 mg/kg. No soil sample was collected at a deeper level at the adjacent borehole location (DH5) as the underlying geology comprised of boulders and fractured granite rock from 0.5 meter below ground level (m bgl) to the end of drilling at 6.8 m bgl. TPH was not detected in any other soil samples collected from the Project Areas.

No target volatile organic compounds (VOCs) including Benzene, Toluene, Ethyl Benzene and Xylene (BTEX) and semi-volatile organic compounds

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(1) Expressed as the sum of light diesel (C10-C14) (83 mg/kg), heavy diesel (C15-C28) (1,170 mg/kg) and heavy oil (C29-C36) (605 mg/kg).

(SVOCs) were detected at concentrations exceeding the laboratory reporting limits.

2.1.3 *Groundwater*

The static groundwater levels were between 2.4 to 5.5 m bgl (or 1.23 and 2.7 mPD). Based on the groundwater water levels measured and the local surface hydrology, the shallow groundwater in the Site area is anticipated to flow in a generally southern or south-westerly direction and may be influenced by tidal motion in the nearby coastal area.

Light diesel, heavy diesel and/or heavy oil were detected in groundwater samples collected from the Site. The sum of light diesel, heavy diesel and heavy oil concentrations in the groundwater samples from DH1 to DH7 ranged from 812 μg/L to 3,120 μg/L and exceeded the Dutch "C" value of 600 μg/L for mineral oil. The sum of the light diesel, heavy diesel and heavy oil fractions in the groundwater sample collected from DH8 was 204 μg/L which is marginally above the "B" value (ie 200 μg/L) for mineral oil.

No free-floating oil product was observed on the groundwater surface.

VOCs and other SVOCs were not detected in the groundwater samples except di-n-butyl phthalate and bis (2-ethylhexyl) phthalate. Di-n-butyl phthalate were detected at concentrations ranging from 31 to 459 μg/L in the groundwater samples from all groundwater wells whereas bis (2-ethylhexyl) phthalate were detected at concentrations ranging from 21 to 32 μg/L in the groundwater samples from DH3 and DH5 (1). The phthalates in groundwater however does not represent a risk for this specific Site as there is no abstraction of groundwater for any use and there is no exposure to groundwater under normal circumstances.

2.2 *ASSESSMENT OF LAND CONTAMINATION EXTENT*

TPH in Soil at TP3

The concentration of TPH [light diesel (C10-C14), heavy diesel (C15-C28) and heavy oil (C29-C36)] in soil at TP3 at 0.9 m bgl exceeded the Dutch "B" value but was below the Dutch "C" value. As no TPH was detected in soil at the other sampling locations, the TPH detected contamination was considered to be localised. The estimated amount of potentially contaminated soil within the Project boundary is 50 m^3.

TPH, Di-n-butyl Phthalate and Bis (2-ethylhexyl) Phthalate in Groundwater

TPH (light diesel, heavy diesel and heavy oil) contamination at above Dutch "B" and "C" levels has been reported in all the groundwater samples (DH1 to

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(1) The sum of phthalates for the groundwater sample from all groundwater wells was higher than the corresponding Dutch Intervention Value (DIV) of 5 μg/L.

DH8). The TPH concentrations detected in the samples from wells DH1 and DH2 were primarily attributable to the light diesel and heavy diesel fractions. TPH concentrations at DH3 to DH8 were primarily attributable to the heavy diesel and heavy oil fractions. Phthalates were found in the groundwater samples from all groundwater wells (DH1 to DH8) but this does not represent a risk since groundwater is not abstracted for any use at this Site and there is no exposure to groundwater under normal circumstances.

The FODT was located above the ground, has been provided with secondary containment systems and no oil spills and leakages have been reported or observed during the site investigation works in this area. An oil pipe leakage near the fuel oil pump house was reported to the Marine Department and the EPD in July 2004.

The potential transport mechanism for the TPH, di-n-butyl phthalate and bis (2-ethylhexyl) phthalate contamination in the groundwater at CPB is the flow of shallow groundwater, which was measured at about 1.23 to 2.7 mPD. The groundwater flow within CPB is likely to be influenced by tidal movements as the site is located on a reclaimed area approximately 100 to 400 m from the waterfront.

As CPB is paved, and groundwater is not used for either domestic or industrial purposes at CPB and in the adjacent areas, the potential exposure to TPH in groundwater could only take place during the demolition and construction stages of the Project. The potential exposure pathways include dermal contact and accidental ingestion.

With the implementation of appropriate environmental, health and safety control measures (as described in *Section 3*), no potential adverse impacts are anticipated during the demolition and construction activities.

2.3 *EVALUATION OF CONSTRUCTION METHODS FOR FGD PLANT*

2.3.1 *Tanks and Oil/Water Separator Sump Demolition*

To accommodate the installation/construction of the proposed Selective Catalytic Reduction (SCR) and Limestone Flue Gas Desulphurisation (LS-FGD) equipment, demolition works are required to relocate a number of existing facilities, as described in *Section 1.1*.

In addition gypsum storage facilities are proposed to be constructed within the western coal storage yard.

The demolition works will take about eight months and are currently scheduled to commence in early 2007. Excavations for the construction of foundations are anticipated to commence in around third or fourth quarters of 2007.

The FODT and the oil separator serving it will be washed/decontaminated prior to demolition. This will also enable the materials to be disposed as non-contaminated construction and demolition wastes.

A total of about 835 tonnes of scrap steel will be produced from the demolition of the fuel oil day tank, LPG and CO_2 tanks, pumps and the associated fixtures/ appendages such as pipeline, spiral stair and catwalk attached to the tanks. The steel sheets of the facilities will be cut into small panels for easy transportation. All the scrap steel will be transported off-site by barges or lorries for recycling.

A total of 1,830 m^3 of uncontaminated reinforced concrete (after applying a bulking factor of 1.4) will be generated from the demolition of the fuel oil day tank retaining walls, DG stores, LPG switch room and vaporiser, LPG tank foundation and pipe trenches. The concrete is not contaminated and will be separated from other waste to avoid contamination. The concrete (C&D materials) will be reused on-site for the subsequent construction within the northern and western coal yard areas or sent to public filling facilities /other reclamation sites for reuse.

2.3.2 Excavated Materials

Non-Contaminated Excavated Materials

Excavation works would be required for the construction of the piles and shallow foundations to support the new facilities. A total of about 30,000m^3 (after applying a bulking factor of 1.2) of excavated materials (assumed to be mainly soft materials) will be generated from the demolition of the existing facilities and excavation for the construction of the foundations for new facilities.

After excavating the in-ground foundations and concrete structures, the area will be backfilled with the excavated uncontaminated soil and imported fill materials to the existing grade. In addition, excavated soil will be reused as far as practicable in the Project Area located within the existing north coal yard which will need to be raised from the existing +5 to +6 mPD to approximately +7 mPD.

Potentially Contaminated Excavated Materials

Excavation works will be required at the TP3 area for the construction of the foundations of an FGD absorber. An estimated total of 50 m^3 of potentially contaminated soil (after applying a bulking factor of 1.2) will be excavated and treated before reuse within the Project or disposal.

The excavated potentially contaminated soil will be managed in accordance with the EPD's *ProPECC PN 3/94* and *Guidance Notes for Investigation and Remediation of Contaminated Sites of Petrol filling Stations, Boatyards, and Car/Repair/Dismantling Workshops*. The proposed strategy for the excavation, testing, remediation and disposal is presented in the following *Section 3*.

3 *REMEDIATION ACTIONS*

Following the completion of the land contamination site investigation at the Project area, the following remediation programmes are proposed.

3.1 *SOIL EXCAVATION AND CONFIRMATION/VERIFICATION SAMPLING*

The only soil contamination identified during the SI programme described in *Section 2.1* is the TPH contamination observed in soil samples at TP3. According to the arrangements in the current construction plan discussed in *Section 2.3.2*, only minor excavation works for the construction of the foundations of the FGD facilities are expected to be required. Moreover, the existing ground level at the TP3 location as well as its neighbourhood area will have to be raised by backfilling with filling materials (excavated or imported) for the installation of the emissions control facilities.

For the remediation of petroleum hydrocarbon contaminated soil to be excavated at TP3, the following steps are proposed:

- Excavation of 50 m^3 soil around TP3.
- Temporary stockpiling of the excavated materials from TP3.
- The temporary stockpile will be contained in a container covered by HDPE sheet on top.
- Conducting verification sampling for TPH contamination in the soil around the excavated parcel. The soil samples will be obtained at each boundary of the excavation parcel at 0.5m, 1m and 1.5 m bgl.
- Bioremediation by applying nutrient to the soil will be employed for the on-site treatment of contaminated soils at a location within the Project boundary. Suitable kinds of nutrient will be added to the soil and the soil will be turned regularly to ensure sufficient air goes into the soil to undergo biodegradation.
- Where the treated soil showed TPH concentrations below the Dutch “B” value, the treatment is considered completed and the soil can be used as fill materials on-site or disposed of as fill materials at the public fill bank.
- If disposal to the public fill bank is required, vehicles containing any excavated materials will be suitably covered to limit potential dust emissions or wastewater run-off, and truck bodies and tailgates will be sealed to minimise the risk of a discharge during transportation or during wet conditions.
- Records of the quantities of soil generated for off-site disposal will be maintained.

- A decontamination verification report will be prepared upon the completion of the decontamination works.

3.2 *GROUNDWATER HANDLING*

Groundwater was found to be contaminated in the groundwater samples collected from all wells with the total TPH at concentrations ranged from 204 to 3,120 µg/L. Di-n-butyl phthalate were detected at concentrations ranging from 31 to 459 µg/L in the groundwater samples from all groundwater wells whereas bis (2-ethylhexyl) phthalate were detected at concentrations ranging from 21 to 32 µg/L in the groundwater samples from DH3 and DH5. There is no abstraction of groundwater at this Site for any use.

As such, it is proposed that the following control measures are implemented during the demolition and excavation to minimise potential environmental impacts from the groundwater contamination. The following steps are proposed:

- Cleaning of the FODT and the oil separator serving it prior to demolition. Oily water and sludge collected from the cleaning should be treated at the on-site wastewater treatment facility. Oily water and sludge collected from the cleaning should be collected and disposed of as chemical waste at Government chemical waste treatment facility.

- Only licensed waste contractors shall be used to collect and transport any chemical waste. The necessary waste disposal permits will be obtained, as required, from the appropriate authorities, in accordance with the *Waste Disposal Ordinance (Cap 354)* and *Waste Disposal (Chemical Waste) (General) Regulation (Cap 354C)*, as required.

As groundwater is not used for either domestic or industrial purposes at the site or in the adjacent areas, remediation of groundwater is not considered to be necessary for the Project to proceed. If groundwater is encountered during the construction of foundations, the groundwater abstracted or collected will be recharged back to the site.

3.3 *HEALTH AND SAFETY CONTROL MEASURES*

The remediation work will involve soil excavation, soil stockpiling and soil sampling. To minimise the contacts of the workers with the contaminated materials and to ensure a safe work environment during the remediation works, the following control measures are proposed:

- Prior to commencing any remediation works, a health and safety risk assessment should be performed for the remediation works to identify potential work related hazards and prepare appropriate control measures.

- Appropriate Personal Protective Equipment (PPE) such as safety hat, chemical protective gloves, masks (for both dust and vapour), eye goggles, protective clothing and protective footwear should be provided to staff who would be involved in the contaminated area (TP3) remediation works. No works should be allowed without the suitable PPE.

- The workers should inspect and check their PPE before, during and after use. In cases where any of the PPE is impaired, the workers should stop work immediately and inform their supervisor. The workers should not be allowed to re-start their work until the impaired PPE is replaced.

- The workers should always maintain basic hygiene standard (eg hand wash before leaving the contaminated work area). The workers should also be responsible for cleaning and storing their own PPE in a secure place before leaving the site.

- Eating, drinking and smoking should be strictly prohibited within the contaminated area.

- The designated site management representatives must be informed if any workers feel uncomfortable physically or mentally during the remediation works. All workers should leave the work areas and the works should be temporarily suspended until the reason for the uncomfortable feeling has been identified.

- The works should be stopped or discontinued when Typhoon Signal No. 3 or Rainstorm Warnings are hoisted. All stockpile materials (if any) should be covered immediately by tarpaulin or other similar protective and waterproof materials.

- Bulk earth-moving excavator equipment should be used to minimise construction workers’ potential contact with contaminated materials.

Annex E1

Contamination Assessment Report

Emissions Control Project at Castle Peak Power Station "B" Units

Environmental Impact Assessment

Contamination Assessment Report

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1 INTRODUCTION

1.1 BACKGROUND TO THE STUDY

The Castle Peak Power Company (CAPCO) has initiated a project for emission control at the Castle Peak Power Station "B" units (CPB) ("Project"), in response to the Hong Kong SAR Government (HKSARG)'s stated intent to reduce emissions in Hong Kong. An Environmental Impact Assessment (EIA) Study Brief was issued for the Project by the Environmental Protection Department (EPD) in October 2005 (EIA Study Brief No. ESB-134/2005). In compliance with one of the Study Brief requirements, a land contamination assessment will be carried out for the Project Areas.

To accommodate the new development, extensive demolition works are required to relocate a number of existing facilities, including:

- CPB Fuel Oil Day Tank (FODT, hereafter referred to as the aboveground fuel oil day tank) and associated pipe works connecting with fuel oil pump house (FOPH) and oil interceptor;
- Dangerous Goods (DG) stores; and
- Intermediate Pressure Reduction Station (IPRS), LPG compound and CO_2 storage tanks.

The preliminary Project Areas are shown in *Figure 1.1a* of the approved CAP (*Annex E1a*).

Environmental Resources Management (ERM) was commissioned by CAPCO to conduct a land contamination assessment of the site, in accordance with the Study Brief requirements. A Contamination Assessment Plan (CAP) was prepared, submitted to and was approved by the EPD (*Annex E1a*) and forms a basis of this assessment.

Site inspection including soil and groundwater sampling and analysis was conducted to identify potential sources of contamination from historical and on-going operations in this area in accordance with the CAP.

1.2 OBJECTIVES OF THE LAND CONTAMINATION ASSESSMENT

The main objectives of the land contamination assessment were to establish the presence or absence of soil and groundwater contamination and, if present, the degree of contamination.

1.3 SCOPE OF THE LAND CONTAMINATION ASSESSMENT

The scope of the assessment included the following:

- to review the available history of the site in relation to the potential for land contamination;
- to review the available geology and hydrogeology information of the site;
- to conduct a site investigation programme through soil and groundwater sampling at twelve strategic locations;
- to perform laboratory analyses of soil and groundwater samples for the target analytical parameters; and
- to report on the findings of the available information, the field observations, the interpretation of laboratory analytical results, and the assessment of potential contamination.

1.4 STRUCTURE OF THE CAR

The remainder of this report is structured as follows:

- *Section 2* summarises the background information, including historical land uses, geology, hydrogeology and the results of previous investigations at the site, if any;
- *Section 3* summarises the methodology used to carry out the land contamination assessment;
- *Section 4* summaries the field activities and field observations;
- *Section 5* presents the laboratory analytical results for the samples collected; and
- *Section 6* provides the conclusions and recommendations.

Annexes to this report include:

- *Annex E1a* Contamination Assessment Plan
- *Annex E1b* Borehole Logs
- *Annex E1c* Groundwater Monitoring Well Diagrams
- *Annex E1d* Selected Photographs
- *Annex E1e* Laboratory Analytical Results
- *Annex E1f* The Dutch List

2 BACKGROUND

2.1 SITE DESCRIPTION

The Project Areas are located within the CPB, situated on the coast of Tap Shek Kok in Tuen Mun, New Territories.

The Castle Peak ”B” station was commissioned between 1985 and 1989. The area of this land contamination assessment covers the proposed Project Areas, including part of the northern coal storage yard, fuel oil day tank (FODT), dangerous goods (DG) stores, intermediate pressure reduction station (IPRS), LPG compound, CO_2 storage tanks and a proposed area for proposed gypsum dewatering and storage facilities located within the western coal storage yard. These facilities are presented in *Figure 1.1a* of the approved CAP (*Annex E1a*).

The coastline is located approximately 350 to 500 meters to the south and southwest of the Project Areas. The direction of groundwater flow underlying the Project Areas is anticipated to be affected by the nearby tidal motion and groundwater is likely to be recharged by seawater during high tides and discharged to the sea during low tides.

Groundwater is not used for either domestic or industrial purposes at the site or the adjacent areas.

2.2 SURROUNDING LAND USE

The land uses in the immediate surroundings of the Project Areas include:

North: The power generation units of Castle Peak Power Station “A” (CPA);

South: The north coal yard, the coastline is located approximately 350 m to the south;

East: The power generation units of CPB and Green Island Cement Plant; and

West: The west coal yard, the coastline is approximately 500 m to the west.

3 *METHODOLOGY*

The site investigation programme was designed in accordance with the Environmental Protection Department (EPD)'s *Practice Notes for Professional Persons: Contaminated Land Assessment and Remediation ProPECC PN 3/94* (*ProPECC PN3/94*) and *Guidance Notes for Investigation and Remediation of Contaminated Sites of Petrol Filling Stations, Boatyards, and Car Repair/Dismantling Workshops* (*Guidance Notes*).

3.1 *SOIL CONTAMINATION ASSESSMENT*

The soil contamination assessment was carried out through analysis of soil samples collected from strategic locations at different depths in accordance with the EPD-approved CAP. Soil sampling was conducted through soil excavation or intrusive soil drilling in accordance with the American Society for Testing and Materials' (ASTM) standards (1).

3.2 *GROUNDWATER CONTAMINATION ASSESSMENT*

The groundwater contamination assessment was carried out through the analysis of groundwater samples collected from eight groundwater sampling wells. Groundwater well installation, well development and sampling were carried out following the guidance for groundwater sampling developed by USEPA for groundwater contamination investigation (2).

3.3 *LABORATORY ANALYSIS*

The methodologies used for the laboratory analysis were as follows:

- Total petroleum hydrocarbons (TPH) for soil and groundwater samples by USEPA Method 8260 & 8015;
- benzene, toluene, ethylbenzene, xylene (BTEX) for soil and groundwater samples by USEPA Method 8260;
- polycyclic aromatic hydrocarbons (PAHs) for soil and groundwater samples by USEPA Method 8270;
- Volatile organic compounds (VOCs) for soil and groundwater samples by USEPA Method 8260; and

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(1) The soil drilling was carried out using rotary drilling rigs and soil sample collection was conducted using split-barrel samplers following the standard procedures described in the *ASTM's D1586-99 Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils*.

(2) *USEPA's Groundwater Sampling Guidelines for Superfund and RCRA Project Managers, Attachment 4 - Standard Operating Procedure for the Standard/Well-Volume Method for Collecting a Groundwater Sample released* in the USEPA Technology Innovation Program (TIP).

- Semi-volatile organic compounds (SVOCs) for soil and groundwater samples by USEPA Method 8270.

4 FIELD ACTIVITIES AND OBSERVATIONS

4.1 FIELD ACTIVITIES

4.1.1 Underground Soil boring and Sampling

Hand excavation and soil sampling was carried out at four trial pits. Soil boring and sampling were carried out at eight drilling locations. The trial pits were excavated manually, and soil boring was conducted using rotary drilling rigs. The approximate locations of trial pits and boreholes are shown on *Figure 3.1a* of the approved CAP (*Annex E1a*).

Soil samples were collected from the trial pits and boreholes at designated depths for visual inspection on the soil geological classification and signs of contamination, on-site photo-ionisation detector (PID) testing for volatile organic compound vapour and laboratory analysis. Soil sampling at the trial pits was performed manually using a stainless steel scoop. Soil sampling in the boreholes was conducted using split barrels following the standard penetration testing (SPT) procedures. Of note is that no soil sample was collected from the depths where hard strata (ie boulders, cobbles or bedrock) were encountered during the drilling or sampling. A summary of the soil boring and sampling works is provided in *Table 4.1a*.

The four trial pits TP1, TP2, TP3 and TP4 were located near the boring locations DH7, DH6, DH5 and DH4, respectively, and were excavated to depths between 0.7 and 1.5 m bgl. Soil sampling for the depths near the ground surface (ie 0.5 to 1.0 m bgl) was not carried out at boreholes DH4 to DH7 but at the trial pits TP1 to TP4 instead.

Table 4.1a Soil Boring and Sampling for the Land Contamination Assessment

Locations	Total drilling depth (m bgl)	Collected soil sample for PID testing and laboratory analysis (m bgl)	Remarks
DH1	6.27	DH1 0.6 m	Boulder/cobble/rock encountered from depth 0.6 to 6.27 m bgl.
DH2	6.77	DH2 0.6 m	Boulder/cobble/rock encountered from depth 1.0 to 6.77 m bgl.
DH3	7.07	DH3 0.8 m	Cobble/granite encountered from depth 1.9 to 7.07 m bgl.
DH4	6.81	No soil sample collected	Boulder/cobble/rock encountered from depth 0.25 to 6.81 m bgl.
DH5	6.80	No soil sample collected	Boulder/cobble/rock encountered from depth 0.48 to 6.80 m bgl.
DH6	7.15	No soil sample collected	Boulder/cobble/rock encountered from depth 0.6 to 7.15 m bgl.
DH7	6.77	No soil sample collected	Boulder/cobble/rock encountered from depth 1.38 to 6.77 m bgl.
DH8	7.53	DH8 0.8 m	Boulder/cobble/rock encountered from depth 1.0 to 7.53 m bgl.
TP1	1.5	TP1 1.5 m	TP1 was located near DH7.

Locations	Total drilling depth (m bgl)	Collected soil sample for PID testing and laboratory analysis (m bgl)	Remarks
TP2	1.1	TP2 0.8 m (a)	TP2 was located near DH6.
TP3	1.1	TP3 0.9 m	TP3 was located near DH5.
TP4	1.0	TP4 0.7 m	TP4 was located near DH4.

Note:

(a) One soil field duplicate sample (TP2 (duplicate)) was collected from this location.

The underground soil profiles observed during the drilling were recorded are presented in the *Borehole Logs, Annex E1b.*

All soil samples collected from the boreholes were placed immediately into laboratory pre-cleaned sample bottles and stored with ice in a cooler on-site before delivery to the laboratory for analysis.

ERM supervised the field drilling and soil sampling to meet the requirements of the project QA / QC and appropriate decontamination procedures.

4.1.2 Groundwater Well Installation and Sampling

Groundwater was encountered at all eight boreholes during the drilling. The boreholes were converted into groundwater monitoring wells to facilitate groundwater sampling. In general, groundwater monitoring wells were installed to approximately 2 m below the measured groundwater levels using perforated u-PVC pipes. Diagrams showing details of the installed groundwater wells are provided in the *Groundwater Monitoring Well Diagrams, Annex E1c.*

After groundwater well installation, each well was developed by removing at least five times the well volume by hand bailing. Groundwater samples were collected using new dedicated Teflon bailers for each well.

A total of eight groundwater samples (exclusive of QA / QC samples), marked as DH1 to DH8, were collected. All groundwater samples collected from the wells were placed immediately into laboratory pre-cleaned and pre-preserved sample bottles and stored with ice in a cooler on-site before delivery to the laboratory for analysis.

ERM supervised the groundwater sampling to meet the requirements of the project QA / QC and appropriate decontamination procedures.

4.1.3 QA/QC Programme and Sample Delivery

A field QA / QC program was incorporated into the land contamination investigation for the site. The program consisted of collection of field QA / QC samples which included one soil field duplicate sample, one groundwater field duplicate sample, three equipment blank samples, and seven trip blank samples. The field QA / QC samples collected or prepared are summarized in *Table 4.1b.*

Table 4.1b Collected QA/QC Samples for the Site Investigation

QA/QC sample	**Sample ID**	**Associated sample**
Soil duplicate sample	TP2 (duplicate)	TP2 at 0.8m bgl
Groundwater duplicate sample	DH6 (duplicate)	DH6
Equipment Blank samples	EQ BLK 1	Soil samples TP1 1.5m, TP2 0.8m, TP3 0.9m, TP4 0.7m and DH9 0.8m.
	EQ BLK 2	Soil samples DH1 0.6m and DH2 0.6m.
	EQ BLK 3	Soil sample DH8 0.8m
Trip blank samples	Trip blank 1	Soil samples TP1 1.5m, TP2 0.8m, TP3 0.9m, TP4 0.7m and DH9 0.8m.
	Trip blank 2	Soil samples DH1 0.6m and DH2 0.6m.
	Trip Blank 3	Groundwater samples DH4, GH5, DH6, DH7, DH9 and soil sample DH3 0.8m.
	Trip Blank 4	Groundwater samples DH1 and DH2.
	Trip Blank 5	Soil samples DH8 0.8m.
	Trip Blank 6	Groundwater sample DH3.
	Trip Blank 7	Groundwater sample DH8.

All trip blank samples were pre-prepared in the laboratory, stored with the samples in the sample coolers, and delivered with the samples to the laboratory.

All soil and groundwater samples along with the field QA / QC samples were delivery to the laboratory on ice in coolers on each sampling day.

4.2 FIELD OBSERVATIONS

4.2.1 Soil

At all land contamination investigation locations, the ground surface generally comprised yellowish brown medium to coarse sand from the ground surface to approximately 0.25 to 1.9 meters below ground level (m bgl) following by cobbles, boulders or bed rocks (granite) to the end of the drilling depths (ie 6 to 8 m bgl).

No evidence of soil contamination such as staining, discoloration or abnormal odour was observed during the soil drilling and sampling.

4.2.2 PID Test Results

The photo-ionisation detector (PID) test results for the soil samples are summarized in *Table 4.2a.*

Table 4.2a Soil Sample PID Test Results

Locations	Soil sample (m bgl)	PID test Results (ppm)	Remarks
TP1	TP1 1.5 m	0.8	TP1 was located near DH7
TP2	TP2 0.8 m	1.5	TP2 was located near DH6
TP3	TP3 0.9 m	1.0	TP3 was located near DH5
TP4	TP4 0.7 m	4.0	TP4 was located near DH4
DH1	DH1 0.6m	2.0	
DH2	DH2 0.6 m	2.0	
DH3	DH3 0.8 m	0.5	
DH8	DH8 0.8 m	0.8	

4.2.3 Groundwater

The groundwater levels encountered during the drilling and measured at equilibrium condition are provided in *Table 4.2b.*

Table 4.2b Groundwater Level Measured at the Monitoring Wells

Groundwater Monitoring Well	Groundwater Level Encountered During Drilling (m bgl)	Groundwater Level Measured at Equilibrium Condition (m bgl)	Groundwater Level Elevation (mPD) (a)
DH1	2.38	2.38	2.67
DH2	2.55	2.55	2.57
DH3	3.70	4.19	2.81
DH4	4.70	4.70	1.31
DH5	4.62	4.76	1.25
DH6	4.60	5.00	1.23
DH7	4.72	4.72	1.95
DH8	5.50	5.51	1.56

Note:

(a) Groundwater level elevations (meter above principal datum (mPD)) were estimated based on the ground level survey data and groundwater levels measured at equilibrium condition.

Based on the groundwater water levels measured and the local surface hydrology, the shallow groundwater in the site area is anticipated to flow in a generally southern or south-westerly direction. However, the direction of groundwater flow underlying the site area is likely to be affected by the nearby tidal motion.

No evidence of groundwater contamination such as free floating products, discoloration or abnormal odour was observed at the sampling locations during the drilling, well development and groundwater sampling.

5 ANALYTICAL RESULTS

The analytical results for the soil and groundwater samples collected from the Site are summarised in *Tables 5.1a* and *5.1b*, respectively, and are discussed in the following sections. The detailed results of the laboratory analyses along with the QA/QC information are presented in *Annex E1e*.

5.1 CRITERIA FOR ASSESSMENT

The EPD's *ProPECC PN 3/94* has adopted the *Dutch Ministry of Housing, Planning and Environment Soil and Groundwater Standards* (the '*Dutch List*') as the criteria for assessing soil and groundwater contamination in Hong Kong. The *Dutch List* was used as the reference against the analytical results for the samples.

As an initial screening tool for establishing a general understanding of the degree and extent of soil and groundwater contamination, the *Dutch List* defines three different levels, ie 'A', 'B' and 'C', for the concentration of contaminants found in soil and groundwater. The interpretation of the contaminant concentrations is as follows:

- Concentrations below 'A' and/or 'B' values refer to a situation in which the soil and/or groundwater is considered 'unpolluted' and can fulfil all possible functions and no further actions are required.

- Concentrations above 'B' but below 'C' values refer to a situation in which the soil and/or groundwater is potentially contaminated and requires further investigation. In Hong Kong, the Dutch 'B' values are currently used by the EPD as the soil cleanup target for most cases. Soil and groundwater with contaminant concentrations exceeding such values are considered by the EPD to be contaminated and may need to be remediated to below this level.

- Concentrations above 'C' are considered to represent significant contamination and cleanup action is likely to be required.

In the absence of appropriate criteria applicable to industrial use, the *Dutch Intervention Values* (DIVs), which are much more stringent criteria intended for groundwater abstracted for drinking purpose, are used for comparison with the measured results for substances in groundwater samples that are not included in the *Dutch List* adopted in EPD's *ProPECC PN 3/94*.

Table 5.1a Analytical Results for Soil Samples (all results in mg/ kg$^-$ dry weight) (a) (b)

Parameter	**Dutch ‘A’**	**Dutch ‘B’**	**Dutch ‘C’**	**Report Limit**	**TP1 1.5 m**	**TP2 0.8 m (e)**	**TP3 0.9 m**	**TP4 0.7 m**	**DH1 0.6 m**	**DH2 0.6 m**	**DH3 0.8 m**	**DH8 0.8 m**
Moisture Content (%)	N / A	N / A	N / A	0.1	6.9	4.5	6.6	5	10.1	8.5	7.7	4.3
TPH												
Gasoline (C6-C9)	20	100	800	2	ND	ND	ND	ND	ND	ND	ND	ND
Light Diesel (C10-C14)	N / A	N / A	N / A	50	ND	ND	83	ND	ND	ND	ND	ND
Heavy Diesel (C15-C28)	N / A	N / A	N / A	50	ND	ND	1,170	ND	ND	ND	ND	ND
Heavy Oil (C29-C36)	N / A	N / A	N / A	50	ND	ND	605	ND	ND	ND	ND	ND
Mineral Oil (c)	100	1,000	5,000	N / A	ND	ND	**1,858**	ND	ND	ND	ND	ND
BTEX												
Benzene	0.01	0.5	5	0.5	ND	ND	ND	ND	ND	ND	ND	ND
Toluene	0.05	3	30	0.5	ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	0.05	5	50	0.5	ND	ND	ND	ND	ND	ND	ND	ND
meta- & para-Xylene	N / A	N / A	N / A	1	ND	ND	ND	ND	ND	ND	ND	ND
ortho-Xylene	N / A	N / A	N / A	0.5	ND	ND	ND	ND	ND	ND	ND	ND
Total xylene (d)	0.05	5	50	N / A	ND	ND	ND	ND	ND	ND	ND	ND
Chlorobenzene	0.05	2	20	0.5	ND	ND	ND	ND	ND	ND	ND	ND
PAHs	Various	Various	Various	Various	ND	ND	ND	ND	ND	ND	ND	ND
Other VOCs	Various	Various	Various	Various	ND	ND	ND	ND	ND	ND	ND	ND
SVOCs	Various	Various	Various	Various	ND	ND	ND	ND	ND	ND	ND	ND

Notes:

(a) Underlined and **Bold** Results = concentration exceeds the Dutch “B” values; Underlined, **Bold**, and *Italic* Results = concentration exceeds the Dutch “C” values;

(b) N / A = not available; ND = not detectable.

(c) Mineral oil is sum of total detected results of light diesel, heavy diesel and heavy oil.

(d) Total xylene is sum of m,p-xylene and o-xylene.

(e) Duplicate samples were analysed for this sampling location. Higher results were selected for presenting in the table where the two sample results differ from each other.

Table 5.1b Analytical Results for Groundwater Samples (a) (b)

Parameter	Unit	Dutch 'A'	Dutch 'B'	Dutch 'C'	Report Limit	DH1	DH2	DH3	DH4	DH5	DH6 (f)	DH7	DH8
pH					0.1	7.2	6.4	7.9	7.4	7.6	7.6	7.4	7.7
TPH													
Gasoline (C6-C9)	µg/L	10	40	150	20	ND	ND	ND	ND	ND	ND	ND	ND
Light Diesel (C10-C14)	µg/L	N/A	N/A	N/A	50	63	91	ND	ND	ND	ND	ND	ND
Heavy Diesel (C15-C28)	µg/L	N/A	N/A	N/A	100	1,460	2,590	1,590	712	1,400	733	1,560	125
Heavy Oil (C29-C36)	µg/L	N/A	N/A	N/A	50	ND	78	1,490	368	1,720	79	62	79
Mineral Oil (c)	µg/L	20	200	600	N/A	***1,523***	***2,759***	***3,080***	***1,080***	***3,120***	***812***	***1,622***	**204**
BTEX													
Benzene	µg/L	0.2	1	5	5	ND	ND	ND	ND	ND	ND	ND	ND
Chlorobenzene	µg/L	0.02	0.5	2	5	ND	ND	ND	ND	ND	ND	ND	ND
Toluene	µg/L	0.5	15	50	5	ND	ND	ND	ND	ND	ND	ND	ND
Ethyl-benzene	µg/L	0.5	20	60	5	ND	ND	ND	ND	ND	ND	ND	ND
m,p-Xylene	µg/L	N/A	N/A	N/A	10	ND	ND	ND	ND	ND	ND	ND	ND
o-Xylene	µg/L	N/A	N/A	N/A	5	ND	ND	ND	ND	ND	ND	ND	ND
Total xylene (d)	µg/L	0.5	20	60	N/A	ND	ND	ND	ND	ND	ND	ND	ND
PAHs	µg/L	Various	Various	Various	Various	ND	ND	ND	ND	ND	ND	ND	ND
Other VOCs (e)													
Chloroform	µg/L	N/A	N/A	N/A	5	ND	ND	8	ND	ND	ND	ND	ND
SVOCs (e)													
Dimethyl phthalate	µg/L		-		2	ND	ND	ND	ND	ND	ND	ND	ND
Diethyl phthalate	µg/L		-		2	ND	ND	ND	ND	ND	ND	ND	ND
Di-n-butyl phthalate	µg/L		-		2	44	132	66	31	459	47	57	46
Butyl benzyl phthalate	µg/L		-		2	ND	ND	ND	ND	ND	ND	ND	ND
Bis(2-ethylhexyl) phthalate	µg/L		-		20	ND	ND	32	ND	21	ND	ND	ND
Di-n-octyl phthalate	µg/L		-		2	ND	ND	ND	ND	ND	ND	ND	ND
Phthalates (sum)	µg/L		5 (g)		-	44	132	98	31	480	47	57	46

Notes:

(a) Underlined and **Bold** Results = concentration that exceed the Dutch "B" values; Underlined, **Bold**, and *Italic* Results = concentration that exceed the Dutch "C" values.

(b) N/A = not available; ND = not detectable.

(c) Mineral oil is sum of light diesel, heavy diesel and heavy oil.

(d) Total xylene is sum of m,p-xylene and o-xylene.

(e) Only the compounds in the group that were detected in at least one sample are shown.

(f) Duplicate samples were analysed for this sampling location. Higher results were selected for presenting in the table where the two sample results differ from each other.

(g) Dutch Intervention Value (DIV) of total phthalates was adopted to compare with the measured results.

5.2 RESULTS FOR SOIL SAMPLES

5.2.1 Total Petroleum Hydrocarbons (TPH)

TPH in the fractions of light diesel, heavy diesel and heavy oil was detected in one soil sample collected from TP3 at a depth 0.9 m bgl. The sum of light diesel, heavy diesel and heavy oil for this soil sample (1,858 mg/kg) exceeded the *Dutch* '*B*' value for mineral oil (ie 1,000 mg/kg).

5.2.2 BTEX

Benzene, toluene, ethylbenzene and xylene were not detected at concentrations exceeding the laboratory reporting limits in any soil sample collected from the Site.

5.2.3 PAHs

No target PAHs were detected at concentrations exceeding the laboratory reporting limits in the soil samples collected from the Site.

5.2.4 VOCs

No target VOCs were detected at concentrations exceeding the laboratory reporting limits in the soil samples collected from the Site.

5.2.5 SVOCs

No target SVOCs were detected above the laboratory reporting limits in the soil samples collected from the Site.

5.3 RESULTS FOR GROUNDWATER SAMPLES

5.3.1 Total Petroleum Hydrocarbons (TPH)

Light diesel, heavy diesel and/or heavy oil were detected in all groundwater samples collected from the Site. With the exception of the groundwater sample from DH8, the sum of light diesel, heavy diesel and heavy oil fractions for the groundwater samples ranged from 812 µg/L to 3,120 µg/L and exceeded the *Dutch* ' *C*' value (600 µg/L for mineral oil). The sum of the light diesel, heavy diesel and heavy oil fractions for the groundwater sample collected from DH8 was 204 µg/L which is marginally above the '*B*' value (ie 200 µg/L) for mineral oil.

5.3.2 BTEX

Benzene, toluene, ethylbenzene and xylene were not detected at concentrations exceeding the laboratory reporting limits in any groundwater sample collected from the Site.

5.3.3 PAHs

No target PAHs were detected at concentrations exceeding the laboratory reporting limits in the groundwater samples collected from the Site.

5.3.4 VOCs

No VOCs were detected in the groundwater samples collected from the Site at concentrations exceeding either the laboratory reporting limits or the applicable EPD *Dutch 'B'* or *'C'* values except chloroform at DH3. 8 µg/L of Chloroform was detected at DH3 which is above the reporting limit of 5 µg/L.

5.3.5 SVOCs

Two SVOCs (di-n-butyl phthalate and bis (2-ethylhexyl) phthalate were detected in the groundwater samples collected. Di-n-butyl phthalate were detected at concentrations ranging from 31 to 459 µg/L in the groundwater samples from all groundwater wells whereas bis (2-ethylhexyl) phthalate were detected at concentrations ranging from 21 to 32 µg/L in the groundwater samples from DH3 and DH5. The sum of phthalates for the groundwater sample from all groundwater wells was higher than the DIV of 5 µg/L for total phthalates.

5.4 QA /QC SAMPLE RESULTS AND DATA USABILITY

5.4.1 Field QA/QC Sample Results

Assessment of field QA/QC sample results included checking of relative percent difference (RPD) for field duplicate samples, equipment blank and trip blank samples.

RPD Results

The relative percent difference (RPD[1]) was used to assess the sampling and laboratory reproducibility and precision. The USEPA acceptable limits for RPD are less than 30% for groundwater and less than 50% for soil. No RPD is required where the sample result is below two times the method detection limits or below the method detection limits.

The values of RPD calculated the detected results for the soil duplicate samples (TP2 0.8 and DH9 0.8) were within the 50% acceptance limit.

The RPD values calculated for the groundwater duplicate samples (DH6 and DH9) were within the 30% acceptance limit.

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[1] RPD is calculated from the detected results of field duplicate samples, which should be higher than two times the detection limits.

Equipment and Trip Blank Sample Results

The results of the equipment or trip blank samples are summarized in *Table 5.4a*.

Table 5.4a *Summery of Detected QA/QC Sample Results*

Sample ID	**Sample**	**Detected parameter**	**Detected result (µg/L)**	**Laboratory report limit (µg/L)**
EQ BLK3	Equipment blank sample	TPH (C6 - C9 fraction)	22	20
EQ BLK3	Equipment blank sample	Toluene	22	5
EQ BLK3	Equipment blank sample	Phenol	8	2
Trip blank 4	Trip blank sample	Di-n-butyl phthalate	5	2

TPH (C6-C9 fraction), toluene, and phenol were detected in the equipment blank sample (EQ BLK3), but was not detected in the associated soil sample DH8 0.8m. The equipment blank sample result, therefore, did not impact on the associated soil sample results.

Di-n-butyl phthalate was detected in Trip Blank 4 and in the associated groundwater samples (DH1 and DH2). The detected concentrations of di-n-butyl phthalate in the associated groundwater samples DH1 and DH2 were 44 and 132 µg/L, respectively, which are more than 4 times higher than the concentration detected in the trip blank. In accordance with the USEPA Region 1's *Data Validation Guidance*, the detected di-n-butyl phthalate results in the trip blank did not impact the sample results.

5.4.2 Laboratory Internal QA/QC Sample Results

The laboratory QA/QC sample results included surrogate recoveries, matrix spike sample, laboratory duplicate samples and method blanks and met their respective requirements.

5.5 DATA USABILITY

Based on the review of QA/QC sample results, all laboratory results for the soil and groundwater samples are considered useable.

6 CONTAMINATION ASSESSMENT FOR SOIL AND GROUNDWATER

6.1 SOIL

Elevated concentrations of light diesel, heavy diesel and heavy oil were detected in one soil sample collected from location (TP3) at a depth near the ground surface (ie 0.9 m bgl). The detected TPH had the highest concentration (1,170 mg/kg) for heavy diesel. The total concentration of light diesel, heavy diesel and heavy oil in this soil sample was 1,858 mg/kg and exceeded the *Dutch 'B'* value of 1,000 mg/kg. No TPH was detected in any of other soil samples collected from the site.

6.2 GROUNDWATER

TPH including light diesel, heavy diesel, and heavy oil fractions was identified in the groundwater samples collected from the wells DH1 and DH2. Heavy diesel and heavy oil were detected in the groundwater samples collected at the other six locations. Of the TPH fractions, diesel oil was detected at the highest concentrations ranging from 100 to 2,590 µg/L. The total concentrations of light diesel, heavy diesel and heavy oil for all groundwater samples taken from the site (ranged from 812 to 3,080 µg/L) exceeded the *Dutch 'C'* value for mineral oil (ie 600 µg/L) with the exception of the sample from DH8. The total of light diesel, heavy diesel and heavy oil for DH8 (204 µg/L) marginally exceeded the *Dutch 'B'* value for mineral oil (200 µg/L).

Di-n-butyl phthalate was identified in the groundwater samples collected from all wells (DH1 to DH8) and bis (2-ethylhexyl) phthalate was detected in the groundwater samples from DH3 and DH5. The sum of phthalates for the groundwater sample from all groundwater wells was higher than the DIV of 5 µg/L for total phthalates. It should be noted that groundwater is not used for either domestic or industrial purposes at the site.

6.3 QUALITATIVE RISK ASSESSMENT

6.3.1 Potential Source of TPH Contamination in Soil and TPH, Di-n-butyl Phthalate and Bis (2-ethylhexyl) Phthalate in Groundwater

The Castle Peak 'A' and 'B' Power Station (commenced operation between 1982 and 1985) has several oil storage tanks and associated pipe lines.

The Castle Peak "B" power station has been operating since 1985. The power station was developed on a partially undeveloped land and partially reclaimed land.

The fuel oil day tank, which is located up gradient of the location where soil TPH contamination was detected, is located above ground level and was commissioned at the same time as the power station. The tank is surrounded by a concrete pavement and is provided with secondary containment. No oil spills and leakages have been reported at the tank and none were observed during the site. An oil pipe leakage near the fuel oil pump house was reported to the Marine Department and the EPD in July 2004.

6.3.2 Chemicals of Concern

The chemicals of concern are mainly TPH in the soil and groundwater and di-n-butyl phthalate and bis (2-ethylhexyl) phthalate in groundwater. The TPH included light diesel (C10-C14), heavy diesel (C15-C28) and heavy oil (C29-C36) fractions.

6.3.3 Potential Migration and Exposure

The potential transport mechanism for the TPH contamination in surface soil at TP3 and TPH, di-n-butyl phthalate and bis (2-ethylhexyl) phthalate in the groundwater in the Site area is the flow of shallow groundwater underneath the site which was measured at about 1.3 to 2.5 mPD. The groundwater flow within the Site area is likely influenced by tidal movements as the Site is located on a reclaimed area approximately 100 to 400 m from the waterfront.

As the Site area is paved, and groundwater is not used for either domestic or industrial purposes at the Site and in the adjacent areas, the potential exposure to TPH, di-n-butyl phthalate and bis (2-ethylhexyl) phthalate in groundwater could only take place during the demolition and construction stages of the Project. The potential exposure pathways include dermal contact and accidental ingestion of the soil and groundwater.

6.3.4 Potential Receptor

During the demolition of the facilities and the construction phases, potential on-site receptors include workers involved in demolition and construction actives who may be handling or come into contact with the contaminated materials. Mitigations measures are proposed in the Remediation Action Plan (RAP) to minimise worker exposure during this period. No adverse impacts are anticipated after the proposed measures have been implemented.

The site and the surrounding areas are used by Castle Peak ‘B’ power station. The site area is fully paved and direct human contact with the underlying soil materials is not anticipated during current or future operations. As the groundwater is not used at the area for either domestic or industrial purposes there is no on-site or off-site potential receptor of the TPH, di-n-butyl phthalate and bis (2-ethylhexyl) phthalate contaminated groundwater.

7 CONCLUSIONS AND RECOMMENDATIONS

A site investigation was completed and the findings are reported in this CAR. The land contamination assessment was performed in accordance with the procedures and requirements set out in the CAP. The CAP made reference to EPD's *Practice Note for Professional Persons* (*ProPECC PN 3/94)* and *Guidance Notes for Investigation and Remediation Contaminated Site of Petrol Filling Stations, Boatyard and Car Repair/Dismantling Workshops.*

The conclusions of the land contamination assessment are summarized below.

7.1 SOIL

TPH was detected at a concentration (1,858 mg/kg) which exceeded the EPD *Dutch 'B'* value for mineral oil (1,000 mg/kg) in a soil sample taken from one location (TP3), at a depth 0.9 m bgl. The detected TPH concentration was in the light diesel (83 mg/kg), heavy diesel (1,170 mg/kg) and heavy oil fractions (605 mg/kg). Other than this, no TPH was detected in any soil sample.

7.2 GROUNDWATER

TPH in the fractions of heavy diesel and heavy oil were detected at concentrations which ranged from 204 to 3,120 µg/L, exceeding the *Dutch 'B'* value (200 µg/L for mineral oil) in all groundwater samples. Seven out of the eight groundwater samples exceeded the *Dutch 'C'* value (600 µg/L for mineral oil).

As groundwater is not used for either domestic or industrial purposes at the site and in the adjacent areas, remediation of groundwater contamination of the Site is not considered necessary. If groundwater is encountered during the construction of the Project, the groundwater abstracted or collected should be recharged back to the site. Health and safety control measures will also be implemented for the workers who may come into contact with contaminated groundwater.

Annex E1a

Contamination Assessment Plan

中華電力

CLP Power

ExxonMobil

Capco 青山發電有限公司 Castle Peak Power Co. Ltd.

Emissions Control Project at Castle Peak Power Station "B" Units
Environmental Impact Assessment

Contamination Assessment Plan

April 2006

Environmental Resources Management
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www.erm.com

ERM

FINAL REPORT

CAPCO

Emissions Control Project at Castle Peak Power Station "B" Units: *Contamination Assessment Plan*

April 2006

Reference 0024405

For and on behalf of
Environmental Resources Management

Approved by: Freeman Cheung

Signed:

Position: Executive Director

Date: 10 April 2006

CONTENTS

1 *INTRODUCTION*

1.1 *BACKGROUND TO THE STUDY*

The Castle Peak Power Company (CAPCO) has initiated a project for emission control at the Castle Peak Power Station "B" units (CPPSB) ("Project"), in response to the Hong Kong SAR Government (HKSARG)'s stated intent to reduce emissions in Hong Kong. An Environmental Impact Assessment (EIA) Study Brief was issued for the Project by the Environmental Protection Department (EPD) in October 2005 (EIA Study Brief No. ESB-134/2005). In compliance with one of the Study Brief requirements, a land contamination assessment will be carried out for the Project Areas ("the site").

To accommodate the new development, extensive demolition works are required to relocate a number of existing facilities, including:

- CPB Fuel Oil Day Tank (FODT, hereafter referred to as the aboveground fuel oil day tank) and associated pipe works connecting with fuel oil pump house (FOPH) and oil interceptor;
- Dangerous Goods (DG) stores; and
- Intermediate Pressure Reduction Station (IPRS), LPG compound and CO_2 storage tanks.

The preliminary Project Areas are shown in *Figure 1.1a*.

Environmental Resources Management (ERM) was commissioned by CAPCO to conduct a land contamination assessment of the site, in accordance with the Study Brief requirements.

Site inspection including the sampling and analysis will be conducted to identify potential sources of contamination from historical and current operations in this area.

This report describes the Contamination Assessment Plan (CAP) for the land contamination assessment.

1.2 *OBJECTIVE OF THE CAP*

The purpose of the CAP is to provide information, guidance and instruction for characterising land contamination at the proposed Project Areas. This CAP documents procedures for identifying land contamination, carrying out the site investigation and evaluating the results to identify the nature and extent of contamination at the site. The specific tasks of the CAP include:

- Review of the history of the Project Areas in relation to possible land contamination;

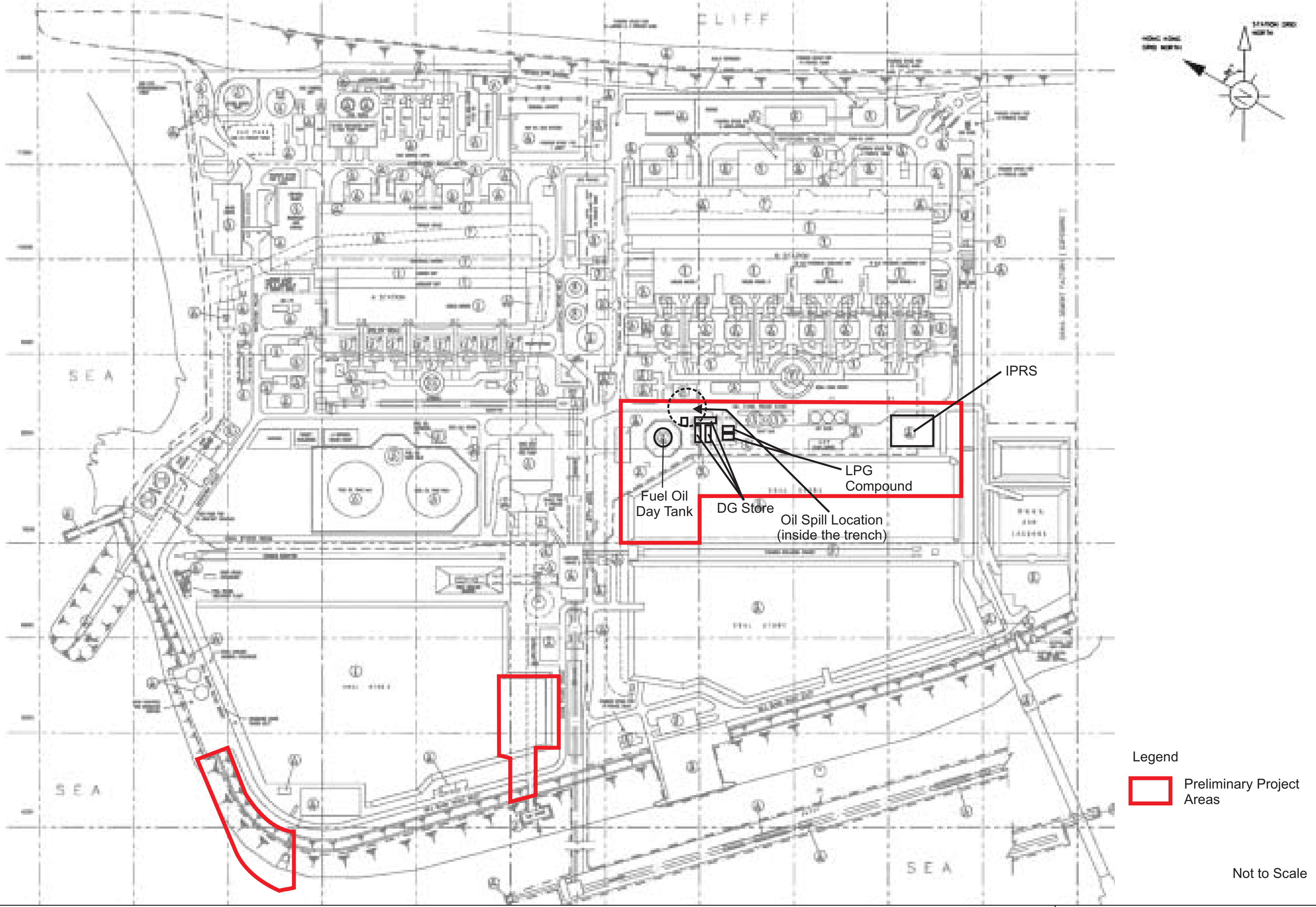

Figure 1.1a

Site Layout Map

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- Identification of potential contamination and associated impacts, risks or hazards; and

- Preparation of a plan for the actual contamination assessment, which includes a proposal on soil and, where appropriate, groundwater sampling and analysis, for agreement with the EPD prior to its implementation.

The findings of the site investigation will be evaluated and reported in the Contamination Assessment Report (CAR). If the findings confirm that the site is contaminated, a Remediation Action Plan (RAP) will be prepared and submitted to EPD for approval.

1.3 ENVIRONMENTAL LEGISLATION AND NON-STATUTORY GUIDELINES

The assessment of land contamination sources and the potential impacts will be carried out in accordance with the guidelines set out in the Environmental Protection Department's (EPD) *Practice Note for Professional Person* (*ProPECC) PN3/94 - Contaminated Land Assessment and Remediation*; and EPD's *Guidance Notes for Investigation and Remediation of Contaminated Sites of Petrol Filling Stations, Boatyards, and Car Repair/Dismantling Workshop* (Guidance Notes) and other relevant guidance notes.

Under the *Technical Memorandum on Environmental Impact Assessment Process* (*EIAO-TM), Annex 19 Guidelines for Assessment of Other Impacts*, consideration should be given during development and redevelopment projects to a number of potentially contaminating historical land uses, which have the potential to cause, or have caused, land contamination. This includes developing a CAP for the investigation where such land uses are identified, preparation of CAR after the investigation has been completed, and if contamination is confirmed, a RAP.

2 SITE APPRAISAL

2.1 SITE APPRAISAL AND REVIEW OF HISTORICAL SITE INVESTIGATION DATA

ERM conducted a walkthrough of the proposed Project Areas on 16 November 2005 and identified the areas of potential sources of contamination as follows.

Potential sources of contamination within the Project Areas:

- An aboveground fuel oil day tank, aboveground steel structures of 4,680 tonnes capacity underlain and surrounded with a concrete bund. Visual inspection of the concrete bund area showed no evidence of oil leakage or spillage.

- Dangerous goods (DG) storage, two one-storey concrete buildings located on concrete paved ground. Visual inspection of the concrete floor around the DG stores showed no evidence of oil leakage or spillage.

- Intermediate pressure reduction station (IPRS), LPG compound and CO_2 storage tanks.

Locations of these facilities are presented in *Figure 1.1a*.

The aboveground fuel oil day tank (FODT) was surrounded with reinforced-concrete slabs with bund walls. The bund walls were designed to provide containment volumes of not less than the maximum operating capacity of the oil tank and the containment was fitted with drain channels connecting to a sump pit, where the oil/oily drainage will be further diverted via a pipeline to a nearby oil interceptor. Visual inspection of the tank and containment area identified no apparent evidence of oil staining.

According to information provided by CAPCO, oil leakage at one of the pipelines connecting the FOPH and the FODT inside the pipeline trench was reported on 29 July 2004 and the oil spill was cleaned up and written report submitted to Marine Department on 10 August 2004.

2.2 POTENTIAL SOIL AND GROUNDWATER CONTAMINATION

Based on the review of site information and the walkthrough, the potential sources of soil and groundwater contamination include the oil and chemical storage and handling and oil transmission facilities, are described in *Section 2.1*. The facilities in the Project Areas may be considered to be potential sources of land contamination due to the following reasons:

- Leakage and/or spillage from the oil tank to the underlying soil and groundwater;

- Leakage and/or spillage of chemicals during handling in the DG stores.

The likely contaminants associated with the fuel storage and transfer facilities include total petroleum hydrocarbons (TPH), benzene, toluene, ethylbenzene, xylene (BTEX) and polycyclic aromatic hydrocarbons (PAHs). The likely contaminants associated with the chemicals (DG stores) storage include total petroleum hydrocarbons (TPH), volatile organic compounds (VOCs, including benzene, toluene, ethylbenzene, xylene, BTEX) and semivolatile organic compounds (SVOCs, including polycyclic aromatic hydrocarbons, PAHs).

3 PROPOSAL FOR SITE INVESTIGATION

3.1 SAMPLING STRATEGY

The soil and groundwater sampling plan presented in the following Sections aims to determine the presence and/or extent of soil and groundwater contamination in the proposed Project Areas.

3.1.1 Sampling Location and Sampling Depths

The sampling locations and depths are recommended based on the findings of the site appraisal and have made reference to the guidelines presented in the *Guidance Notes*.

The proposed site investigation programme is described below and is summarised in *Table 3.1a*.

- Conduct a utility scanning and excavation of inspection pits to 1.2m below ground level (m bgl) to ensure no interference with underground utilities;
- Eight (8) boreholes (DH1 to DH8) shall be drilled to 2 m below the groundwater level, these include:
    - Four (4) boreholes (DH 4 to DH 7) located within the northern coal storage yard to the south of the fuel oil day tank, DG stores, FOPH, APS/ADCR building and IPRS;
    - One borehole (1) (DH 3) located north of the fuel oil day tank;
    - One (1) borehole (DH 8) located at the IPRS; and
    - Two (2) boreholes (DH 1 and DH 2) located within the proposed gypsum dewatering and storage facilities area in the western coal storage yard.
- Four (4) trial pits (TP1 to TP4) located within the northern coal storage yard area for surface soil sampling;
- Sampling of soil for on-site visual investigation and screening using photo-ionisation detector (PID) from sub-surface (around 0.5 m) and every 1.0 m until the end of drilling;
- Three soil samples shall be collected from each borehole to ascertain the vertical distribution of any detected contamination (1). It is proposed that samples be taken from the unsaturated zone to below the groundwater level (eg at between 0.5m to 1m bgl, at soil and groundwater interface, at 1m below groundwater level) or where there is visual evidence of contamination;

---

(1) In accordance with the *ProPECC PN 3/94* and the *Guidance Notes.*

- One soil sample shall be collected from each trial pit to provide additional information on the surface soil condition;
- All eight boreholes will be converted into eight (8) temporary groundwater monitoring wells to facilitate groundwater sampling (1);
- One (1) groundwater (GW) sample shall be collected from each monitoring well; and
- Free-floating products in groundwater, if observed, will also be collected for laboratory analysis.

Figure 3.1a shows the proposed soil and groundwater sampling locations.

3.2 *ANALYTICAL PARAMETERS*

With respect to the nature of the substances stored and used at the fuel oil day tank (medium fuel oil), diesel storage and filling station (diesel oil), vehicle maintenance workshop (lubricant oils and solvent), dangerous goods store, where paints and solvents are stored, it is proposed that the soil and groundwater samples collected will be analysed for TPH (total petroleum hydrocarbons), benzene, toluene, ethylbenzene, xylene (BTEX), polycyclic aromatic hydrocarbons (PAHs) volatile organic compounds (VOCs), and semivolatile organic compounds (SVOCs).

Summary of analytical parameters are presented in *Table 3.1a*.

TCLP tests and analysis of leachate for metal concentrations (as per **Landfill Disposal Criteria for Contaminated Soil** listed in the *EPD's Guidance Notes for Investigation and Remediation of Contaminated Sites of Petrol Filling Stations, Boatyards, Car Repair/Dismantling Workshops*) for the material's suitability for landfill disposal will be conducted for the samples confirmed to be contaminated.

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(1) Purpose made UPVC or HDPE slotted risers and blank pipes (50mm diameter) will be used for the groundwater wells. The slotted risers will be installed from 2m below groundwater levels to 1-2 m above groundwater levels. The risers will be connected with blank pipes up to approx. 0.5m above ground surface. Voids between risers/pipes and the drill holes will be filled with clean gravel. Wells will be purged (pumped or bailed) 5 times the volumes of the wells after installation to rid of dirt/potential cross contamination during well installation.

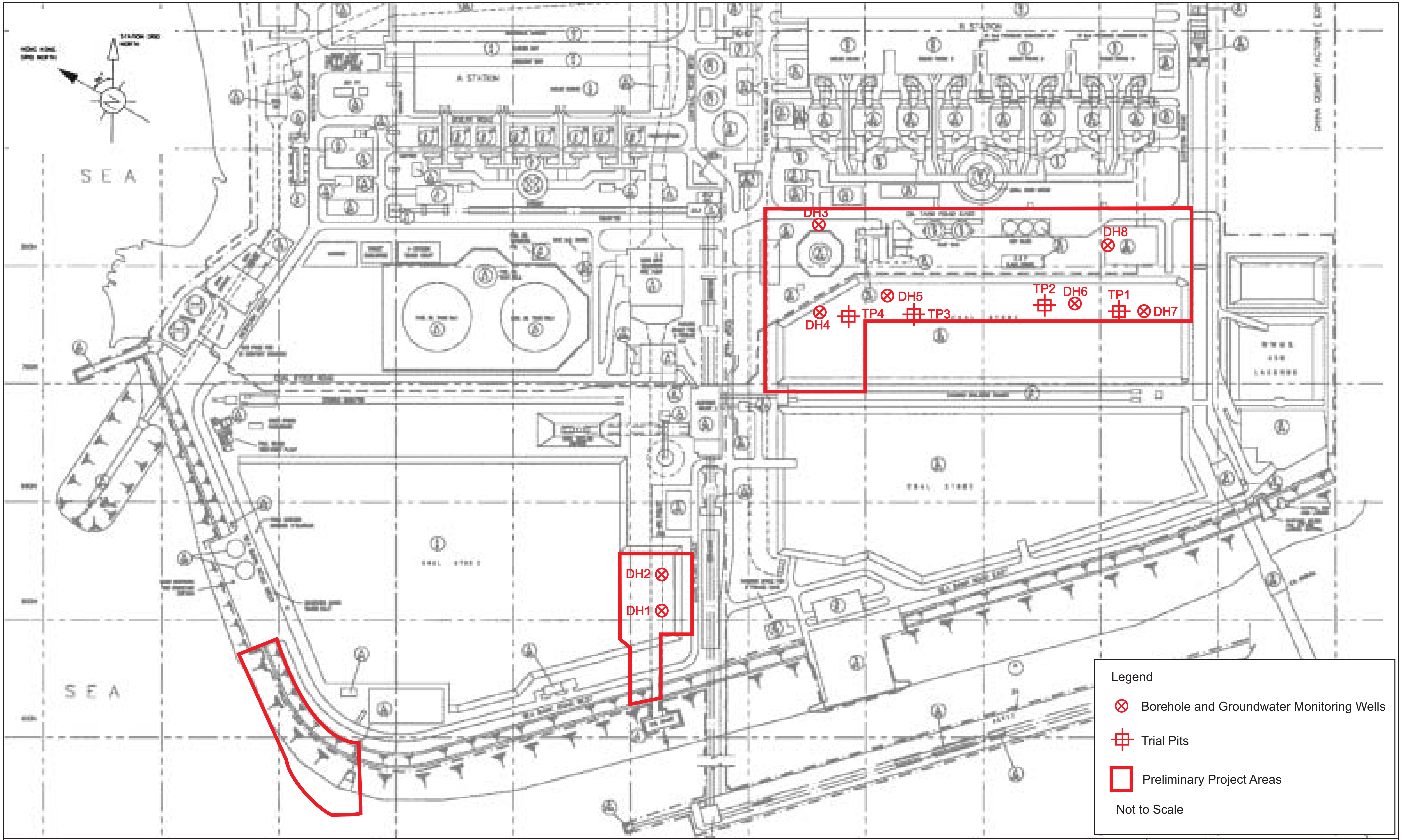

Figure 3.1a

Approximate Sampling Locations for Land Contamination Assessment

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Table 3.1a *Proposed Site Investigation Programme*

Location	Rationale	Depth	Temporary Monitoring Well	# Soil Samples	# Groundwater Samples	Analytical Parameters
Borehole/Monitoring Well/Trial Pits						
DH1	Located in the northern part of the proposed long-term gypsum storage area	2 m below groundwater level	1	3	1	**Soil:** TPH, BTEX and PAHs **Groundwater:** TPH, BTEX and PAHs
DH2	Located in the southern part of the proposed long-term gypsum storage area	2 m below groundwater level	1	3	1	
DH3	Located up-gradient from the fuel oil day tank and up-gradient from all proposed project areas	2 m below groundwater level	1	3	1	**Soil:** TPH, VOCs (including BTEX) and SVOCs (including PAHs) **Groundwater:** TPH, VOCs (including BTEX) and SVOCs (including PAHs)
DH4	Located within the north coal storage yard and also down-gradient from the fuel oil day tank	2 m below groundwater level	1	3	1	**Soil:** TPH, BTEX and PAHs **Groundwater:** TPH, BTEX and PAHs
TP4	Located within the north coal storage yard and also down-gradient from the day tank	Up to 1.2 m below ground level	-	1	-	
DH6	Located within the north coal storage yard	2 m below groundwater level	1	3	1	**Soil:** TPH, BTEX and PAHs **Groundwater:** TPH, BTEX and PAHs
DH7	Located within the north coal storage yard	2 m below groundwater level	1	3	1	
TP2	Located within the north coal storage yard	Up to 1.2 m below ground level	-	1	-	
DH5	Located within the north coal storage yard and down gradient from the DG Stores	2 m below groundwater level	1	3	1	**Soil:** TPH, VOCs (including BTEX) and SVOCs (including PAHs) **Groundwater:** TPH, VOCs (including BTEX) and SVOCs (including PAHs)
TP3	Located within the north coal storage yard and down gradient from the DG Stores	Up to 1.2 m below ground level	-	1	-	

Location	Rationale	Depth	Temporary Monitoring Well	# Soil Samples	# Groundwater Samples	Analytical Parameters
DH8	Located within the current Intermediate Pressure Reduction Station to be demolished	2 m below groundwater level	1	3	1	**Soil:** TPH, BTEX and PAHs **Groundwater:** TPH, BTEX and PAHs
TP1	Located within the north coal storage yard and down gradient from the current Intermediate Pressure Reduction Station	Up to 1.2 m below ground level	-	1	-	
(To be selected on site)				1 Duplicate Soil Sample per 20 Soil Samples	1 Duplicate Groundwater Sample	As per samples
Trip Blank					Estimated 5 delivery trips (water samples)	**Soil:** TPH, VOCs (including BTEX) and SVOCs (including PAHs) **Groundwater:** TPH, VOCs (including BTEX) and SVOCs (including PAHs)
Equipment Rinsate					Estimated 3 (with 3 rigs on-site) (water samples)	
			Total	30	17	

3.3 SAMPLING METHOD

A utility scan will be conducted prior to the commencement of any excavation/drilling. At each of the sampling locations, a trial pit will be excavated to 1.2 m bgl. Trial pits will be dug manually using hand tools and necessary concrete breaking hand operated mechanical tools to ensure no interference with underground utilities. Sampling below trial pit levels, will be conducted using drilling rig. Drilling rigs, drilling equipment that do not come in contact with samples and hand breakers will be steam cleaned prior to mobilisation to the site. Prior to sampling, all sampling equipment and well materials will be steam cleaned, scrubbed with a non-phosphate soap solution, washed with tap water and rinsed with distilled water. This procedure will be repeated after use at each sampling location to avoid potential cross contamination, and between samples to ensure that any contamination from the surface of the site does not affect deeper substrata or the groundwater.

In addition to taking samples for analysis, the strata log will be recorded. This includes recording the general structure of the ground and the depth and thickness of each band of material. The depths at which samples are taken will be recorded with a description of each sample such as grain size, colour, and wetness. Extreme care will be exercised when toxic gases or hazardous materials are suspected. Photographs will be taken during the site investigation and for each sample.

3.3.1 *Sample Collection*

The soil or groundwater sampling will be undertaken following appropriate protocols so as to minimise the potential for cross-contamination between sampling locations and depths. The soil sampling methodologies are based on methods developed by US Environmental Protection Agency (US EPA), as outlined below.

Decontamination Procedures

Sampling equipment used during the course of the site investigation programme will be decontaminated using the following procedures:

- Manual washing and scrubbing with non-phosphate detergent;
- Tap water and distilled water rinse; and
- Air drying.

Where available, a steam cleaner or pressure washer will be used.

During the sampling and decontamination activities, disposable latex gloves will be worn to prevent transfer of contaminants from other sources. Any disposable equipment such as latex gloves will be disposed of as general waste after each use. Provisions will be made to containerise any decontamination fluids, although the volume of fluids to be produced is expected to be low.

Soil Sample Collection

Soil samples will be taken by ERM staff and placed into appropriate clean glass bottles or sampling containers (provided by the laboratory) immediately after collection. Before sampling commences, the laboratory will be consulted on the particular sample size and preservation procedures that are necessary for each chemical analyses. The sample containers will be laboratory cleaned, made of glass or other suitable materials with aluminium or teflon-lined lids, so that the container surface will not react with the sample or adsorb contaminants. The containers will be labelled with the sampling location codes and the depths at which the samples are taken. They will then be transferred to an icebox or cooler container. Samples will be kept between 0 to 4°C but not frozen.

Groundwater, if encountered, will be sampled from the monitoring wells using disposable Teflon bailers.

Sampling Management

Samples will be dispatched to the analytical laboratory for analysis as soon as practicable following sampling. All samples will be handled under chain of custody protocols and relinquished to the laboratory representative at the site or at a location specified by the laboratory.

3.4 ANALYTICAL METHOD

The parameters as described in *Section 3.2* will be analysed using the methods stated in *Table 3.4a*.

Table 3.4a Analytical Methods for Contaminants in Soil and Groundwater Samples

Contaminant	**Analytical Methods**
TPH	• US EPA 8260 & 8015
VOCs (incl. BTEX)/SVOCs (incl. PAHs)	• US EPA Method 8260/8270
TCLP	• EPA SW-846 (Method 1311)

3.5 QUALITY CONTROL AND QUALITY ASSURANCE (QC/QA)

Samples collected should be representative of field conditions. At each sampling location, soil (and groundwater, if encountered) samples will be collected using pre-cleaned sampling equipment. All sample containers will be provided by the contracted laboratory who guarantees their sterilisation and preservative contents.

Appropriate QC/QA samples will also be collected during the field investigation, including:

- Equipment (rinsate) blanks (one per machine) for the full suite of target parameters, in order to assess the adequacy of the decontamination procedures;

- Trip blanks (one per cooler/shipment) for the full suit of target parameters in order to assess the potential contamination of the sample handling and transportation processes; and

- Groundwater and soil duplicates (one duplicate sample per 20 samples) for the full suite of analyses to assess the precision of the procedures.

Precision will be calculated as the relative percent difference (RPD) between the original sample and the blind duplicate. For water and soil, the acceptance criteria for precision are 20% RPD and 30% RPD, respectively. Accuracy will be assessed by analysis of blank samples to ensure that no bias is present in the analytical data.

3.6 ANALYTICAL LABORATORY

Analysis of samples will be carried out by an appropriate, HOKLAS-certified (or other equivalent scheme approved by the EPD) analytical laboratory. The laboratory should maintain high standards of analytical and technical services for the detection of trace organic contaminants. All analysis will be conducted according to standard procedures set by the US EPA, along with internal QC/QA procedures.

3.7 HEALTH AND SAFETY

A health and safety risk assessment and health and safety management plan shall be developed for the site investigation works in accordance with CLP Power HK Ltd (CLP) and ERM's internal requirements. All personnel will attend safety training provided by CLP prior to commencing the works at the site.

4 PROGRAMME SCHEDULE & REPORTING

4.1 PROGRAMME SCHEDULE

It is anticipated that site investigation and laboratory analysis will be completed within three to four weeks from the date of approval of the CAP. The CAR will be submitted to the EPD for approval after the completion of the laboratory analysis.

The overall assessment will comprise the following activities:

- Required revision and endorsement of the CAP by EPD;
- Mobilisation of the subcontractor and contracting analytical laboratory;
- Field sampling programme;
- Analytical programme/laboratory turnaround (normal turnaround time is expected two weeks);
- Assessment and reporting of results in a CAR, including, if required, development of a remedial action plan (RAP). The CAR will include all laboratory testing results of chemical analyses; and
- In the event that landfill disposal is proposed for contaminated soil materials, prior agreement will need to be reached with the EPD and the application accompanied by the RAP and the TCLP test results.

No demolition works involving excavation will be conducted at the project area before the assessment and the necessary remediation works have been established.

4.2 ASSESSMENT AND REPORTING

A CAR will be prepared after obtaining analytical results from the laboratory. The report will present the findings of the CAP and site investigation assessment (including the methodology used during the soil and groundwater sampling and details of field observations such as visual observations made during the investigation).

There are no legislative standards requiring clean up of soil and groundwater contamination in Hong Kong. The analytical results will be compared against recognized standards for soil and ground water contamination. The remediation standards to be agreed with EPD should not be so high that it makes land decontamination operation unreasonably uneconomical. A risk-based approach as a flexible and pragmatic approach, as the amount of decontamination work required would be determined on a case-by-case basis, taking into account the future land use of specific sites.

CAPCO notes that Dutch "B" values are currently being adopted as the cleanup targets for most of the land decontamination cases in Hong Kong. EPD has indicated during their discussions with CAPCO that there is no potable use of groundwater in Hong Kong, and therefore the evaluation of results for groundwater can be based on an approach more inclined towards that of a risk assessment.

The CAR will be prepared and submitted to the EPD.

If necessary, a RAP will be prepared in consultation with the EPD, with the objective of mitigating the site to an agreed upon condition. Any proposed mitigation recommendations will be considered under several factors including nature of the contamination, degree of the contamination, the potential receiver, time allocation, treatment cost and availability of local expertise for undertaking the treatment in accordance with the *ProPECC PN3/94* and other relevant guidance notes. The RAP will also outline requirements for construction workers to follow to limit potential future exposures.

The results of the sampling programme, the report, and the objectives of the RAP will be submitted to EPD. It should be noted that no estimate of the time frame for any mitigation is presented at this time.

Annex A

Selected Site Photographs

1 *SITE PHOTOGRAPHS*

Photo P1 – Castle Peak "B" Fuel Oil Day Tank (FODT)

Photo P2 - Inside the FODT Bunded Area

Photo P3 - North Coal Storage Yard

Photo P4 - Dangerous Goods Stores

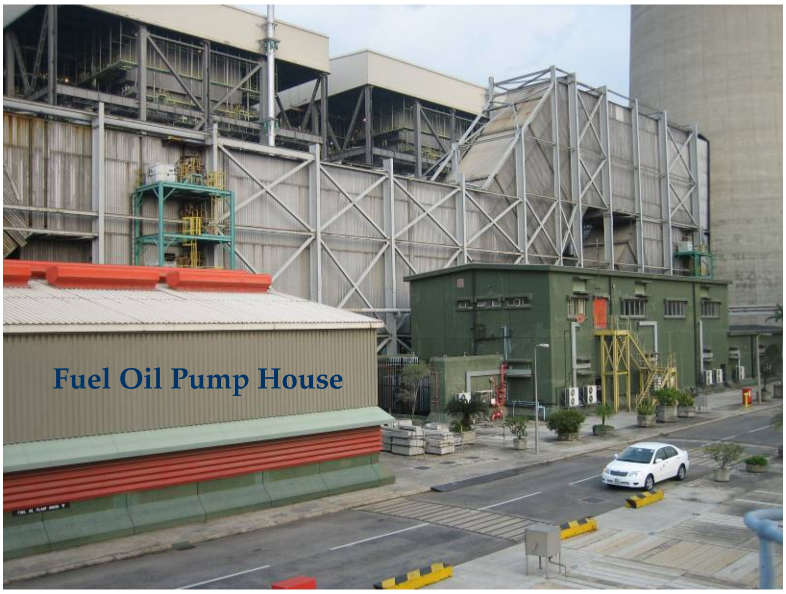


Photo P5 – Fuel Oil Pump House (FOPH)

Annex B

Landfill Disposal Criteria

1 LANDFILL DISPOSAL CRITERIA

Table1.1 Landfill Disposal Criteria for Contaminated Soil

Parameter	**TCLP Limit (ppm)***
Cadmium	10
Chromium	50
Copper	250
Nickel	250
Lead	50
Zinc	250
Mercury	1
Tin	250
Silver	50
Antimony	150
Arsenic	50
Beryllium	10
Thallium	50
Vanadium	250
Selenium	1
Barium	1000

Note: Soil samples should be stored at 0-4 °C. This allowable storage time for mercury in soil samples is 8 days while the storage time for the rest of the parameters (above) in soil samples can be up to 6 months. Soil samples, if stored beyond the allowable storage time, are not considered representative of the actual site conditions (ASTM-E1391-90).

**Reference to EPDs Guidance Notes for Investigation and Remediation of Contaminated Sites of: Petrol Filling Stations, Boatyards, Car Repair/Dismantling workshops.*

Annex E1b

Borehole Logs

Lam Geotechnics Limited
2304-6 World Trade Centre, 280 Gloucester Road, Causeway Bay, Hong Kong.
Tel: 2882-3939 Fax: 2882-3331

華益土力有限公司

Our Ref. : *LG24009/25/1.0/014/05*
Date : *28th December 2005*

ECPD/PR802.01/MCP/[illegible]-100018

By Fax & Post
(2678-5808)

CLP Power Hong Kong Limited
Emissions Control Project Office
1/F, Castle Peak 'B' Power Station Administration Block
Castle Peak Power Station
Lung Yiu Street
Tuen Mun
N.T.

4/01/2006

Attn: Mr. T K Chiu / Mr. David Yip

30/12/05

Dear Sir,

Outline Agreement No. 4600002288
Site Investigation Works for
Existing/Prospective Sites of CLP Power's Premises (2004 – 2007)
Castle Peak Power Station
Contamination Assessment Survey
Preliminary Drillhole Record

With reference to the captioned project, we hereby enclose 1 copy of the following record for your information.

Preliminary Drillhole Record:

Drillhole No.
DH1
DH2
DH3
DH4
DH5
DH6
DH7
DH8

Yours faithfully,
For and on behalf of
LAM GEOTECHNICS LIMITED

Iain S McGlen
Project Manager

Encl.

MD/ISM/qs

PRELIMINARY

DRILLHOLE RECORD

DRILLHOLE No.	**DH1**		
SHEET	1	of	1

PROJECT	**PO No. 4500295935 Castle Peak Power Station Contamination Assessment Survey**

METHOD	**IP+W+RC**	CO-ORDINATES		PROJECT No.	**LG24009/25**
MACHINE & No.	**Longyear L38, D85**	E N	**809524.17** **826128.17**	DATE from	**03/12/2005** to **03/12/2005**
FLUSHING MEDIUM	**Water**	ORIENTATION	**Vertical**	GROUND LEVEL	**+ 5.05** mPD

Drilling Progress	Casing Depth/Size	Water Depth (m)	Water Recovery %	Total Core Recovery %	Solid Core Recovery %	R.Q.D.	Fracture Index	Tests	Samples No.	Samples Type	Samples Depth	Reduced Level 5.05	Depth (m) 0.00	Legend	Grade	Description
03/12/2005	PX								1	INSPECTION PIT ●	0.50			▩		Brown, very silty fine to coarse SAND with some angular fine to coarse gravel sized strong rock fragments (FILL)
								PID = 2.00 ppm	2	●	0.60	4.45	0.60	▩		Light grey and brown, angular COBBLE and BOULDER sized up to 0.56m strong rock fragments (FILL)
			0	79						T6-116	1.23			▩		
				100						T6-116	1.56			▩		
	PX 2.07 HX			88						T6-116	2.07	2.98	2.07	▩		2.07-2.50m: with steel bar fragments
			50	81						T6-116	2.50	2.55	2.50	▩		
				79						T2101	2.88			▩		
				80						T2101	3.33			▩		
				73						T2101	3.95			▩		
			60	56						T2101	4.76			▩		
				59						T2101	5.10			▩		
				60						T2101	5.60			▩		
03/12/2005	HX 6.27	2.38m at 13:00		84						T2101	6.27	-1.22	6.27	▩		
													10.00			End of investigation hole at 6.27m

● Small Disturbed Sample
▲ Water Sample
▯ SPT Liner Sample
◩ U76 Undisturbed Sample
■ U100 Undisturbed Sample
▨ Mazier Sample
▤ Piston Sample
Ⅰ Packer Test
Piezometer / Standpipe Tip
↓ Standard Penetration Test
Pressuremeter Test
Permeability Test
Impression Packer / Televiewer Test
V In-situ Vane Shear Test

LOGGED **H.K.Fung**
DATE **12/12/2005**
CHECKED **I.S.McGlen**
DATE **21/12/2005**

REMARKS
1. Inspection pit excavated to 0.60m depth.
2. Groundwater sampling well installed at 5.00m.
3. PID test carried out at 0.60m depth.

PRELIMINARY

lam

DRILLHOLE RECORD

DRILLHOLE No.	**DH2**
SHEET	**1** of **1**
PROJECT	**PO No. 4500295935 Castle Peak Power Station Contamination Assessment Survey**
METHOD	**IP+W+RC**
MACHINE & No.	**Longyear L38, D85**
FLUSHING MEDIUM	**Water**
CO-ORDINATES	E **809543.86** N **826138.36**
ORIENTATION	**Vertical**
PROJECT No.	**LG24009/25**
DATE from	**01/12/2005** to **02/12/2005**
GROUND LEVEL	**+ 5.12** mPD

Drilling Progress	Casing Depth/Size	Water Depth (m)	Water Recovery %	Total Core Recovery %	Solid Core Recovery %	R.Q.D.	Fracture Index	Tests	Samples No.	Samples Type	Samples Depth	Reduced Level 5.12	Depth (m) 0.00	Legend	Grade	Description
01/12/2005	PX													▩		Greyish brown, very silty fine to coarse SAND (FILL)
								PID = 2.00 ppm	1	INSPECTION PIT ●	0.50					
									2	●	1.00	4.12	1.00	▩		Light grey and brown, angular COBBLE with some coarse gravel sized moderately strong to strong rock fragments (FILL)
			0	83						T6-116	1.78					
				78						T6-116	2.36					
				100						T6-116	2.70					
				73						T6-116	3.32	1.80	3.32			3.32-3.76m: with some sandy SILT
01/12/2005		Dry at 18:00		80						T6-116	3.76	1.36	3.76			
02/12/2005		Dry at 08:00		63						T6-116	4.52	0.60	4.52			4.52-5.24m: with occasional cobble sized concrete fragments
			50	60						T6-116	5.24	-0.12	5.24			
				50						T6-116	5.60					
				44						T6-116	6.28					
02/12/2005	PX 6.77	2.55m at 13:00		55						T6-116	6.77	-1.65	6.77			End of investigation hole at 6.77m
													10.00			

●	Small Disturbed Sample	I	Packer Test
▲	Water Sample	⍋	Piezometer / Standpipe Tip
▯	SPT Liner Sample	↓	Standard Penetration Test
◪	U76 Undisturbed Sample	I	Pressuremeter Test
■	U100 Undisturbed Sample	I	Permeability Test
▨	Mazier Sample	I	Impression Packer / Televiewer Test
▤	Piston Sample	V	In-situ Vane Shear Test

LOGGED	H.K.Fung
DATE	12/12/2005
CHECKED	I.S.McGlen
DATE	21/12/2005

REMARKS

1. Inspection pit excavated to 1.00m depth.
2. Groundwater sampling well installed at 6.00m.
3. PID test carried out at 0.60m depth.

PRELIMINARY

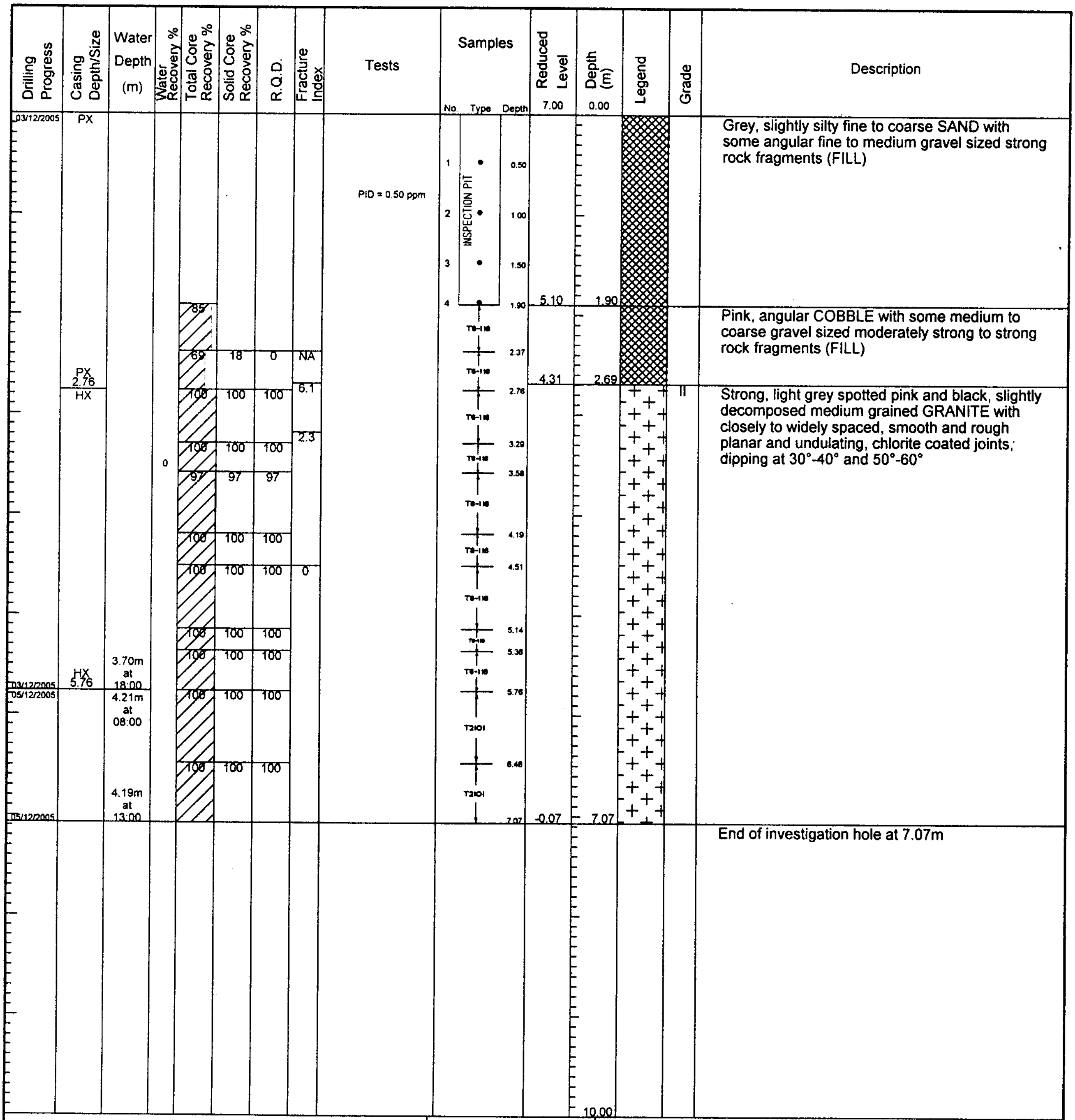
DRILLHOLE RECORD

DRILLHOLE No. **DH3**

SHEET 1 of 1

PROJECT **PO No. 4500295935 Castle Peak Power Station Contamination Assessment Survey**

METHOD **IP+W+RC**	CO-ORDINATES	PROJECT No. **LG24009/25**
MACHINE & No. **Edeco H40, D70**	E **809873.45** N **826186.05**	DATE from **03/12/2005** to **05/12/2005**
FLUSHING MEDIUM **Water**	ORIENTATION **Vertical**	GROUND LEVEL **+ 7.00** mPD



Drilling Progress	Casing Depth/Size	Water Depth (m)	Water Recovery %	Total Core Recovery %	Solid Core Recovery %	R.Q.D.	Fracture Index	Tests	Samples No.	Type	Depth	Reduced Level	Depth (m)	Legend	Grade	Description
03/12/2005	PX											7.00	0.00	▨		Grey, slightly silty fine to coarse SAND with some angular fine to medium gravel sized strong rock fragments (FILL)
									1	● INSPECTION PIT	0.50					
								PID = 0.50 ppm								
									2	●	1.00					
									3	●	1.50					
				85					4	●	1.90	5.10	1.90	▨		Pink, angular COBBLE with some medium to coarse gravel sized moderately strong to strong rock fragments (FILL)
				69	18	0	NA			T6-116	2.37					
	PX 2.76 HX			100	100	100	6.1			T6-116	2.76	4.31	2.69	+	II	Strong, light grey spotted pink and black, slightly decomposed medium grained GRANITE with closely to widely spaced, smooth and rough planar and undulating, chlorite coated joints, dipping at 30°-40° and 50°-60°
			0	100	100	100	2.3			T6-116	3.29					
				97	97	97				T6-116	3.58					
				100	100	100				T6-116	4.19					
				100	100	100	0			T6-116	4.51					
				100	100	100				T6-116	5.14					
				100	100	100				T6-116	5.36					
03/12/2005	HX 5.76	3.70m at 18:00								T6-116	5.76					
05/12/2005		4.21m at 08:00		100	100	100										
				100	100	100				T2101	6.48					
05/12/2005		4.19m at 13:00								T2101	7.07	-0.07	7.07			End of investigation hole at 7.07m
													10.00			

- ● Small Disturbed Sample
- ▲ Water Sample
- ▯ SPT Liner Sample
- ◩ U76 Undisturbed Sample
- ■ U100 Undisturbed Sample
- ▨ Mazier Sample
- ▤ Piston Sample
- ⌶ Packer Test
- ⌶ Piezometer / Standpipe Tip
- ↓ Standard Penetration Test
- ⌶ Pressuremeter Test
- ⌶ Permeability Test
- ⌶ Impression Packer / Televiewer Test
- V In-situ Vane Shear Test

LOGGED **H.K.Fung**
DATE **12/12/2005**
CHECKED **I.S.McGlen**
DATE **21/12/2005**

REMARKS

1. Inspection pit excavated to 1.90m depth.
2. Groundwater sampling well installed at 6.21m.
3. PID test carried out at 0.80m depth.

PRELIMINARY

lam

DRILLHOLE RECORD

DRILLHOLE No. **DH4**

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

PROJECT **PO No. 4500295935 Castle Peak Power Station Contamination Assessment Survey**

METHOD **IP+W+RC**	CO-ORDINATES E **809823.87** N **826137.28**	PROJECT No. **LG24009/25**
MACHINE & No. **Longyear L38, D68**		DATE from **01/12/2005** to **01/12/2005**
FLUSHING MEDIUM **Water**	ORIENTATION **Vertical**	GROUND LEVEL **+ 6.01** mPD

Drilling Progress	Casing Depth/Size	Water Depth (m)	Water Recovery %	Total Core Recovery %	Solid Core Recovery %	R.Q.D.	Fracture Index	Tests	Samples No.	Samples Type	Samples Depth	Reduced Level 6.01	Depth (m) 0.00	Legend	Grade	Description
01/12/2005	PX															Wash drilling
			80	100				PID = 4.00 ppm		T8-116	0.25	5.76	0.25	▩		Pink and grey, angular COBBLE and BOULDER sized up to 0.50m moderately strong to strong rock fragments (FILL)
				67						T8-116	0.78					
			60	81						T8-116	1.38					
				73						T8-116	2.22					
				58						T8-116	3.00					
				39						T8-116	3.65					
			0	40						T8-116	4.32					
				60						T8-116	5.20					
				70						T8-116	5.95					
01/12/2005	PX 6.81	4.70m at 18:00									6.81	-0.80	6.81			End of investigation hole at 6.81m
													10.00			

● Small Disturbed Sample

▲ Water Sample

▯ SPT Liner Sample

▨ U76 Undisturbed Sample

■ U100 Undisturbed Sample

▨ Mazier Sample

▤ Piston Sample

I Packer Test

Piezometer / Standpipe Tip

↓ Standard Penetration Test

I Pressuremeter Test

I Permeability Test

I Impression Packer / Televiewer Test

V In-situ Vane Shear Test

LOGGED H.K.Fung

DATE 12/12/2005

CHECKED I.S.McGlen

DATE 21/12/2005

REMARKS

1. Groundwater sampling well installed at 6.81m.
2. PID test carried out at 0.70m depth.

PRELIMINARY

Lam	DRILLHOLE RECORD	DRILLHOLE No. **DH5** SHEET 1 of 1

PROJECT **PO No. 4500295935 Castle Peak Power Station Contamination Assessment Survey**

METHOD **IP+W+RC**	CO-ORDINATES E **809853.93** N **826111.57**	PROJECT No. **LG24009/25**
MACHINE & No. **Edeco H40, D70**		DATE from **01/12/2005** to **02/12/2005**
FLUSHING MEDIUM **Water**	ORIENTATION **Vertical**	GROUND LEVEL **+ 6.01** mPD

Drilling Progress	Casing Depth/Size	Water Depth (m)	Water Recovery %	Total Core Recovery %	Solid Core Recovery %	R.Q.D.	Fracture Index	Tests	Samples No.	Samples Type	Samples Depth	Reduced Level 6.01	Depth (m) 0.00	Legend	Grade	Description
01/12/2005	PX															Wash drilling
				97				PID = 1.50 ppm		T6-116	0.48	5.53	0.48	▩		Light grey and pink, angular COBBLE and BOULDER sized up to 0.61m strong rock fragments (FILL)
				89						T6-116	1.10					
				82						T6-116	1.72					
				63						T6-116	2.23					
			70	59						T6-116	2.95					
				91						T6-116	3.54					
				73						T6-116	4.20					
01/12/2005	PX 5.40	4.62m at 18:00		100						T6-116	4.68					
02/12/2005	HX	4.76m at 08:00		80						T6-116	5.40					
	HX 6.48			78						T6-116	6.21					
02/12/2005		4.76m at 18:00		94						T2101	6.48 6.80	-0.79	6.80			
																End of investigation hole at 6.80m
													10.00			

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

LOGGED	H.K.Fung
DATE	12/12/2005
CHECKED	I.S.McGlen
DATE	21/12/2005

REMARKS

1. Groundwater sampling well installed at 6.80m.
2. PID test carried out at 0.90m depth.

PRELIMINARY

Lam

DRILLHOLE RECORD

DRILLHOLE No.	**DH6**
SHEET	**1** of **1**

PROJECT **PO No. 4500295935 Castle Peak Power Station Contamination Assessment Survey**

METHOD **IP+W+RC**	CO-ORDINATES	PROJECT No. **LG24009/25**
MACHINE & No. **Edeco H40, D79**	E **809921.15** N **825972.60**	DATE from **29/11/2005** to **30/11/2005**
FLUSHING MEDIUM **Water**	ORIENTATION **Vertical**	GROUND LEVEL **+ 6.23** mPD

Drilling Progress	Casing Depth/Size	Water Depth (m)	Water Recovery %	Total Core Recovery %	Solid Core Recovery %	R.Q.D.	Fracture Index	Tests	Samples No.	Samples Type	Samples Depth	Reduced Level 6.23	Depth (m) 0.00	Legend	Grade	Description
29/11/2005	SX															Wash drilling
	SX 0.60										0.60	5.63	0.60			
	PX			93				PID = 1.00 ppm		T8-116	1.30			▨		Pink and light grey, angular COBBLE and BOULDER sized up to 0.32m moderately strong to strong rock fragments (FILL)
				100						T8-116	1.90					
				83						T8-116	2.20					
				83						T8-116	2.50					
				100						T8-116	3.00					
				83						T8-116	3.40					
29/11/2005		Dry at 18:00	80	90						T8-116	3.70					
30/11/2005		4.60m at 08:00		100						T8-116	4.30					
				100						T8-116	4.60					
				58						T8-116	5.20					
				85						T8-116	5.85					
				95						T8-116	6.40					
				94						T8-116	6.90					
30/11/2005	PX 7.15	5.00m at 13:00		100						T8-116	7.15	-0.92	7.15			
																End of investigation hole at 7.15m
													10.00			

●	Small Disturbed Sample	I	Packer Test
▲	Water Sample	⏄	Piezometer / Standpipe Tip
▯	SPT Liner Sample	↓	Standard Penetration Test
▨	U76 Undisturbed Sample	I	Pressuremeter Test
■	U100 Undisturbed Sample	I	Permeability Test
▨	Mazier Sample	I	Impression Packer / Televiewer Test
▤	Piston Sample	V	In-situ Vane Shear Test

LOGGED	H.K.Fung
DATE	12/12/2005
CHECKED	I.S.McGlen
DATE	21/12/2005

REMARKS

1. Groundwater sampling well installed at 7.00m.
2. PID test carried out at 0.80m depth.

PRELIMINARY

Lam

DRILLHOLE RECORD

DRILLHOLE No.	**DH7**
SHEET	**1** of **1**
PROJECT	**PO No. 4500295935 Castle Peak Power Station Contamination Assessment Survey**
METHOD	**IP+W+RC**
MACHINE & No.	**Longyear L38, D85**
FLUSHING MEDIUM	**Water**
CO-ORDINATES	E **809950.96** N **825918.58**
ORIENTATION	**Vertical**
PROJECT No.	**LG24009/25**
DATE from	**30/11/2005** to **30/11/2005**
GROUND LEVEL	**+ 6.67** mPD

Drilling Progress	Casing Depth/Size	Water Depth (m)	Water Recovery %	Total Core Recovery %	Solid Core Recovery %	R.Q.D.	Fracture Index	Tests	Samples No	Samples Type	Samples Depth	Reduced Level 6.67	Depth (m) 0.00	Legend	Grade	Description
30/11/2005	SX															Wash drilling
	SX 1.38 PX			64				PID = 0.80 ppm		T6-116	1.38	5.29	1.38	▩		Light grey and pink, angular COBBLE and BOULDER sized up to 0.23m with some coarse gravel sized moderately strong to strong rock fragments (FILL) 1.38-2.16m: with some coal fragments
				80						T6-116	2.16	4.51	2.16	▩		
				81						T6-116	2.70			▩		
			0	89						T6-116	3.44			▩		
				100						T6-116	4.15			▩		
				83						T6-116	4.55	2.12	4.55	▩		4.55-5.15m: with some sandy silt matrix
				74						T6-116	5.15	1.52	5.15	▩		
				66						T6-116	5.62			▩		
				84						T6-116	6.18			▩		
30/11/2005	PX 6.77	4.72m at 18:00		100							6.63 6.77	-0.10	6.77	▩		
																End of investigation hole at 6.77m
													10.00			

●	Small Disturbed Sample
▲	Water Sample
▯	SPT Liner Sample
◩	U76 Undisturbed Sample
■	U100 Undisturbed Sample
▨	Mazier Sample
▤	Piston Sample
I	Packer Test
♁	Piezometer / Standpipe Tip
↓	Standard Penetration Test
I	Pressuremeter Test
I	Permeability Test
I	Impression Packer / Televiewer Test
V	In-situ Vane Shear Test

LOGGED **H.K.Fung**

DATE **12/12/2005**

CHECKED **I.S.McGlen**

DATE **21/12/2005**

REMARKS

1. Groundwater sampling well installed at 6.76m.
2. PID test carried out at 1.50m depth.

iam	# DRILLHOLE RECORD	DRILLHOLE No. **DH8** SHEET **1** of **1**

PROJECT **PO No. 4500295935 Castle Peak Power Station Contamination Assessment Survey**

METHOD **IP+W+RC**	CO-ORDINATES	PROJECT No. **LG24009/25**
MACHINE & No. **Edeco H40, D70**	E **809968.82** N **825975.56**	DATE from **06/12/2005** to **08/12/2005**
FLUSHING MEDIUM **Water**	ORIENTATION **Vertical**	GROUND LEVEL **+ 7.07** mPD

Drilling Progress	Casing Depth/Size	Water Depth (m)	Water Recovery %	Total Core Recovery %	Solid Core Recovery %	R.Q.D.	Fracture Index	Tests	Samples No	Samples Type	Samples Depth	Reduced Level	Depth (m)	Legend	Grade	Description
												7.07	0.00			
06/12/2005	PX								1	INSPECTION PIT ●	0.50			▩		Light grey, silty fine to coarse SAND with some angular fine to medium gravel sized strong rock fragments (FILL)
								PID = 0.80 ppm						▩		
									2	●	1.00	6.07	1.00	▩		Light grey and pink, angular COBBLE and BOULDER sized up to 0.40m strong rock fragments (FILL)
				75						T6-116	1.36			▩		
				81						T6-116	1.98			▩		
				81						T6-116	2.51			▩		
				88						T6-116	3.28			▩		
				89						T6-116	3.73			▩		
06/12/2005		5.50m at 18:00		83						T6-116	4.15			▩		
08/12/2005		5.50m at 08:00		100						T6-116	4.85			▩		
				90						T6-116	5.14			▩		
				90						T6-116	5.86			▩		
				88						T6-116	6.50			▩		
				94						T6-116	7.20			▩		
08/12/2005	PX 7.53	5.51m at 13:00		91						T6-116	7.53	-0.46	7.53	▩		
																End of investigation hole at 7.53m
													10.00			

● Small Disturbed Sample	Packer Test	LOGGED **H.K.Fung**
▲ Water Sample	Piezometer / Standpipe Tip	DATE **12/12/2005**
▯ SPT Liner Sample	↓ Standard Penetration Test	CHECKED **I.S.McGlen**
▨ U76 Undisturbed Sample	Pressuremeter Test	DATE **21/12/2005**
■ U100 Undisturbed Sample	Permeability Test	
▨ Mazier Sample	Impression Packer / Televiewer Test	
▤ Piston Sample	V In-situ Vane Shear Test	

REMARKS

1. Inspection pit excavated to 1.00m depth.
2. Groundwater sampling well installed at 7.53m.
3. PID test carried out at 0.80m depth.

PRELIMINARY

TRIAL PIT RECORD

TRIAL PIT No.	TP1
PROJECT No.	LG24009/25

PROJECT **PO No. 4500291694 Castle Peak Power Station Geotechnical Survey**

CO-ORDINATES E **809948.01** N **825926.23**

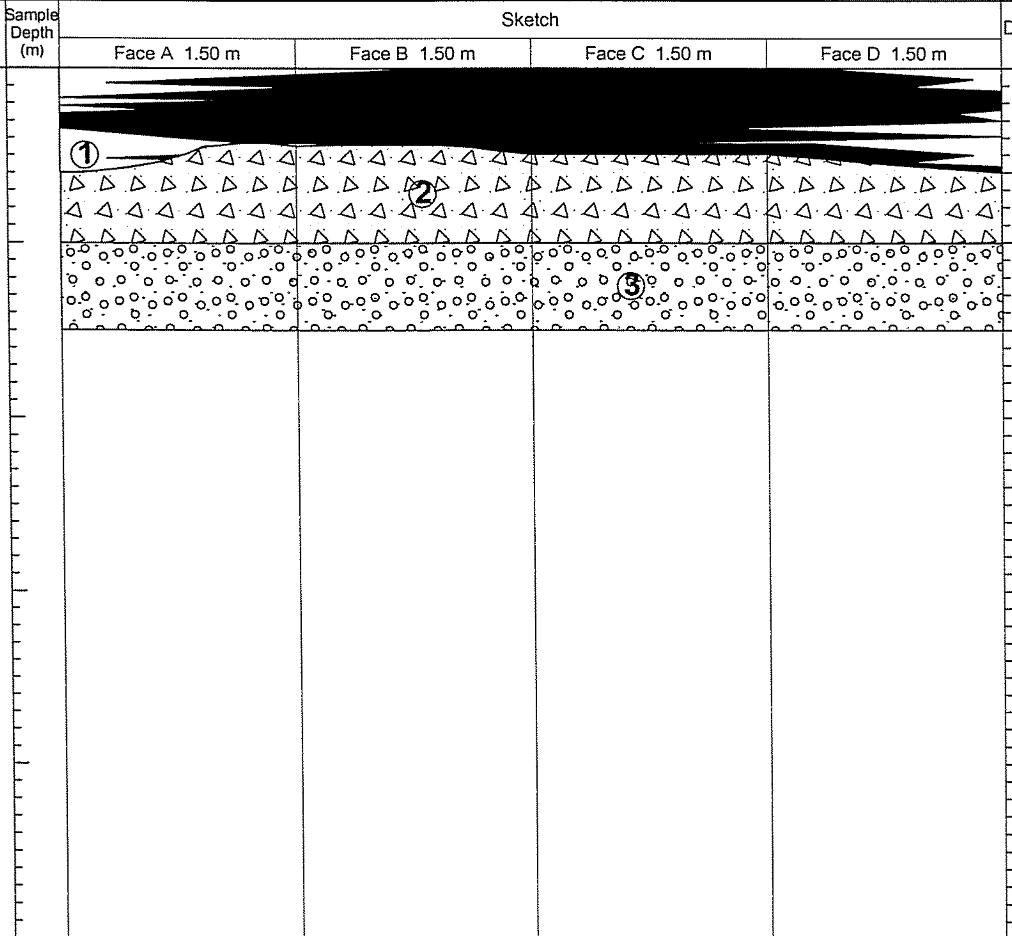
GROUND LEVEL **+6.54** mPD

LOGGED **H.K.Fung** DATE **24/11/2005**

CHECKED **I.S.McGlen** DATE **28/11/2005**

EXCAVATION DATE **17/11/2005** to **23/11/2005**

BACKFILL DATE

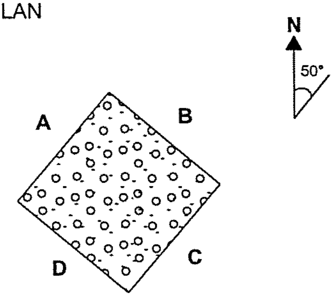


Depth (m)	Legend (Face D)	Grade	Description
0.60	▨		① Black, COAL, ash and fragments (FILL)
1.00	▨		② Dense, light grey, FUEL ASH fragments (FILL)
1.50	▨		③ Loose, brown and grey, sandy angular fine to coarse GRAVEL with some cobble and occasional boulder sized up to 0.22m moderately strong to strong rock fragments (FILL)

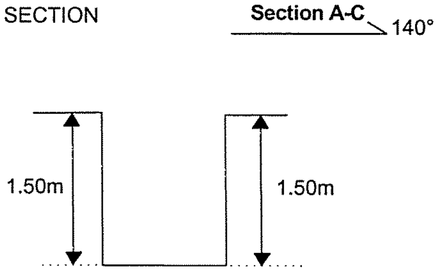
SYMBOL

●	Small Disturbed Sample	¦	Large Disturbed Sample
▯	U76 Vertical Sample	☒	Block Sample
▭	U76 Horizontal Sample	⊤	In-situ Density Test
▮	U100 Vertical Sample	▲	Water Sample
▬	U100 Horizontal Sample	≀	Water Seepage
		←	N - Schmidt Hammer Test

SKETCH PLAN



SKETCH SECTION



REMARKS

1. Average depth 1.50m.
2. No seepage observed.
3. Shoring installed at 1.50m depth (maximum).
4. Trial pit remained stable during excavation.

PRELIMINARY

Lam

TRIAL PIT RECORD

TRIAL PIT No. **TP2**

PROJECT No. **LG24009/25**

PROJECT **PO No. 4500291694 Castle Peak Power Station Geotechnical Survey**

CO-ORDINATES E **809916.37** N **825981.71**

GROUND LEVEL **+6.30** mPD

LOGGED **H.K.Fung** DATE **18/11/2005**

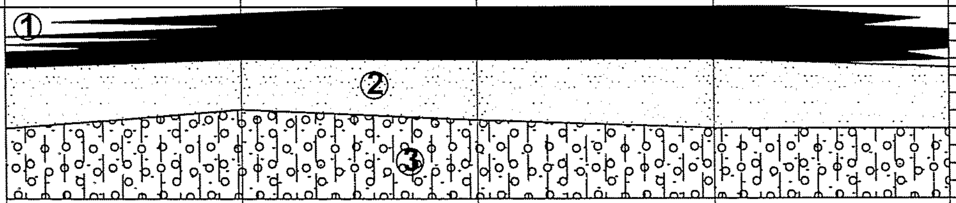
CHECKED **I.S.McGlen** DATE **21/11/2005**

EXCAVATION DATE **17/11/2005** to **17/11/2005**

BACKFILL DATE

Sample & Tests | Sample Depth (m)

Sketch: Face A 1.50 m | Face B 1.50 m | Face C 1.50 m | Face D 1.50 m

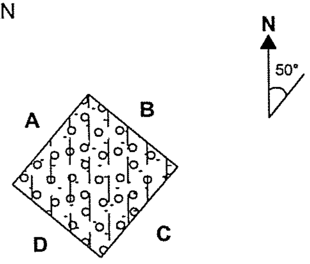


Depth (m)	Legend (Face D)	Grade	Description
0.35	▨		① Medium dense, black, COAL, ash and fragments (FILL)
0.70	▨		② Dense, light grey, CEMENT and SAND cushion (FILL)
1.10	▨		③ Medium dense, brownish yellow, very silty sandy angular fine to coarse GRAVEL sized strong rock fragments with occasional plastic fragments (FILL)

SYMBOL

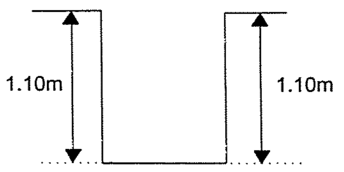
●	Small Disturbed Sample	¦	Large Disturbed Sample
▥	U76 Vertical Sample	☒	Block Sample
▨	U76 Horizontal Sample	⊤	In-situ Density Test
▮	U100 Vertical Sample	▲	Water Sample
▬	U100 Horizontal Sample	≀	Water Seepage
		⌐	N - Schmidt Hammer Test

SKETCH PLAN



SKETCH SECTION

Section A-C 140°



REMARKS

1. Average depth 1.10m.
2. No seepage observed.
3. No shoring installed.
4. Trial pit remained stable during excavation.

PRELIMINARY

TRIAL PIT RECORD

TRIAL PIT No. **TP3**

PROJECT No. **LG24009/25**

PROJECT **PO No. 4500291694 Castle Peak Power Station Geotechnical Survey**

CO-ORDINATES E **809858.68** N **826086.46**

GROUND LEVEL **+6.28** mPD

LOGGED **H.K.Fung** DATE **18/11/2005**

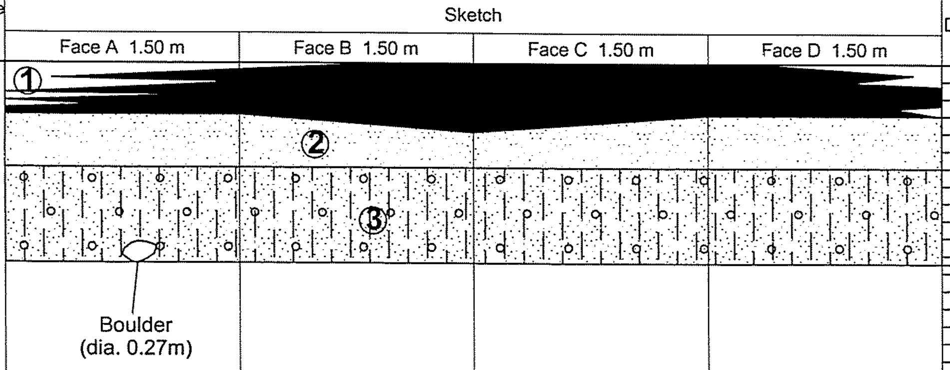
CHECKED **I.S.McGlen** DATE **21/11/2005**

EXCAVATION DATE **17/11/2005** to **17/11/2005**

BACKFILL DATE

Sample & Tests	Sample Depth (m)	Depth (m)	Legend (Face D)	Grade	Description
		0.30	▩		① Dense, black, COAL, ash and fragments (FILL)
		0.60	▩		② Dense, light grey, CEMENT and SAND cushion (FILL)
		1.15	▩		③ Medium dense, yellowish brown, very silty fine to coarse SAND with much angular fine to coarse gravel, cobble and occasional boulder sized up to 0.27m strong rock fragments (FILL)

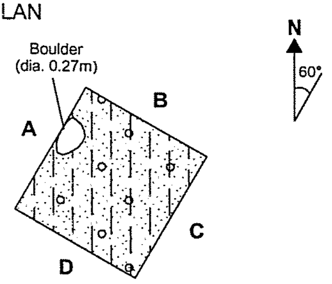
Sketch



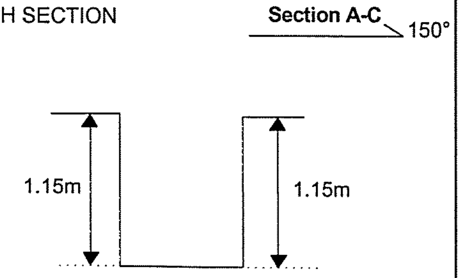
SYMBOL

●	Small Disturbed Sample	ǀ	Large Disturbed Sample
▥	U76 Vertical Sample	☒	Block Sample
▨	U76 Horizontal Sample	Ⴈ	In-situ Density Test
▮	U100 Vertical Sample	▲	Water Sample
▬	U100 Horizontal Sample	≷	Water Seepage
		↼	N - Schmidt Hammer Test

SKETCH PLAN



SKETCH SECTION



REMARKS

1. Average depth 1.15m.
2. No seepage observed.
3. No shoring installed.
4. Trial pit remained stable during excavation.

PRELIMINARY

TRIAL PIT RECORD

TRIAL PIT No. **TP4**

PROJECT No. **LG24009/25**

PROJECT **PO No. 4500291694 Castle Peak Power Station Geotechnical Survey**

CO-ORDINATES E **809837.61** N **826125.95** GROUND LEVEL **+6.06** mPD

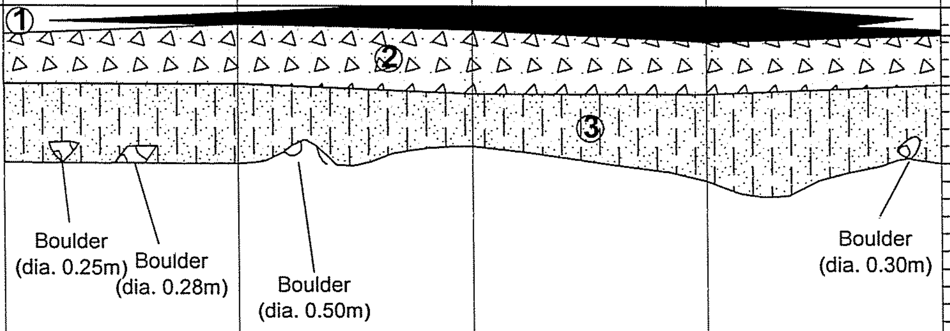
LOGGED **H.K.Fung** DATE **24/11/2005**

CHECKED **I.S.McGlen** DATE **28/11/2005**

EXCAVATION DATE **17/11/2005** to **23/11/2005**

BACKFILL DATE

Sketch

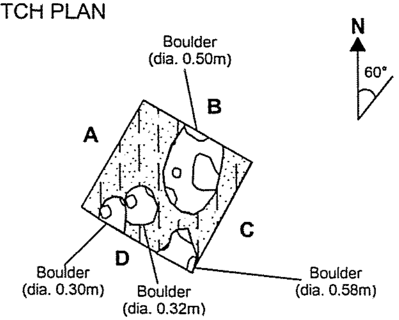


Sample & Tests	Sample Depth (m)	Depth (m)	Legend (Face D)	Grade	Description
		0.16	▨		① Black, COAL, ash and fragments (FILL)
		0.45	▨		② Dense, light grey, FUEL ASH fragments (FILL)
		0.90	▨		③ Loose, brownish yellow, very silty fine to coarse SAND with much angular cobble and boulder sized up to 0.50m strong rock fragments (FILL)

SYMBOL

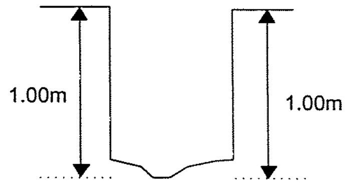
- ● Small Disturbed Sample
- U76 Vertical Sample
- U76 Horizontal Sample
- ▌ U100 Vertical Sample
- ▬ U100 Horizontal Sample
- Large Disturbed Sample
- ☒ Block Sample
- In-situ Density Test
- ▲ Water Sample
- Water Seepage
- N - Schmidt Hammer Test

SKETCH PLAN



SKETCH SECTION

Section A-C 150°



REMARKS

1. Average depth 1.00m.
2. No seepage observed.
3. No shoring installed.
4. Trial pit remained stable during excavation.

Annex E1c

Groundwater Monitoring Wells

GROUNDWATER WELL INSTALLATION

DH1

SOIL DESCRIPTION JOB TITLE 0024405 Land Contamination Study

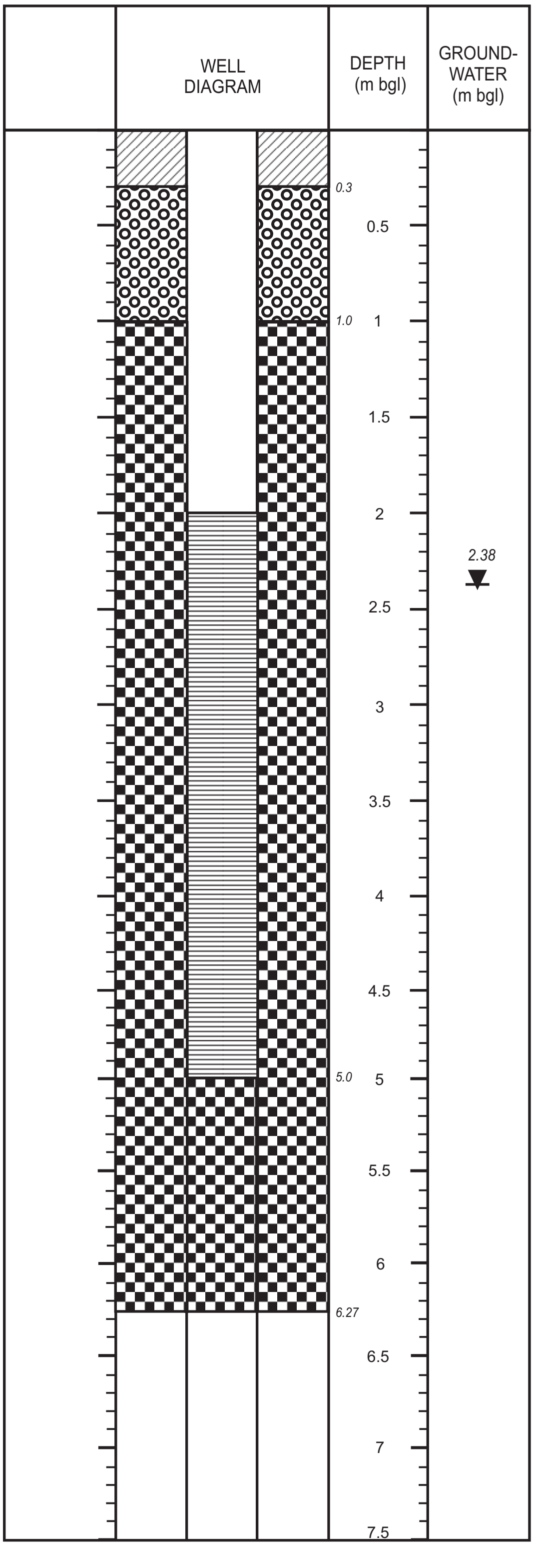
LOCATION Castle Peak, New Territories DATE 03 / 12 / 2005

COORDINATES N : 826128.17 E :809524.17 REFERENCE EL. + 5.05 mRD*

DRILL Rotory

DRILLER LAM LOG BY: Zoe Chan

ERM



Note : End of Drilling at 6.27m bgl.

LEGEND

- ⊙⊙ = BENTONITE
- ▨ = GROUT
- ▚ = SAND PACK
- ☰ = SCREEN
- ▽ = FIRST APPEARANCE LEVEL
- ▼ = STATIC GROUNDWATER LEVEL

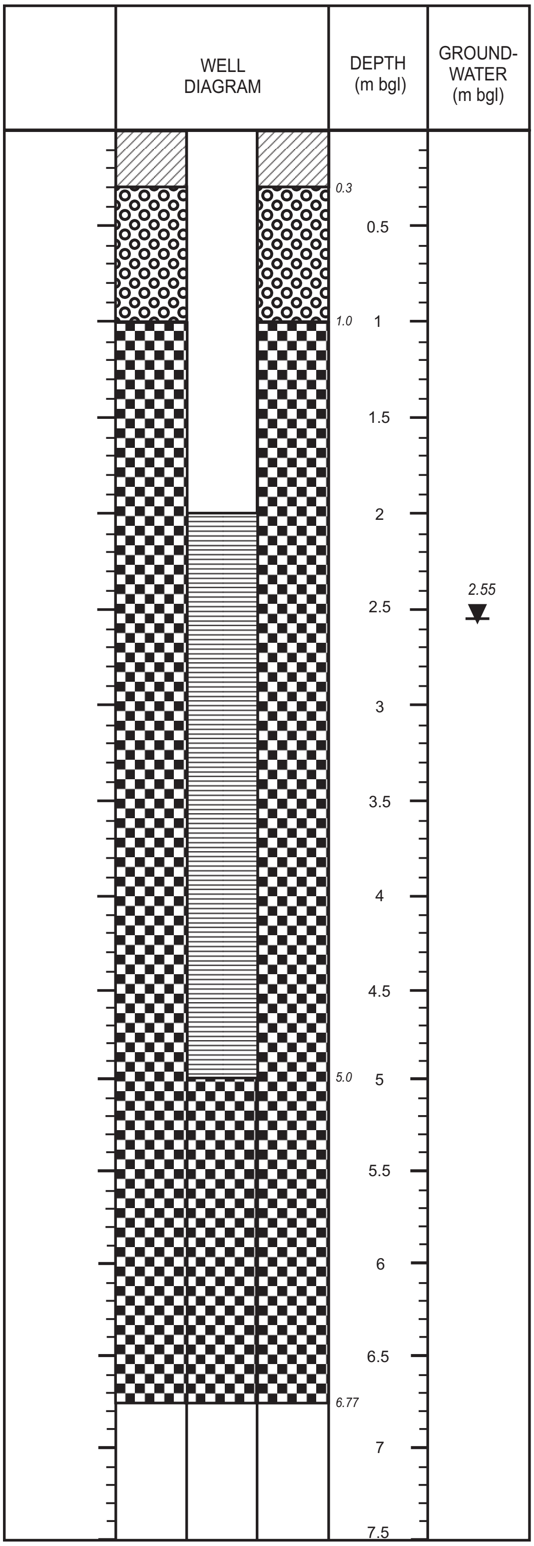
FILE: 0024405i4
DATE: 11/01/2006

GROUNDWATER WELL INSTALLATION

DH2

SOIL DESCRIPTION
JOB TITLE 0024405 Land Contamination Study
LOCATION Castle Peak, New Territories
DATE 02 / 12 / 2005
COORDINATES N : 826138.36 E :809543.86
REFERENCE EL. + 5.12 mRD*
DRILL Rotory
DRILLER LAM
LOG BY: Jane Lin

ERM



Note : End of Drilling at 6.77m bgl.

LEGEND

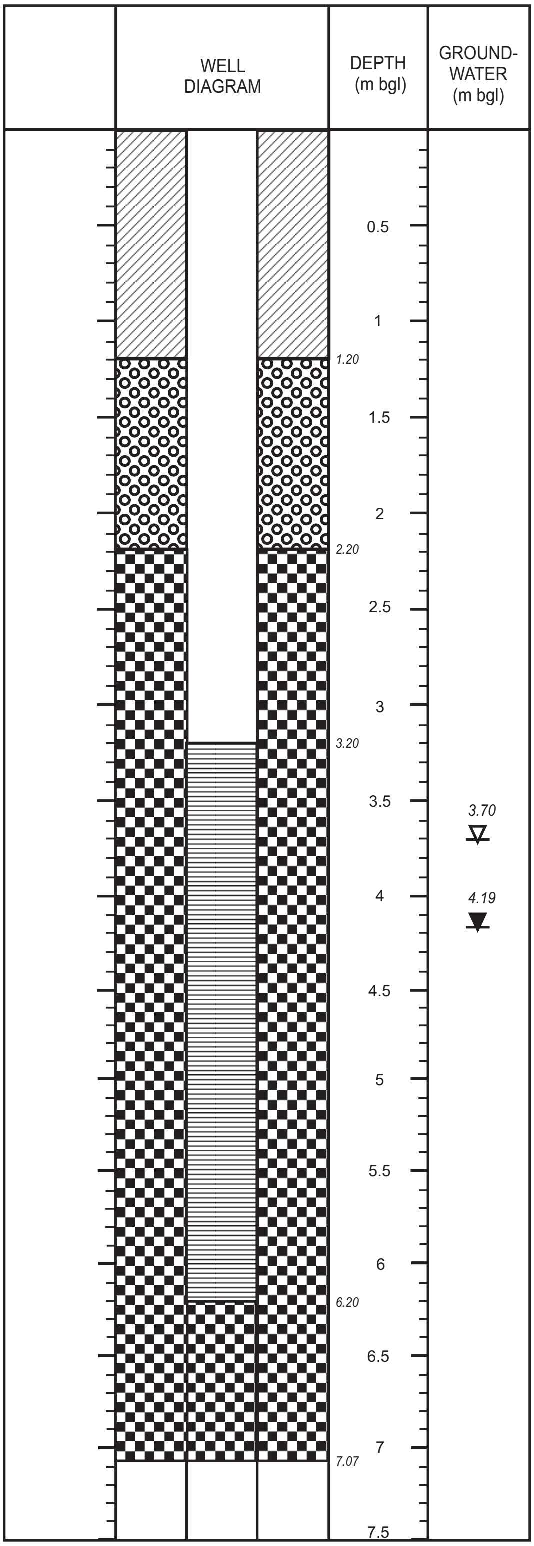
- ⦾ = BENTONITE
- ▨ = GROUT
- ▦ = SAND PACK
- ☰ = SCREEN
- ▽ = FIRST APPEARANCE LEVEL
- ▼ = STATIC GROUNDWATER LEVEL

GROUNDWATER WELL INSTALLATION

DH3

SOIL DESCRIPTION JOB TITLE 0024405 Land Contamination Study
LOCATION Castle Peak, New Territories DATE 05 / 12 / 2005
COORDINATES N : 826186.05 E :809873.45 REFERENCE EL. + 7.00 mRD*
DRILL Rotory
DRILLER LAM LOG BY: Zoe Chan

ERM



Note : End of Drilling at 7.07m bgl.

LEGEND

- ⊚ = BENTONITE
- ▨ = GROUT
- ▦ = SAND PACK
- ☰ = SCREEN
- ▽ = FIRST APPEARANCE LEVEL
- ▼ = STATIC GROUNDWATER LEVEL

FILE: 0024405i5
DATE: 11/01/2006

GROUNDWATER WELL INSTALLATION

DH4

SOIL DESCRIPTION

JOB TITLE 0024405 Land Contamination Study

LOCATION Castle Peak, New Territories

DATE 01 / 12 / 2005

COORDINATES N : 826137.28 E :809823.87

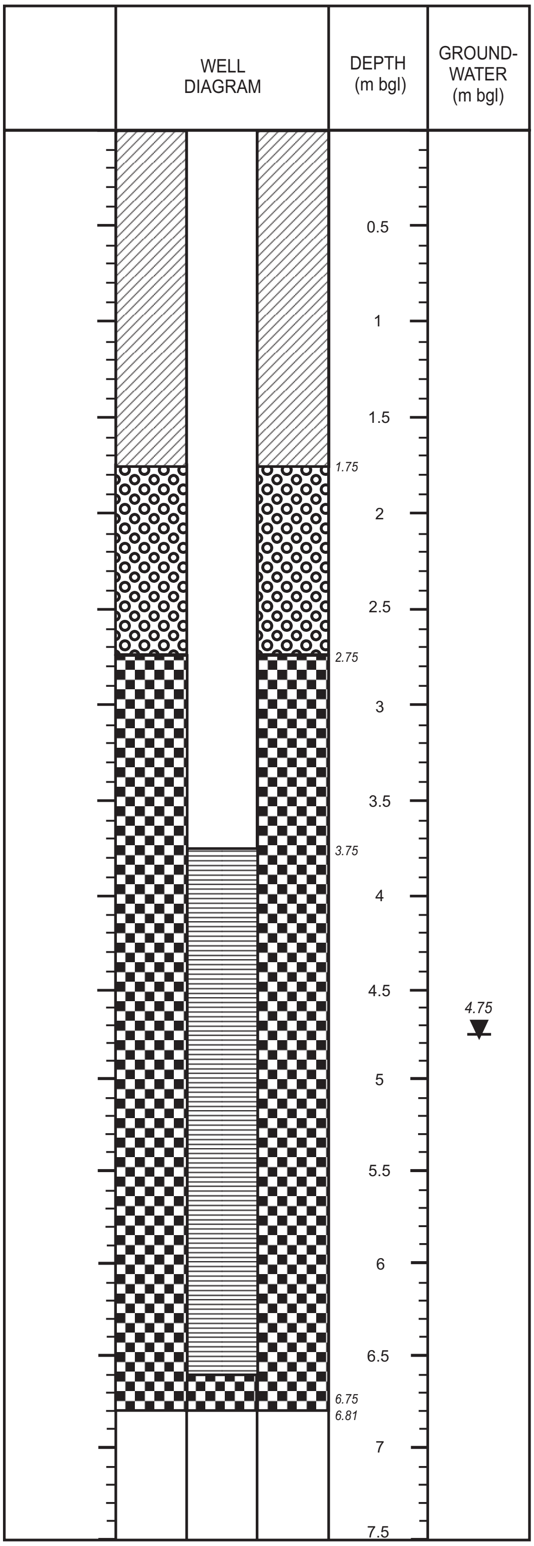
REFERENCE EL. + 6.01 mRD*

DRILL Rotory

DRILLER LAM

LOG BY: Jane Lin

ERM



Note : End of Drilling at 6.81m bgl.

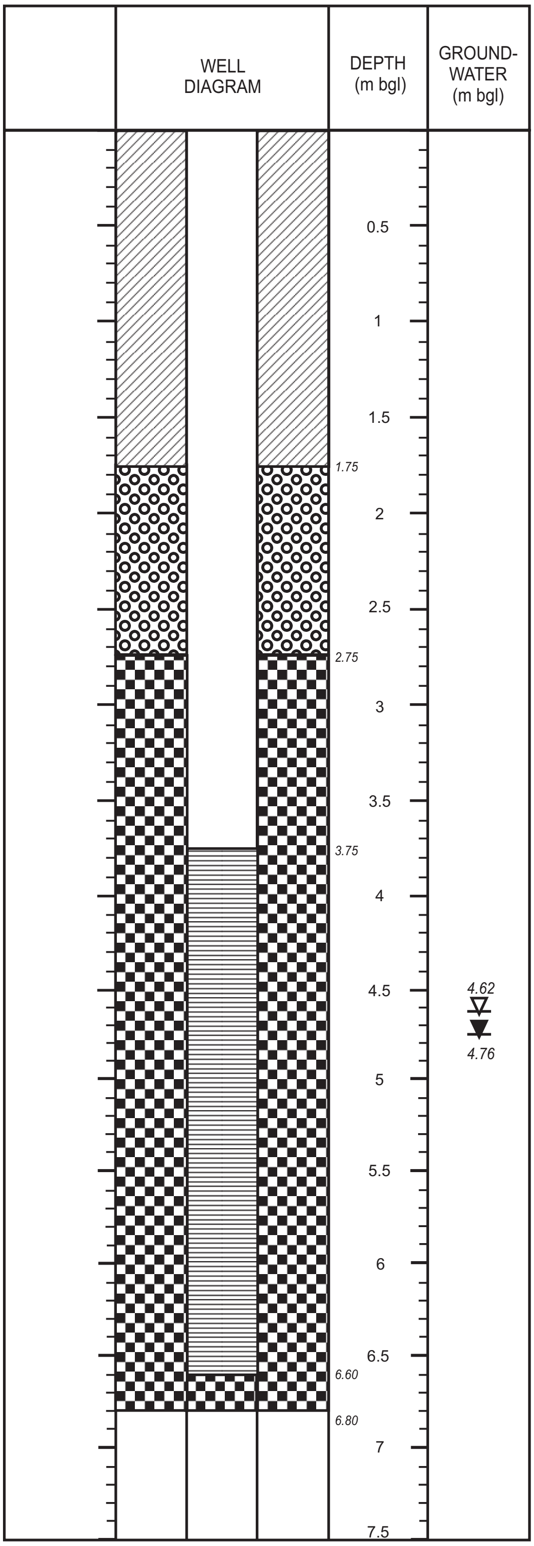
LEGEND

- ⦾ = BENTONITE
- ▨ = GROUT
- ▦ = SAND PACK
- ☰ = SCREEN
- ▽ = FIRST APPEARANCE LEVEL
- ▼ = STATIC GROUNDWATER LEVEL

GROUNDWATER WELL INSTALLATION

DH5

SOIL DESCRIPTION
JOB TITLE 0024405 Land Contamination Study
LOCATION Castle Peak, New Territories
DATE 01 / 12 / 2005
COORDINATES N : 826111.57 E :809853.93
REFERENCE EL. + 6.01 mRD*
DRILL Rotory
DRILLER LAM
LOG BY: Jane Lin



Note : End of Drilling at 6.80m bgl.

LEGEND

- ▨ = BENTONITE
- ▨ = GROUT
- ▦ = SAND PACK
- ▤ = SCREEN
- ▽ = FIRST APPEARANCE LEVEL
- ▼ = STATIC GROUNDWATER LEVEL

FILE: 0024405i8
DATE: 11/01/2006

GROUNDWATER WELL INSTALLATION

DH6

SOIL DESCRIPTION JOB TITLE 0024405 Land Contamination Study

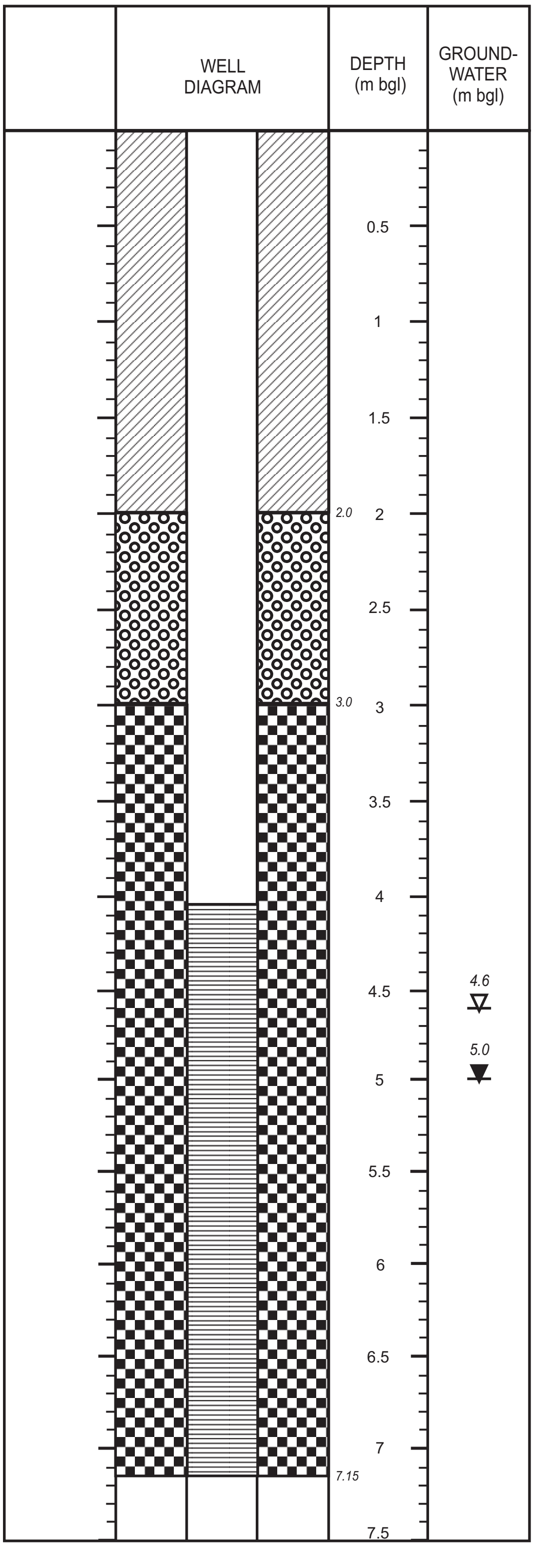
LOCATION Castle Peak, New Territories DATE 30 / 11 / 2005

COORDINATES N : 825972.60 E :809921.15 REFERENCE EL. + 6.23 mRD*

DRILL Rotory

DRILLER LAM LOG BY: Zoe Chan

ERM



Note : End of Drilling at 7.15m bgl.

LEGEND

- ⦾ = BENTONITE
- ▨ = GROUT
- ▦ = SAND PACK
- ☰ = SCREEN
- ▽ = FIRST APPEARANCE LEVEL
- ▼ = STATIC GROUNDWATER LEVEL

FILE: 0024405i1
DATE: 11/01/2006

GROUNDWATER WELL INSTALLATION

DH7

SOIL DESCRIPTION JOB TITLE 0024405 Land Contamination Study

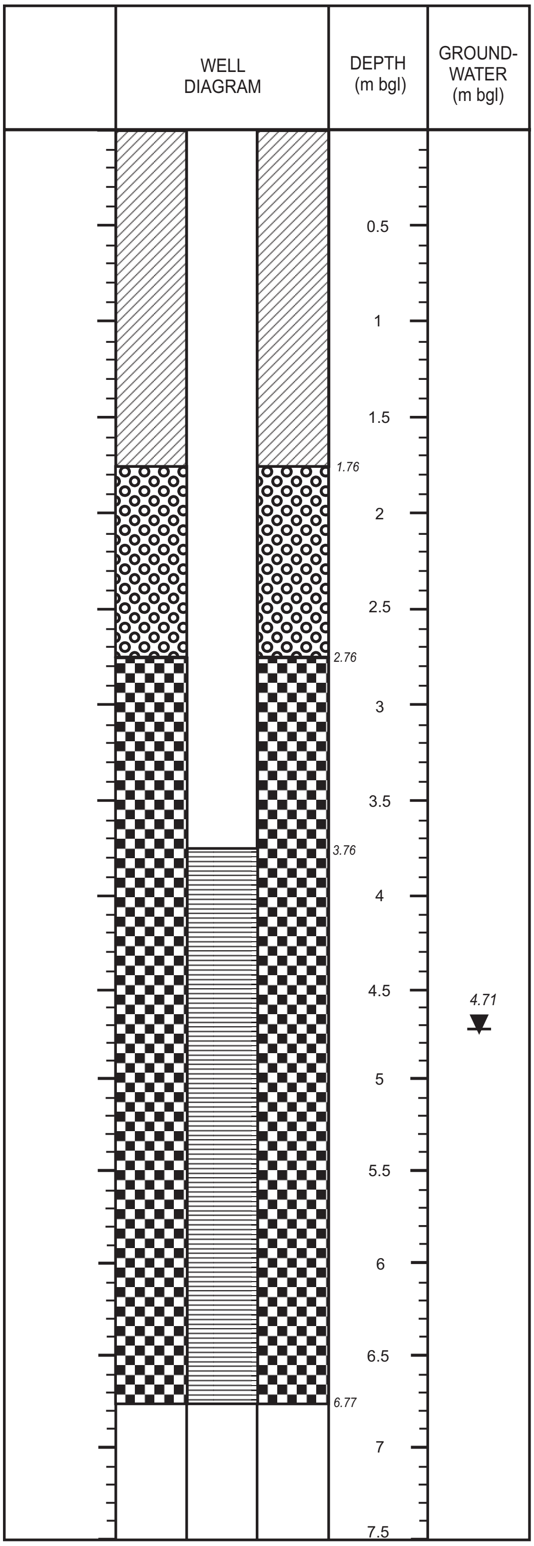
LOCATION Castle Peak, New Territories DATE 30 / 11 / 2005

COORDINATES N : 825918.58 E :809950.96 REFERENCE EL. + 6.67 mRD*

DRILL Rotory

DRILLER LAM LOG BY: Zoe Chan

ERM



Note : End of Drilling at 6.77m bgl.

LEGEND

- ⦾ = BENTONITE
- ▨ = GROUT
- ▚ = SAND PACK
- ☰ = SCREEN
- ▽ = FIRST APPEARANCE LEVEL
- ▼ = STATIC GROUNDWATER LEVEL

FILE: 0024405i2
DATE: 11/01/2006

GROUNDWATER WELL INSTALLATION

DH8

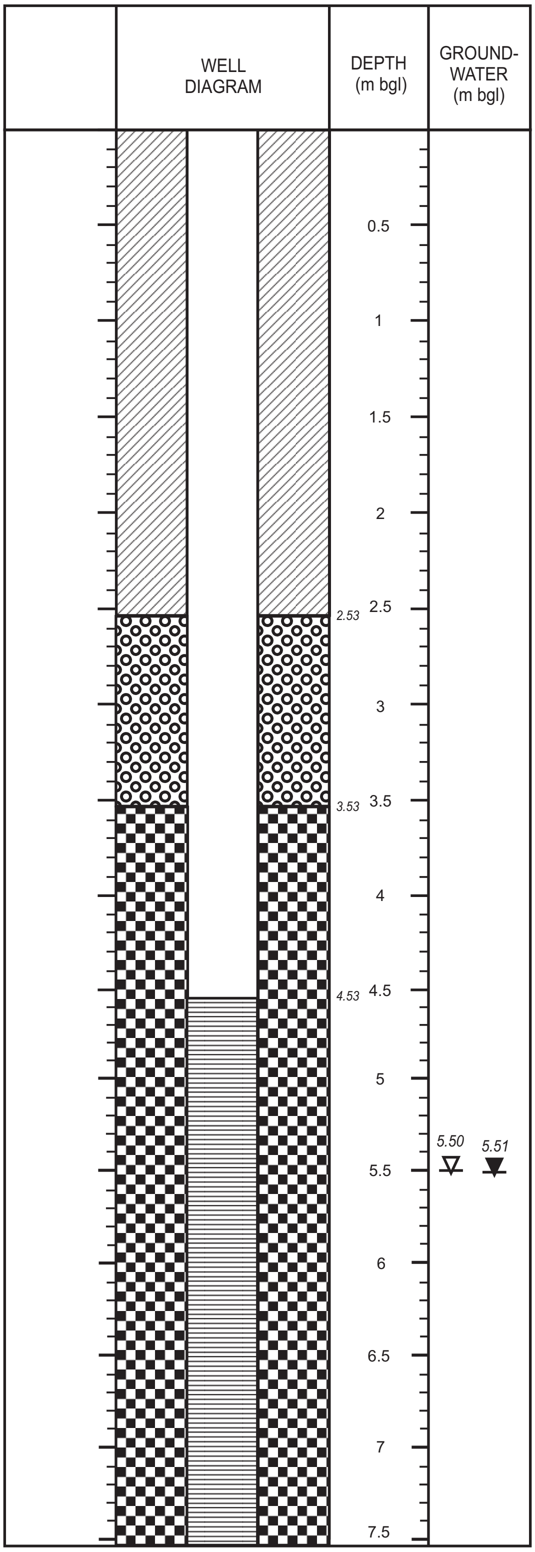
SOIL DESCRIPTION JOB TITLE 0024405 Land Contamination Study

LOCATION Castle Peak, New Territories DATE 08 / 12 / 2005

COORDINATES N : 825975.56 E :809968.82 REFERENCE EL. + 7.07 mRD*

DRILL Rotory

DRILLER LAM LOG BY: Zoe Chan



Note : End of Drilling at 7.53m bgl.

LEGEND

- ◎ = BENTONITE
- ▨ = GROUT
- ▚ = SAND PACK
- ☰ = SCREEN
- ▽ = FIRST APPEARANCE LEVEL
- ▼ = STATIC GROUNDWATER LEVEL

FILE: 0024405i6
DATE: 11/01/2006

Annex E1d

Selected Site Photographs

SELECTED PHOTOGRAPHS FROM THE SITE INVESTIGATION AT CASTLE PEAK POWER STATION

Photo 1 – Land contamination investigation at locations DH6 and DH7.

Photo 2 – Land contamination investigation at location DH2.

Photo 3 - Temporary groundwater sampling well installation at DH8.

Photo 4 – Temporary groundwater sampling well installed at location DH2.

Photo 5 - Temporary groundwater sampling well installed at location DH3.

Photo 6 – Well development at location DH8.

Photo 7 – Reinstated land contamination location DH5.

Photo 8 - Reinstated land contamination location DH4.

Photo 9 – Reinstated land contamination location DH7.

Annex E1e

Laboratory Reports

Annex E1e - Laboratory Results (SOIL)

				HK47528-3	HK47528-4	HK47528-7	HK47528-5	HK47528-6	HK47636-3	HK47636-4	HK47662-7	HK47755-3
				TP1	TP2	TP2 (duplicate)	TP3	TP4	DH1	DH2	DH3	DH8
				1.5M	0.8M	0.8M	0.9M	0.7M	0.6M	0.6M	0.8M	0.8M
				30/11/2005	30/11/2005	30/11/2005	30/11/2005	30/11/2005	01/12/2005	01/12/2005	02/12/2005	06/12/2005
	Analysis Description	**Unit**	**LOR**									
EA055	Moisture Content (dried @ 103'C)	%	0.1	6.9	4.3	4.5	6.6	5.0	10.1	8.5	7.7	4.3
EP071	**TOTAL PETROLEUM HYDROCARBONS**											
	C6 - C9 Fraction	mg/kg	2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	C10 - C14 Fraction	mg/kg	50	<50	<50	<50	83	<50	<50	<50	<50	<50
	C15 - C28 Fraction	mg/kg	100	<100	<100	<100	1170	<100	<100	<100	<100	<100
	C29 - C36 Fraction	mg/kg	100	<100	<100	<100	605	<100	<100	<100	<100	<100
EP074A	**MONOCYCLIC AROMATIC HYDROCARBONS**											
	Benzene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Toluene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Ethylbenzene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	meta- & para-Xylene	mg/kg	1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	ortho-Xylene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
EP074F	**HALOGENATED AROMATIC HYDROCARBONS**											
	Chlorobenzene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
EP075B	**POLYNUCLEAR AROMATICS**											
	Naphthalene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	2-Methylnaphthalene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	2-Chloronaphthalene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Acenaphthylene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Acenaphthene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Fluorene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Phenanthrene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Anthracene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Fluoranthene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Pyrene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	N-2-Fluorenylacetamide	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Benz(a)anthracene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Chrysene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Benzo(b) & (k)fluoranthene	mg/kg	1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	7.12-Dimethylbenz(a)anthracene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Benzo(a)pyrene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	3-Methylcholanthrene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Indeno(1.2.3-cd)pyrene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Dibenz(a.h)anthracene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Benzo(g.h.i)perylene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
EP074A	**MONOCYCLIC AROMATIC HYDROCARBONS**											
	Styrene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Isopropylbenzene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	n-Propylbenzene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	1.3.5-Trimethylbenzene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	tert-butylbenzene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	1.2.4-Trimethylbenzene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	sec-Butylbenzene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	p-Isopropyltoluene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	n-Butylbenzene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
EP074B	**OXYGENATED HYDROCARBONS**											
	Vinyl Acetate	mg/kg	5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	2-Butanone (MEK)	mg/kg	5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	4-Methyl-2-pentanone (MIBK)	mg/kg	5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	2-Hexanone (MBK)	mg/kg	5	<5	<5	<5	<5	<5	<5	<5	<5	<5
EP074C	**SULFONATED COMPOUNDS**											
	Carbon disulfide	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
EP074D	**FUMIGANTS**											
	2.2-Dichloropropane	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	1.2-Dichloropropane	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	cis-1.3-Dichloropropylene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	trans-1.3-Dichloropropylene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	1.2-Dibromoethane (EDB)	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
EP074E	**HALOGENATED ALIPHATIC HYDROCARBONS (VOL)**											
	1.1-Dichloroethene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	trans-1.2-Dichloroethene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	1.1-Dichloroethane	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	cis-1.2-Dichloroethene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	1.1.1-Trichloroethane	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	1.1-Dichloropropylene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Carbon tetrachloride	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	1.2-Dichloroethane	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Trichloroethene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Dibromomethane	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	1.1.2-Trichloroethane	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	1.3-Dichloropropane	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Tetrachloroethene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	1.1.1.2-Tetrachloroethane	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	1.1.2.2-Tetrachloroethane	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	1.2.3-Trichloropropane	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	1.2-Dibromo-3-chloropropane	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Hexachlorobutadiene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
EP074F	**HALOGENATED AROMATIC HYDROCARBONS**											
	Bromobenzene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	2-Chlorotoluene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	4-Chlorotoluene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	1.3-Dichlorobenzene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	1.4-Dichlorobenzene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5

	1.2-Dichlorobenzene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	1.2.4-Trichlorobenzene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	1.2.3-Trichlorobenzene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
EP074G	**TRIHALOMETHANES (VOLATILES)**											
	Chloroform	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Bromodichloromethane	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Dibromochloromethane	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Bromoform	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
EP074H	**NAPHTHALENE**											
	Naphthalene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
EP075A	**PHENOLS**											
	Phenol	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	2-Chlorophenol	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	2-Methylphenol	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	4-Methylphenol	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	2-Nitrophenol	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	2.4-Dimethylphenol	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	2.4-Dichlorophenol	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	4-Chloro-3-methylphenol	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	2.4.6-Trichlorophenol	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	2.4.5-Trichlorophenol	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Pentachlorophenol	mg/kg	3	<3	<3	<3	<3	<3	<3	<3	<3	<3
EP075C	**PHTHALATE ESTERS**											
	Dimethyl phthalate	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Diethyl phthalate	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Di-n-butyl phthalate	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Butyl benzyl phthalate	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Bis(2-ethylhexyl) phthalate	mg/kg	5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	Di-n-octylphthalate	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
EP075D	**NITROSAMINES**											
	N-Nitrosomethylethylamine	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	N-Nitrosodiethylamine	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	N-Nitrosopyrrolidine	mg/kg	1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	N-Nititrosomorpholine	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	N-Nitrosodi-n-propylamine	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	N-Nitrosopiperidine	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	N-Nitrosodibutylamine	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	N-Nitrosodiphenyl & Diphenylamine	mg/kg	1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Diallate	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Methapyrilene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
EP075E	**NITROAROMATICS AND CYCLIC KETONES**											
	2-Picoline	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Acetophenone	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Nitrobenzene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Isophorone	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	2.6-Dinitrotoluene	mg/kg	1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	2.4-Dinitrotoluene	mg/kg	1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	1-Naphthylamine	mg/kg	1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	4-Nitroquinoline-N-oxide	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	5-Nitro-o-toluidine	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Azobenzene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	1.3.5-Trinitrobenzene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Phenacetin	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	4-Aminobiphenyl	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Pentachloronitrobenzene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Pronamide	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Dimethylaminoazobenzene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Chlorobenzilate	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
EP075F	**HALOETHERS**											
	Bis(2-chloroethyl) ether	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Bis(2-chloroethoxy) methane	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	4-Chlorophenyl phenyl ether	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	4-Bromophenyl phenyl ether	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
EP075G	**CHLORINATED HYDROCARBONS**											
	1.3-Dichlorobenzene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	1.4-Dichlorobenzene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	1.2-Dichlorobenzene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Hexachloroethane	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	1.2.4-Trichlorobenzene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Hexachloropropylene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Hexachlorobutadiene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Hexachlorocyclopentadiene	mg/kg	3	<3	<3	<3	<3	<3	<3	<3	<3	<3
	Pentachlorobenzene	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Hexachlorobenzene	mg/kg	1	<1	<1	<1	<1	<1	<1	<1	<1	<1
EP075H	**ANILINES AND BENZIDINES**											
	Aniline	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	4-Chloroaniline	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	2-Nitroaniline	mg/kg	1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	3-Nitroaniline	mg/kg	1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Dibenzofuran	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	4-Nitroaniline	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Carbazole	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	3.3'-Dichlorobenzidine	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
EP075I	**ORGANOCHLORINE PESTICIDES**											
	alpha-BHC	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	beta-BHC & gamma-BHC	mg/kg	1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	delta-BHC	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5

	Heptachlor	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Aldrin	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Heptachlor epoxide	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Endosulfan 1	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	4.4'-DDE	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Dieldrin	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Endrin	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Endosulfan 11	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	4.4'-DDD	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Endosulfan sulfate	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	4.4'-DDT	mg/kg	1	<1	<1	<1	<1	<1	<1	<1	<1	<1
EP075J	**ORGANOPHOSPHORUS PESTICIDES**											
	Methanesulfonate methyl	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Methanesulfonate ethyl	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Dichlorvos	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	cis-Isosafrole	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	trans-Isosafrole	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Safrole	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Dimethoate	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Diazinon	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Chlorpyrifos methyl	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Malathion	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Fenthion	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Chlorpyrifos	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Pirimiphos ethyl	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Chlorfenvinphos-E	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Chlorfenvinphos-Z	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Prothiofos	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Ethion	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5

Annex E1e - Laboratory Results (WATER)

WATER	Analysis Description	Unit	LOR	HK47734-1*	HK47734-2	HK47770-1	HK47662-1*	HK47662-2*	HK47662-3*	HK47662-5*	HK47662-4*	HK47802-1*	HK47528-1**	HK47636-1**	HK47755-1**	HK47528-2**	HK47636-2**	HK47662-6	HK47734-3	HK47755-2**	HK47770-2	HK47802-2
				DH1	DH2	DH3	DH4	DH5	DH6	DH6 (dupllicate)	DH7	DH8	EQ BLK 1	EQ BLK 2	EQ BLK 3	TRIP BLANK	TRIP BLANK	TRIP BLANK 3	TRIP BLANK 4	TRIP BLANK 5	TRIP BLANK 6	TRIP BLANK 7
				05/12/2005	05/12/2005	07/12/2005	02/12/2005	02/12/2005	02/12/2005	02/12/2005	02/12/2005	08/12/2005	30/11/2005	01/12/2005	06/12/2005	30/11/2005	01/12/2005	02/12/2005	05/12/2005	06/12/2005	07/12/2005	08/12/2005
EA002	pH Value @ 25'C		0.1	7.2	6.4	7.9	7.4	7.6	7.6	7.6	7.4	7.7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
EP071	**TOTAL PETROLEUM HYDROCARBONS**																					
	C6 - C9 Fraction	ug/L	20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	22	<20	<20	<20	<20	<20	<20	<20
	C10 - C14 Fraction	ug/L	50	63	91	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
	C15 - C28 Fraction	ug/L	100	1460	2590	1590	712	1400	733	613	1560	125	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
	C29 - C36 Fraction	ug/L	50	<50	78	1490	368	1720	77	79	62	79	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
EP074A	**MONOCYCLIC AROMATIC HYDROCARBONS**																					
	Benzene	ug/L	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
EP074F	**HALOGENATED AROMATIC HYDROCARBONS (VOL)**																					
	Chlorobenzene	ug/L	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
EP074A	**MONOCYCLIC AROMATIC HYDROCARBONS**																					
	Toluene	ug/L	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	22	<5	<5	<5	<5	<5	<5	<5
	Ethylbenzene	ug/L	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	meta- & para-Xylene	ug/L	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
	ortho-Xylene	ug/L	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
EP075B	**POLYNUCLEAR AROMATICS**																					
	Naphthalene	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	2-Methylnaphthalene	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	2-Chloronaphthalene	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Acenaphthylene	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Acenaphthene	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Fluorene	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Phenanthrene	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Anthracene	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Fluoranthene	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Pyrene	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	N-2-Fluorenylacetamide	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Benz(a)anthracene	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Chrysene	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Benzo(b) & (k)fluoranthene	ug/L	4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
	7.12-Dimethylbenz(a)anthracene	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Benzo(a)pyrene	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	3-Methylcholanthrene	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Indeno(1.2.3-cd)pyrene	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Dibenz(a.h)anthracene	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Benzo(g.h.i)perylene	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
EP074A	**MONOCYCLIC AROMATIC HYDROCARBONS**																					
	Styrene	ug/L	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	Isopropylbenzene	ug/L	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	n-Propylbenzene	ug/L	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	1.3.5-Trimethylbenzene	ug/L	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	tert-Butylbenzene	ug/L	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	1.2.4-Trimethylbenzene	ug/L	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	sec-butylbenzene	ug/L	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	p-Isopropyltoluene	ug/L	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	n-Butylbenzene	ug/L	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
EP074B	**OXYGENATED HYDROCARBONS**																					
	Vinyl acetate	ug/L	50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
	2-Butanone (MEK)	ug/L	50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
	4-Methyl-2-pentanone (MIBK)	ug/L	50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
	2-Hexanone (MBK)	ug/L	50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
EP074C	**SULFONATED COMPOUNDS**																					
	Carbon disulfide	ug/L	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
EP074D	**FUMIGANTS**																					
	2.2-Dichloropropane	ug/L	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	1.2-Dichloropropane	ug/L	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	cis-1.3-Dichloropropylene	ug/L	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	trans-1.3-Dichloropropylene	ug/L	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	1.2-Dibromoethane (EDB)	ug/L	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
EP074E	**HALOGENATED ALIPHATIC HYDROCARBONS(VOL)**																					
	1.1-Dichloroethene	ug/L	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	trans-1.2-Dichloroethene	ug/L	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	1.1-Dichloroethane	ug/L	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	cis-1.2-Dichloroethene	ug/L	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	1.1.1-Trichloroethane	ug/L	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	1.1-Dichloropropylene	ug/L	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	Carbon tetrachloride	ug/L	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5

WATER	Analysis Description	Unit	LOR	HK47734-1*	HK47734-2	HK47770-1	HK47662-1*	HK47662-2*	HK47662-3*	HK47662-5*	HK47662-4*	HK47802-1*	HK47528-1**	HK47636-1**	HK47755-1**	HK47528-2**	HK47636-2**	HK47662-6	HK47734-3	HK47755-2**	HK47770-2	HK47802-2
				DH1	DH2	DH3	DH4	DH5	DH6	DH6 (dupllicate)	DH7	DH8	EQ BLK 1	EQ BLK 2	EQ BLK 3	TRIP BLANK	TRIP BLANK	TRIP BLANK 3	TRIP BLANK 4	TRIP BLANK 5	TRIP BLANK 6	TRIP BLANK 7
				05/12/2005	05/12/2005	07/12/2005	02/12/2005	02/12/2005	02/12/2005	02/12/2005	02/12/2005	08/12/2005	30/11/2005	01/12/2005	06/12/2005	30/11/2005	01/12/2005	02/12/2005	05/12/2005	06/12/2005	07/12/2005	08/12/2005
	1.2-Dichloroethane	ug/L	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	Trichloroethene	ug/L	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	Dibromomethane	ug/L	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	1.1.2-Trichloroethane	ug/L	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	1.3-Dichloropropane	ug/L	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	Tetrachloroethene	ug/L	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	1.1.1.2-Tetrachloroethane	ug/L	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	1.1.2.2-Tetrachloroethane	ug/L	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	1.2.3-Trichloropropane	ug/L	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	1.2-Dibromo-3-chloropropane	ug/L	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	Hexachlorobutadiene	ug/L	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
EP074F	**HALOGENATED AROMATIC HYDROCARBONS (VOL)**																					
	Bromobenzene	ug/L	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	2-Chlorotoluene	ug/L	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	4-Chlorotoluene	ug/L	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	1.3-Dichlorobenzene	ug/L	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	1.4-Dichlorobenzene	ug/L	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	1.2-Dichlorobenzene	ug/L	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	1.2.4-Trichlorobenzene	ug/L	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	1.2.3-Trichlorobenzene	ug/L	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
EP074G	**TRIHALOMETHANES (VOLATILES)**																					
	Chloroform	ug/L	5	<5	<5	8	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	Bromodichloromethane	ug/L	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	Dibromochloromethane	ug/L	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	Bromoform	ug/L	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
EP074H	**NAPHTHALENE**																					
	Naphthalene	ug/L	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
EP075A	**PHENOLS**																					
	Phenol	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	8	<2	<2	<2	<2	<2	<2	<2
	2-Chlorophenol	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	2-Methylphenol	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	4-Methylphenol	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	2-Nitrophenol	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	2.4-Dimethylphenol	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	2.4-Dichlorophenol	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	4-Chloro-3-methylphenol	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	2.4.6-Trichlorophenol	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	2.4.5-Trichlorophenol	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Pentachlorophenol	ug/L	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
EP075C	**PHTHALATE ESTERS**																					
	Dimethyl phthalate	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Diethyl phthalate	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Di-n-butyl phthalate	ug/L	2	44	132	66	31	459	47	42	57	46	<2	<2	<2	<2	<2	<2	5	<2	<2	<2
	Butyl benzyl phthalate	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Bis(2-ethylhexyl)phthalate	ug/L	20	<20	<20	32	<20	21	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
	Di-n-octyl phthalate	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
EP075D	**NITROSAMINES**																					
	N-Nitrosomethylethylamine	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	N-Nitrosodiethylamine	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	N-Nitrosopyrrolidine	ug/L	4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
	N-Nititrosomorpholine	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	N-Nitrosodi-n-propylamine	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	N-Nitrosopiperidine	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	N-Nitrosodibutylamine	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	N-Nitrosodiphenyl & Diphenylamine	ug/L	4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
	Diallate	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Methapyrilene	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
EP075E	**NITROAROMATICS AND CYCLIC KETONES**																					
	2-Picoline	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Acetophenone	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Nitrobenzene	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Isophorone	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	2.6-Dinitrotoluene	ug/L	4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
	2.4-Dinitrotoluene	ug/L	4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
	1-Naphthylamine	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	4-Nitroquinoline-N-oxide	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	5-Nitro-o-toluidine	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Azobenzene	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	1.3.5-Trinitrobenzene	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Phenacetin	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2

WATER	Analysis Description	Unit	LOR	HK47734-1*	HK47734-2	HK47770-1	HK47662-1*	HK47662-2*	HK47662-3*	HK47662-5*	HK47662-4*	HK47802-1*	HK47528-1**	HK47636-1**	HK47755-1**	HK47528-2**	HK47636-2**	HK47662-6	HK47734-3	HK47755-2**	HK47770-2	HK47802-2
				DH1	DH2	DH3	DH4	DH5	DH6	DH6 (dupllicate)	DH7	DH8	EQ BLK 1	EQ BLK 2	EQ BLK 3	TRIP BLANK	TRIP BLANK	TRIP BLANK 3	TRIP BLANK 4	TRIP BLANK 5	TRIP BLANK 6	TRIP BLANK 7
				05/12/2005	05/12/2005	07/12/2005	02/12/2005	02/12/2005	02/12/2005	02/12/2005	02/12/2005	08/12/2005	30/11/2005	01/12/2005	06/12/2005	30/11/2005	01/12/2005	02/12/2005	05/12/2005	06/12/2005	07/12/2005	08/12/2005
	4-Aminobiphenyl	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Pentachloronitrobenzene	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Pronamide	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Dimethylaminoazobenzene	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Chlorobenzilate	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
EP075F	**HALOETHERS**																					
	Bis(2-chloroethyl) ether	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Bis(2-chloroethoxy) methane	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	4-Chlorophenyl phenyl ether	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	4-Bromophenyl phenyl ether	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
EP075G	**CHLORINATED HYDROCARBONS**																					
	1.3-Dichlorobenzene	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	1.4-Dichlorobenzene	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	1.2-Dichlorobenzene	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Hexachloroethane	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	1.2.4-Trichlorobenzene	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Hexachloropropylene	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Hexachlorobutadiene	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Hexachlorocyclopentadiene	ug/L	10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
	Pentachlorobenzene	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Hexachlorobenzene	ug/L	4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
EP075H	**ANILINES AND BENZIDINES**																					
	Aniline	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	4-Chloroaniline	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	2-Nitroaniline	ug/L	4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
	3-Nitroaniline	ug/L	4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
	Dibenzofuran	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	4-Nitroaniline	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Carbazole	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	3.3'-Dichlorobenzidine	ug/L	4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
EP075I	**ORGANOCHLORINE PESTICIDES**																					
	alpha-BHC	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	beta-BHC & gamma-BHC	ug/L	4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
	delta-BHC	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Heptachlor	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Aldrin	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Heptachlor epoxide	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Endosulfan 1	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	4.4'-DDE	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Dieldrin	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Endrin	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Endosulfan 11	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	4.4'-DDD	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Endosulfan sulfate	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	4.4'-DDT	ug/L	4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4
EP075J	**ORGANOPHOSPHORUS PESTICIDES**																					
	Methanesulfonate methyl	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Methanesulfonate ethyl	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Dichlorvos	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	cis-Isosafrole	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	trans-Isosafrole	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Safrole	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Dimethoate	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Diazinon	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Chlorpyrifos methyl	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Malathion	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Fenthion	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Chlorpyrifos	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Pirimiphos ethyl	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Chorfenvinphos-E	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Chlorfenvinphos-Z	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Prothiofos	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
	Ethion	ug/L	2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2

Remarks:

N/A: Testing is not required by the client

* Denotes particular samples required dilution prior to Metals analysis due to matrix inferences.

LOR values have been adjusted accordingly.

** Denotes samples were analysis on an as received basis for metals analysis.

Annex E1f

Dutch List

Appendix IV

Soil and ground water criteria used in The Netherlands for contaminated land ("Dutch List")

Component		Soil (mg/kg dry soil)			Ground water (ug/L)		
		A	B	C	A	B	C
1. Metals							
Cr		100	250	800	20	50	200
Co		20	50	300	20	50	200
Ni		50	100	500	20	50	200
Cu		50	100	500	20	50	200
Zn		200	500	3000	50	200	800
As		20	30	50	10	30	100
Mo		10	40	200	5	20	100
Cd		1	5	20	1	2.5	10
Sn		20	50	300	10	30	150
Ba		200	400	2000	50	100	500
Hg		0.5	2	10	0.2	0.5	2
Pb		50	150	600	20	50	200
2. Inorganics							
NH_4 (as N)		–	–	–	200	1000	3000
F (total)		200	400	2000	300	1200	4000
CN	(tot.free)	1	10	100	5	30	100
	(tot.comb.)	5	50	500	10	50	200
S (total)		2	20	200	10	100	300
Br (total)		20	50	300	100	500	2000
PO_4 (as P)		–	–	–	50	200	700
3. Aromatics Compounds							
Benzene		0.01	0.5	5	0.2	1	5
Ethylbenzene		0.05	5	50	0.5	20	60
Toluene		0.05	3	30	0.5	15	50
Xylenes		0.05	5	50	0.5	20	60
Phenols		0.02	1	10	0.5	15	50
Total		0.1	7	70	1	30	100
4. Polycyclic Hydrocarbons							
Naphthalene		0.1	5	50	0.2	7	30
Anthracene		0.1	10	100	0.1	2	10
Fenanthrene		0.1	10	100	0.1	2	10
Flouranthene		0.1	10	100	0.02	1	5
Pyrene		0.1	10	100	0.02	1	5
1,2–benzopyrene		0.05	1	10	0.01	0.2	1
Total		1	20	200	0.2	10	40
5. Chlorinated Hydrocarbons							
Aliphatics							
	(Individual)	0.1	5	50	1	10	50
	(Total)	0.1	7	70	1	15	70
Chlorobenzenes							
	(Individual)	0.05	1	10	0.02	0.5	2
	(Total)	0.05	2	20	0.02	1	5
Chlorophenols							
	(Individual)	0.01	0.5	5	0.01	0.3	1.5
	(Total)	0.01	1	10	0.01	0.5	2
Chlor. PAHs (Tot.)		0.05	1	10	0.01	0.2	1
PCB's (Tot.)		0.05	1	10	0.01	0.2	1
EOCL (Tot.)		0.1	8	80	1	15	70
6. Pesticides							
Chlorinated organics							
	(Individual)	0.1	0.5	5	0.5	0.2	1
	(Total)	0.1	1	10	0.1	0.5	2
Pesticides							
	(Total)	0.1	2	20	0.1	1	5
7. Other Pollutants							
Tetrahydrofuran		0.1	4	40	0.5	20	60
Pyridine		0.1	2	20	0.5	10	30
Tetrahydrothiofene		0.1	5	50	0.5	20	60
Cyclohexanes		0.1	6	60	0.5	15	50
Styrene		0.1	5	50	0.5	20	60
Gasoline		20	100	800	10	40	150
Mineral oil		100	1000	5000	20	200	600

These values are not "standards" but rather guidelines for use in assessing the significance of contaminated land. A simplified explanation of the ABC levels : A–level implies unpolluted, B–level implies pollution present and further investigation required, C–level implies significant pollution present and cleanup (preferably back to the A–level) required.

Annex F

Photomontage

EXISTING VIEW

VIEW SHOWING THE EXISTING POWER STATION WITH THE PROPOSED EMISSIONS CONTROL FACILITIES.

AERIAL PHOTOGRAPH DISPLAYING THE SITE AND VISUALLY SENSITIVE RECEIVER LOCATION.

VIEWPOINT 1 (VP1)
VIEW FROM URMSTON ROAD LOOKING NORTH

GPS: EASTING:	**810032.23944**
NORTHING:	**825168.47987**
GRID DATUM:	**HK 1980**

Figure F1

Photomontage - Viewpoint 1 (VP1)

FILE:0024405x1
DATE:08/06/2006

Environmental
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EXISTING VIEW

AERIAL PHOTOGRAPH DISPLAYING THE SITE AND VISUALLY SENSITIVE RECEIVER LOCATION.

VIEW SHOWING THE EXISTING POWER STATION WITH THE PROPOSED EMISSIONS CONTROL FACILITIES.

VIEWPOINT 2 (VP2)
VIEW FROM URMSTON ROAD LOOKING EAST

GPS: EASTING:	809281.75361
NORTHING:	825967.10472
GRID DATUM:	HK 1980

Figure F2

Photomontage - Viewpoint 2 (VP2)

FILE:0024405x2
DATE:31/07/2006

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