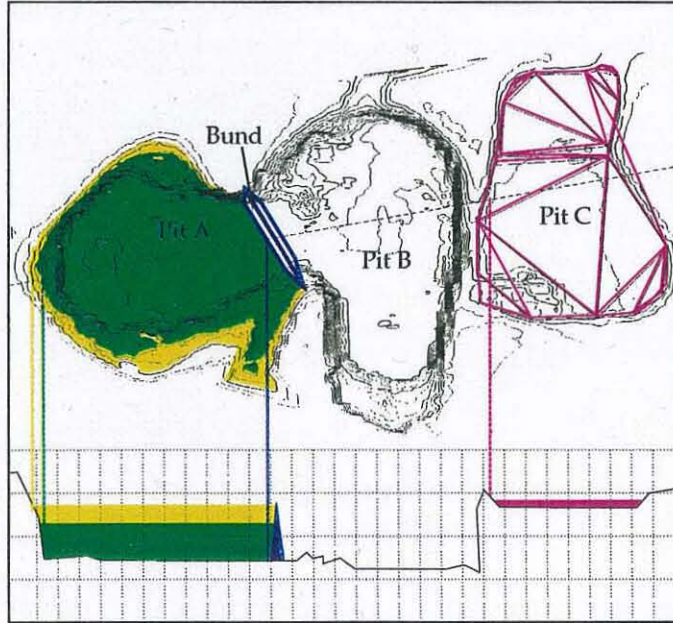


Civil Engineering Department



Environmental Impact Assessment Study for Disposal of Contaminated Mud in the East Sha Chau Marine Borrow Pit

3 March 1997

ERM-HONG KONG, LTD
6th Floor, Hecny Tower
9 Chatham Road, Tsimshatsui
Kowloon, Hong Kong
Telephone 2722 9700
Facsimile 2723 5660



CONSULTING SERVICES BY ENVIRONMENTAL RESOURCES MANAGEMENT

EIA-106.1
BC

Civil Engineering Department

Environmental Impact Assessment
Study for Disposal of Contaminated
Mud in the East Sha Chau Marine
Borrow Pit

3 March 1997

Reference C1501

For and on behalf of ERM-Hong Kong, Ltd

Approved by: S.M. Laister

Signed: [Signature]

Position: Deputy Managing Director

Date: 3rd March 1997

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PURPOSE & OBJECTIVES OF THE MANUAL

This document presents the Environmental Monitoring and Audit (EM&A) requirements for disposal of contaminated mud in the East Sha Chau Marine Borrow Pit. Effects of the works on sensitive receivers are monitored through investigation of water quality, seabed sediment toxicity, effects on benthic biota and demersal fish. Mitigation measures are provided when acceptable levels of impact are exceeded.

Hong Kong environmental regulations for water quality Hong Kong Planning Standards and Guidelines, and recommendations in the EIA study final report on ESC CMP IV have served as environmental standards and guidelines in the preparation of this Manual.

This Manual contains the following:

- duties of the Environmental Team with respect to the environmental monitoring and audit requirements during construction;
- information on project organisation and programming of activities for the project;
- requirements with respect to the project schedule and the necessary environmental monitoring and audit programme to track the varying environmental impact;
- definition of Action and Limit levels;
- establishment of Action/Event Plans;
- requirements for reviewing pollution sources and working procedures in the event of non-compliance with the environmental criteria; and
- requirements for presentation of environmental monitoring and audit data and appropriate reporting procedures.

The primary objectives of the EM&A programme are as follows:

- to determine if there is accumulation of contaminants in water, sediment and tissue of commercial species; and,
- to determine the extent and rate of recolonisation.

The impact hypothesis is defined for this project as follows:

*Impacts associated with disposal of contaminated mud in the East Sha Chau CMP IV are not expected to result in exceedances of water quality objectives at sensitive receivers nor cause exceedances of applicable water quality standards. The operational design has been specified such that disposal of sediments shall not cause a detectable deterioration in sediment quality outside the CMP IV. Physical impacts to fisheries and marine ecological sensitive receivers (eg *Sousa chinensis*) are not expected and no change in contaminant levels in marine organism tissue are predicted to arise from this project. Air and noise impacts are expected to be undetectable.*

This impact hypothesis has been extensively and robustly tested under the EIA, and the aim of the EM&A programme is to verify this hypothesis. Periodic reviews of the project will allow for verification and consequent modifications to the EM&A programme if the need arises.

The East Sha Chau marine borrow pits (CMP IV) were created by sand dredging undertaken by the Airport Authority (AA) and are located to the north of Chek Lap Kok Airport and Lantau Island. The project site is shown in *Figure 1.2a*. The CMPs are to be used for the disposal of contaminated mud, generated by infrastructure development and maintenance of dredging projects.

At present, contaminated mud is disposed at the East Sha Chau Contaminated Mud Pit facilities (CMPs I-III), however the disposal capacity at this site is expected to be exhausted by mid-1997. Additional capacity is required to provide a disposal option for contaminated mud generated by continuing infrastructure development and maintenance dredging projects.

CMP IV has a total volume in excess of 30 Mm³ which will be sufficient to provide contaminated mud disposal capacity for the Territory until the year 2001. The proposed backfilling operations described in this Study represent a continuation of accepted disposal practices for contaminated dredged material in Hong Kong. A recent review of environmental monitoring data collected at the existing CMPs from 1992 to 1995 concluded that there was no evidence of contaminant impacts on biota due to disposal and that contamination from disposal activities has been successfully contained⁽¹⁾. Furthermore, the study reviewed the suitability of a variety of potential sites for new CMPs and concluded that "contained marine disposal in the marine borrow pits (CMP IV) at East Sha Chau is clearly the most suitable site and is the preferred area for continued disposal of contaminated mud in Hong Kong"⁽²⁾.

The Initial Assessment Report (IAR) for Disposal of Contaminated Mud in the East Sha Chau Marine Borrow Pit was released in July 1996 and at that time the Study Management Group authorized preparation of a detailed EIA. The Working Paper on Method Statements was released in October 1996 and contained a discussion of proposed methodologies for use in the draft EIA. The draft EIA, released in November 1996, assessed key issues and evaluated the environmental impacts predicted to result from various operational scenarios.

ENVIRONMENTAL MONITORING AND AUDIT REQUIREMENTS

A water quality monitoring and auditing programme will be conducted during disposal operations to verify whether impact predictions are representative and to ensure the disposal does not result in unacceptable impacts. Where monitoring shows disposal operations are resulting in deterioration of water quality beyond the predictions, and to unacceptable levels, appropriate mitigative measures, such as changes in the operational design, will be introduced.

As the disposal operations at CMP IV will not be fundamentally different from those at the existing CMPs, monitoring and audit procedures will be adapted from the present programme. This EM&A manual represents a continuation of approved monitoring and audit practices at the CMPs, while also, where appropriate, incorporating enhanced features and recently developed improvements in monitoring methodologies.

⁽¹⁾ EVS 1996. Review of Contaminated Mud Disposal Strategy and Status Report on Contaminated Mud Disposal Facility at East Sha Chau. Prepared for the Civil Engineering Department, Hong Kong Government.

⁽²⁾ *Ibid.*

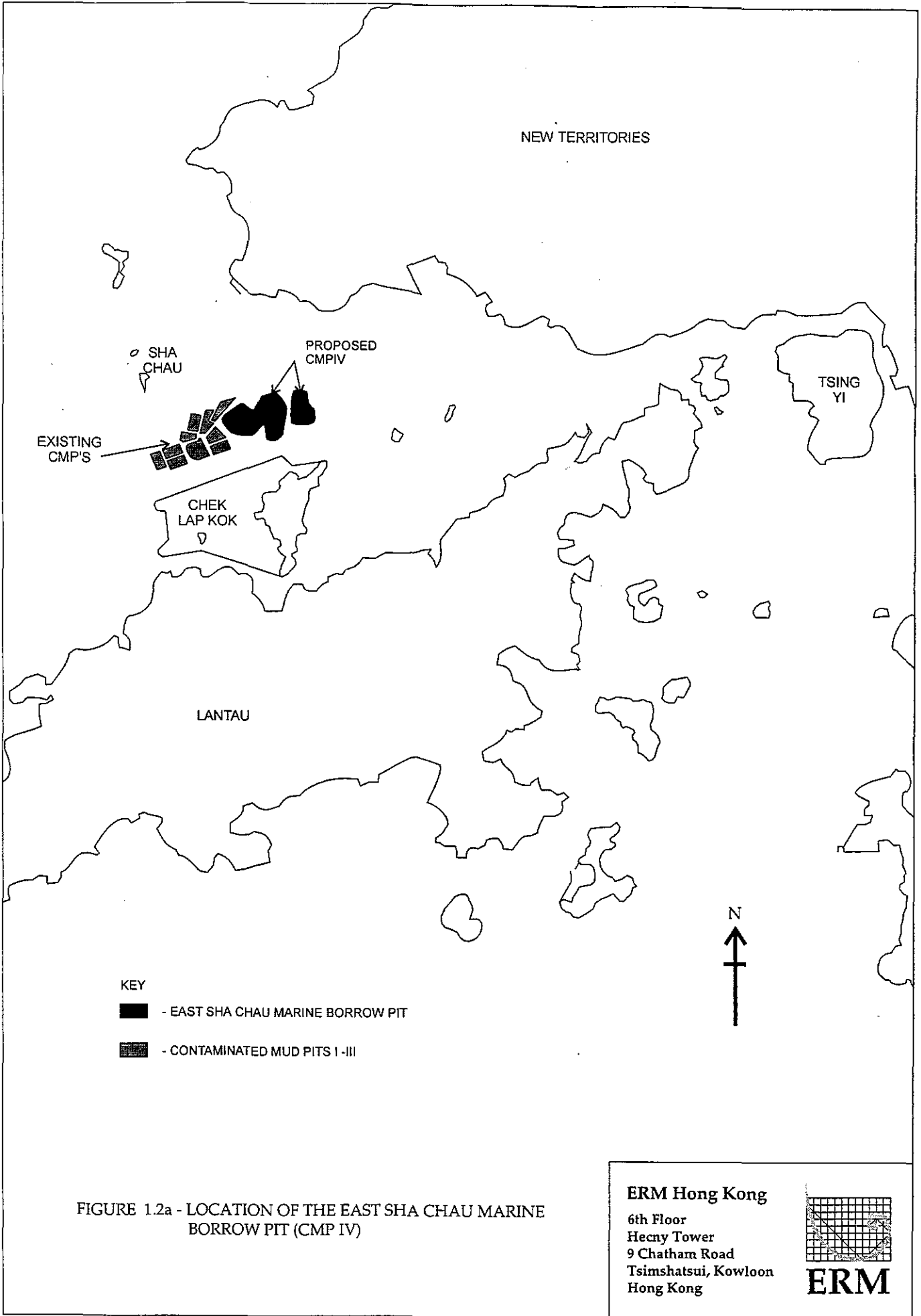


FIGURE 1.2a - LOCATION OF THE EAST SHA CHAU MARINE BORROW PIT (CMP IV)

This EM&A Manual includes site-specific monitoring and auditing protocols for all phases of the backfilling operations. Such protocols include but are not limited to, the location of monitoring stations, parameters and frequencies, monitoring equipment, data management procedures, and reporting of monitoring results. Environmental audit specifications have been developed for all phases of the works, including an organisational and management structure, procedures to ensure compliance with mitigation measures, environmental quality performance limits, and procedures for reviewing results and auditing compliance with specified performance limits.

In addition to the monitoring and audit requirements discussed above, site management will play an important role in controlling impacts. On-site management practices, such as supervision by a 24-hour on-site management team and provision on all licensed barges of automatic self-monitoring tracking devices, which are presently in use at the existing ESC CMPs, will be refined for use at CMP IV. These and potential new measures will assist in preventing inaccurate dumping and controlling environmental impacts associated with disposal activities.

1.4

PROJECT ORGANIZATION

The project organisation and lines of communication with respect to environmental protection works is shown in *Figure 1.4a*.

Site Manager

The Site Manager will play the pivotal role in managing backfilling operations by overseeing the Environmental Consultant and liaising with both the Environmental Protection Department (EPD) and the On-site Management Team. The Site Manager will manage operations in consultation with the East Sha Chau Interagency Working Group which will advise the Site Manager on technical and administrative matters. Specific duties of the Site Manager include reviewing the monthly and quarterly EM&A reports prepared by the Environmental Consultant, informing parties of exceedances, and identifying and imposing corrective actions where necessary. The Site Manager maintains the overall responsibility for controlling backfilling operations to ensure that environmental compliance is maintained and appropriate actions are taken in the event of any documented exceedances.

Environmental Protection Department

EPD's role involves ensuring that site management practices are in compliance with all environmental regulatory criteria, that appropriate conditions are specified in the dumping licence, and that these conditions are met. This will be accomplished through liaison with the Site Manager and periodic auditing of EM&A data submitted by the Site Manager and Environmental Consultant in monthly and quarterly reports. It is anticipated that the EPD Monitoring and Audit Section will take the lead in these activities.

On-site Management Team

The point of contact within the On-site Management Team for EM&A matters should be specified in the EPD dumping licence. It is the responsibility of this point of contact to ensure that backfilling operations are conducted in compliance with the dumping licence and the EM&A programme. Any corrective actions

imposed by the Site Manager will be communicated to the On-site Management Team's point of contact. The On-site Management Team point of contact is responsible for ensuring that these corrective actions are implemented.

Environmental Consultant

The Environmental Consultant is responsible for conducting the EM&A programme and preparing monthly and quarterly reports for the Site Manager. The Environmental Consultant shall collect and analyse field samples (eg suspended solids concentration), and provide monthly and quarterly monitoring reports in approved formats. The Environmental Consultant will also provide a general review to verify the accuracy of the EIA predictions and assess the effectiveness of mitigation measures. The Environmental Consultant shall assist the Site Manager, as directed, in formulating corrective actions and liaison with government departments and the On-site Management Team.

1.5 CONTAMINANTS TO BE TESTED

The following is a list of contaminants currently under consideration for chemical screening of dredged material (*Table 1.5a*). The list includes inorganic and organic contaminants. These contaminants will be monitored during the EM&A programme, though changes to the list may be made by the Study Management Group at any time during disposal operations.

Table 1.5a Contaminants to be Tested

Inorganic Contaminants	Detection Limit (ppb) ¹	Organic Contaminants
Cadmium	0.2	Acenaphthene
Chromium	1.0	Acenaphthylene
Copper	1.0	Anthracene
Lead	5.0	Fluorene
Mercury	1.0	Napthalene
Nickel	5.0	Phenanthrene
Silver		Low Molecular Weight PAHs
Zinc	10.0	Benzo(a)anthracene
Arsenic		Benzo(a)pyrene
		Chrysene
		Dibenzo(a,h)anthracene
		Fluoranthene
		Pyrene
		High Molecular Weight PAHs
		Total PAHs
		Total PCBs
		p,p'-DDE (4,4'-DDE)
		Tributyltin (TBT)
		Total DDT

¹ Detection limits of heavy metals are set out in EPD Technical Circular TC 1-1-92.

1.6 CHARACTERISATION OF SOURCE MATERIAL

As part of the EM&A programme all source material will be sampled from incoming barges in order to characterise the sediments with respect to the contaminants listed in *Table 1.5a*. The sampling regime will be designed when information is available on how many projects will contribute contaminated material. Sampling will be carried out so that at least one barge per project is sampled with remaining sampling resources allocated to barges on a *pro rata*

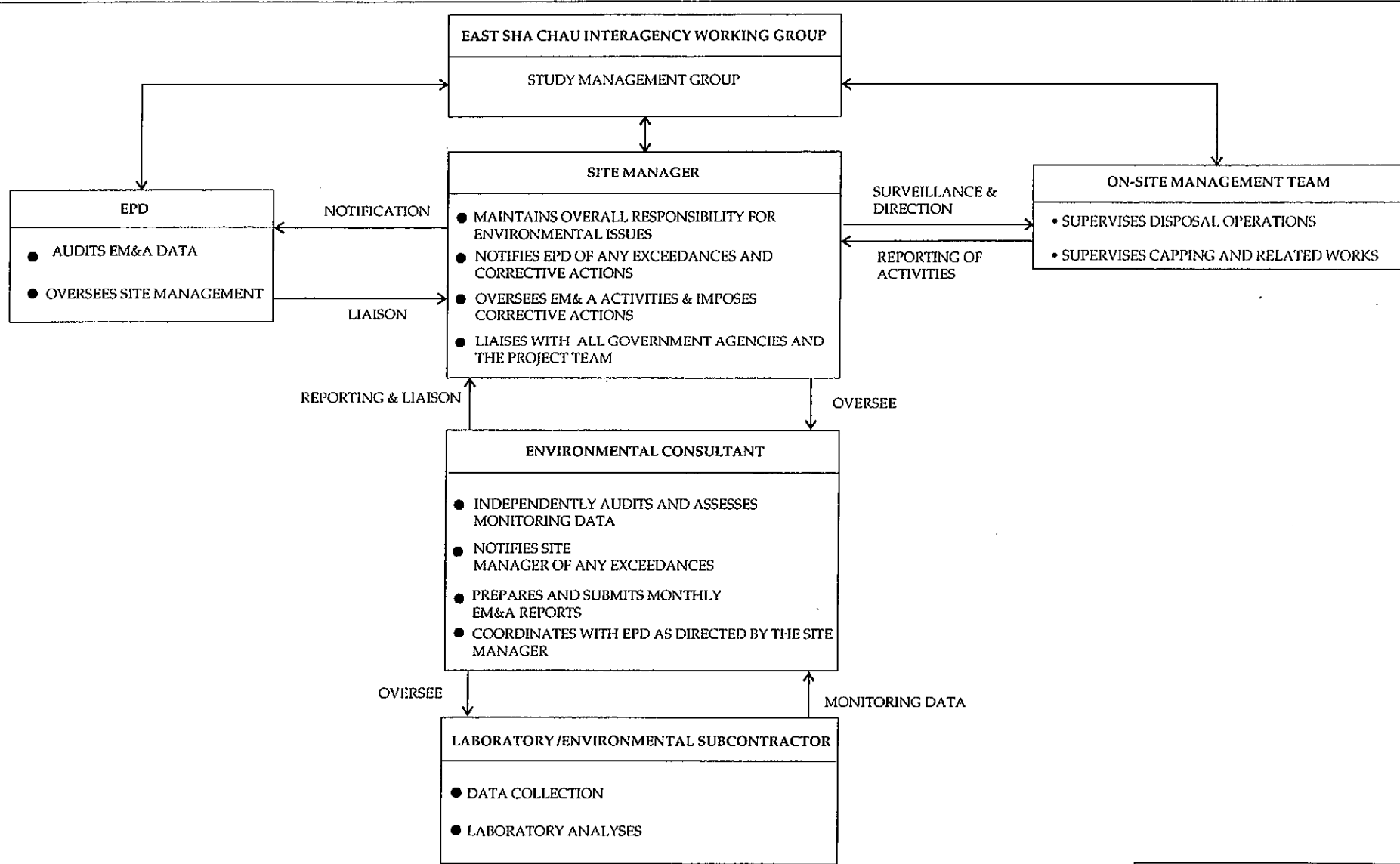
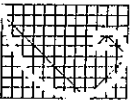


FIGURE 1.4a - ENVIRONMENTAL MONITORING AND AUDIT PROGRAMME ROLES AND RESPONSIBILITIES

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basis. Any concurrent increases in contaminant levels at the monitoring stations may be attributed to particular projects, and appropriate changes made to the operations plan. The methodology for this sampling will be subject to review after commencement of the EPD routine contaminant characterisation programmes for source material to be placed in CMP IV.

1.7

SENSITIVE RECEIVERS

Sensitive receivers, including gazetted beaches, cooling water intakes and fisheries and mariculture zones, the Chinese White Dolphin and the Sha Chau/Lung Kwu Chau Marine Park are discussed in the EIA. No unacceptable impacts or exceedances of water quality objectives / assessment criteria were predicted. Therefore, no specific monitoring stations are recommended for sensitive receiver locations. Should unacceptable impacts be detected at stations on the outer perimeter of the designated monitoring programme, and these impacts be attributable to CMP IV, instituting stations at sensitive receivers will be considered.

This section describes procedure for monitoring and audit of water quality. Sediment quality and biological monitoring and audit are described in Sections 3 and 4, respectively.

2.1 MONITORING METHODOLOGY

Routine monitoring of salinity (%), temperature (°C), suspended solids (SS mg L⁻¹), dissolved oxygen (mg L⁻¹ and %), current speed and direction will be carried out at 5 water quality monitoring stations. These stations should be located along a gradient downstream (100-200m) from active disposal operations (in the plume arising from backfilling). One station will also be located upstream as a control. *In-situ* measurements will be taken using continuous monitoring devices. Monitoring will be carried out monthly at each station for one hour. The tidal conditions at each station during monitoring should be consistent and one sample (2 L) should be taken at mid-depth. The water samples will be filtered and chemical analysis carried out on the filtrate and the residue (suspended sediments). The contaminants measured will be those listed in Table 1.5a.

Water column profiling (1 hour) for salinity, temperature, suspended solids and dissolved oxygen at 1 station up-current and 1 station down-current will be carried out during dumping. The parameters will be measured as before using *in-situ* continuous monitoring equipment. Together with this monitoring, one sample (2 L) should be collected at each station at mid-depth and contaminants analysed according to the procedures used during water quality monitoring above. Monitoring should be carried out by the consultant using suitable sampling methods and equipment as required at the time by the Study working group.

Table 2.1 Summary Table for Water Quality Monitoring Methodology

Monitoring	Pit Specific Impact	
Programme	Stations	Parameters
Water Quality Routine Monitoring	5 stations located downstream of the disposal operations. 1 station located up stream. Mid depth sample. Monthly	Salinity (%) Dissolved Oxygen (mg L ⁻¹) Suspended Solids (mg L ⁻¹) Temperature (°C) Current Speed and Direction
Suspended Sediment Contaminant Testing	5 stations located downstream of the disposal operations. 1 station located upstream. Mid depth sample. Monthly	Analysis of contaminants in Table 1.5a in filtrate and residue
Water Column Profiling	1 station up-current and 1 station down-current. Water column. Monthly	Salinity (%) Dissolved Oxygen Suspended Solids Temperature

Existing, established and validated analytical procedures will be used for the determination of the water quality parameters. The analytical methods which will be used are defined in *Table 2.2a*.

Table 2.2a Analytical Procedures to be used for Analysis of Marine Waters and Sediments

Sample Type	Analyte	Method reference
Marine Water	Total Suspended Solids, metals in filtrate and residue	APHA, AWWA & WPCF Standard Method for the Examination of Water and Wastewater 17th Ed.

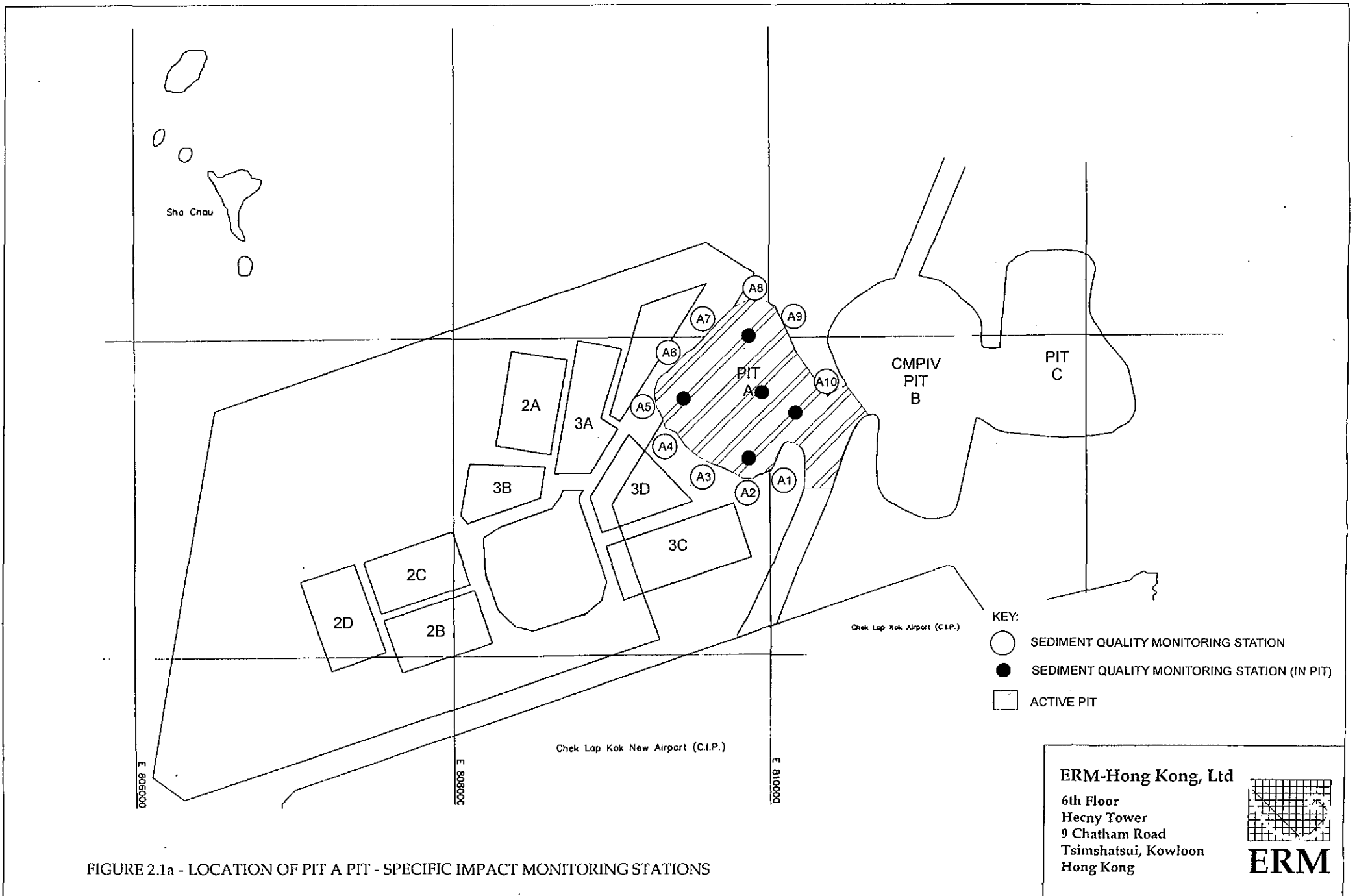
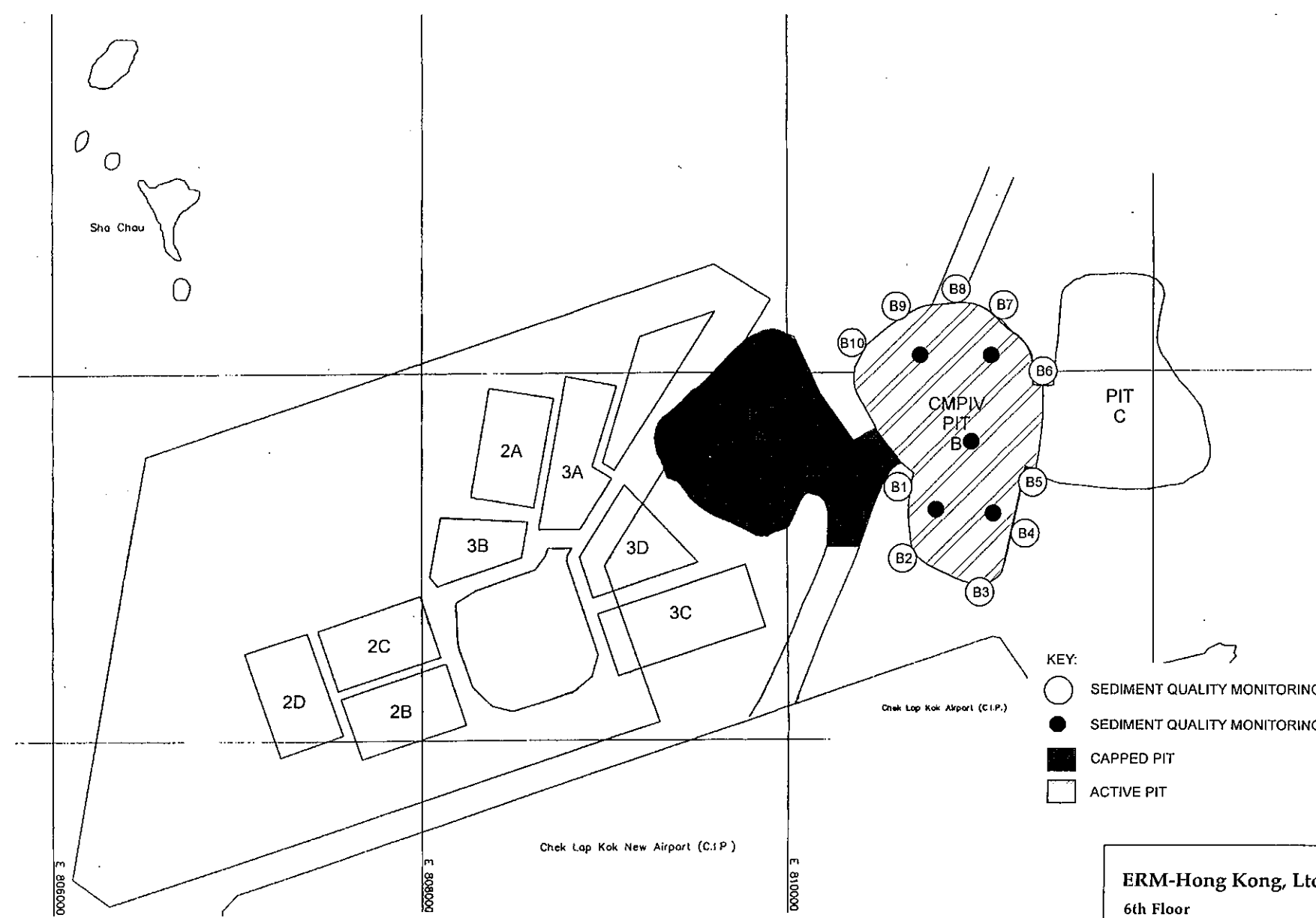


FIGURE 2.1a - LOCATION OF PIT A PIT - SPECIFIC IMPACT MONITORING STATIONS



- KEY:
- SEDIMENT QUALITY MONITORING STATION
 - SEDIMENT QUALITY MONITORING STATION (IN PIT)
 - CAPPED PIT
 - ACTIVE PIT

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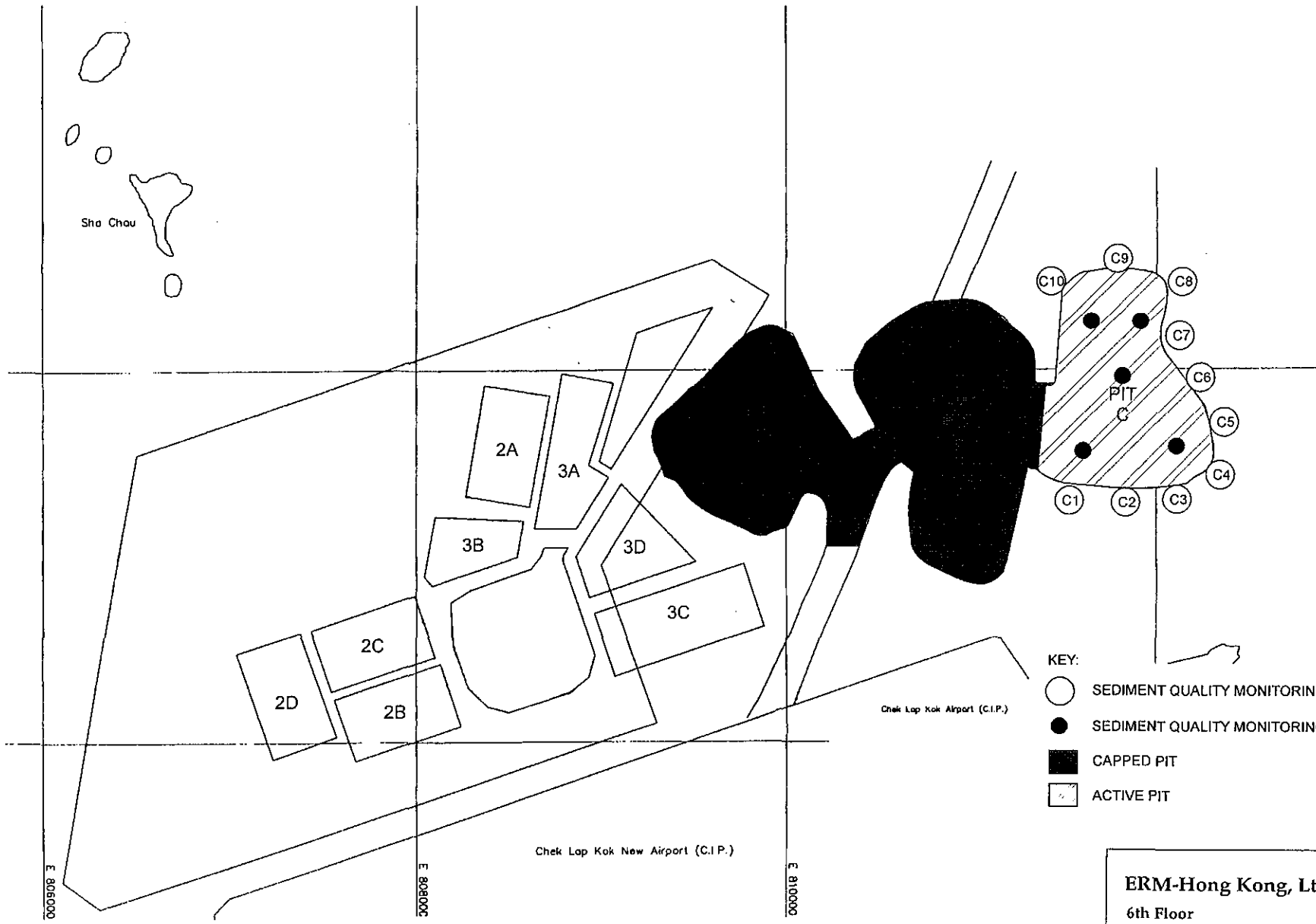


FIGURE 2.1b - LOCATION OF PIT B PIT - SPECIFIC IMPACT MONITORING STATIONS



- KEY:
- SEDIMENT QUALITY MONITORING STATION
 - SEDIMENT QUALITY MONITORING STATION (IN PIT)
 - CAPPED PIT
 - ▨ ACTIVE PIT

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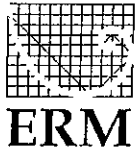


FIGURE 2.1c - LOCATION OF PIT C PIT - SPECIFIC IMPACT MONITORING STATIONS

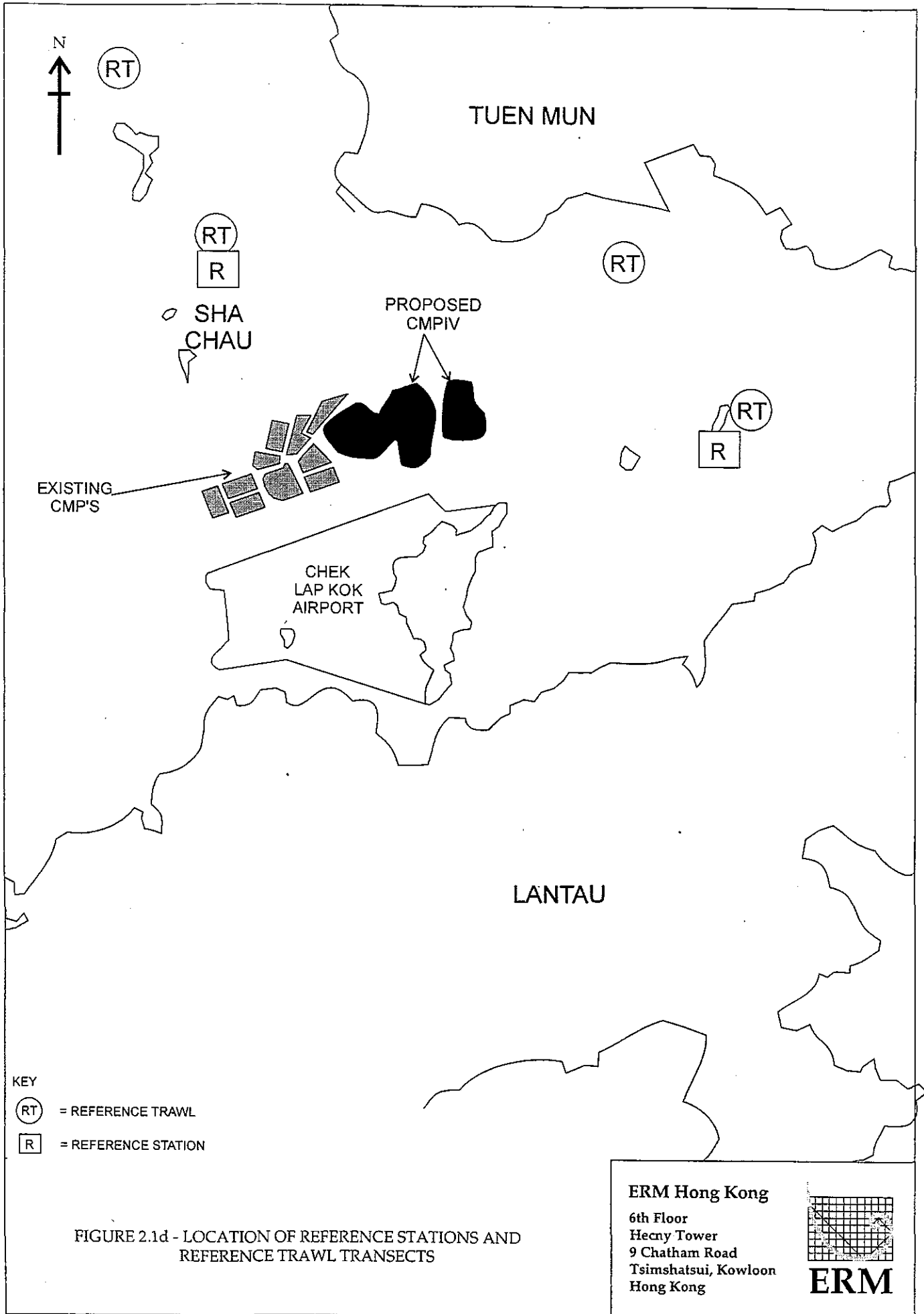


FIGURE 2.1d - LOCATION OF REFERENCE STATIONS AND REFERENCE TRAWL TRANSECTS

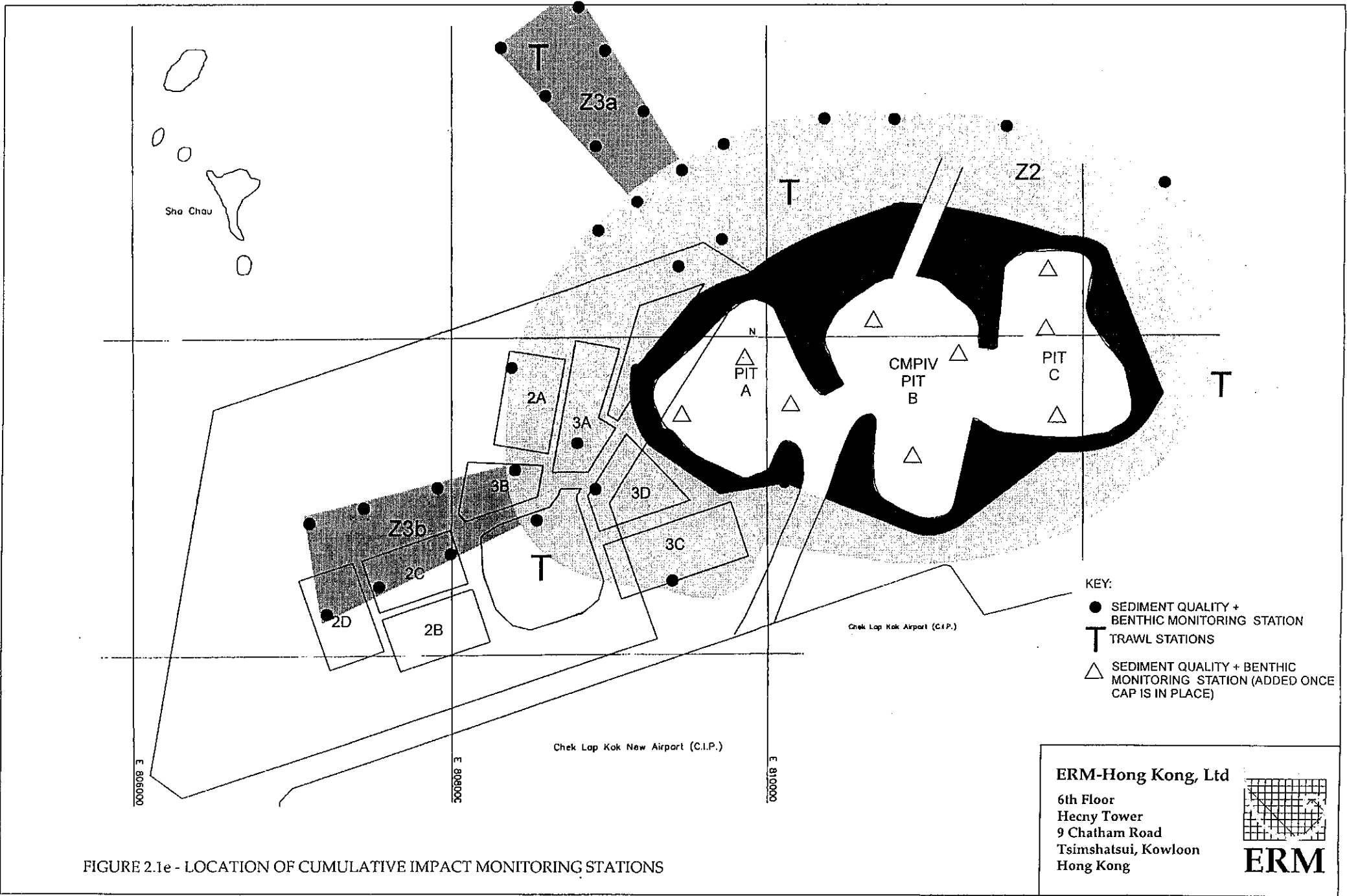


FIGURE 2.1e - LOCATION OF CUMULATIVE IMPACT MONITORING STATIONS

This section describes sampling and analytical procedures for pit-specific and cumulative sediment quality monitoring.

3.1 MONITORING METHODOLOGY

3.1.1 Pit Specific

Routine sediment sampling will be carried out at each of the fifteen sediment sampling stations located in and around the active pit (*Figure 2.1a, b, c*). The top 5cm of sediment from the five replicate samples taken from each station will be analysed for all contaminants listed *Table 1.5a*. Other parameters to be measured are TOC for each replicate and the percentage of silt/clay for one replicate from each station. Sampling will be carried out monthly at the active pit during contaminated mud disposal and capping. In the event of a typhoon occurring, sampling should be carried out within one week after signal number 8.*-

3.1.2 Cumulative Impact

Sediment sampling will be carried out four times per year with two sampling events, in the dry and wet seasons respectively, at each of the 40 impact stations displayed on *Figure 2.1e*. The stations were selected on the basis of the following objectives:

- Comprehensive coverage of the study area;
- Coverage of areas predicted to be contacted by sediment plumes arising from backfilling operations in CMP IV (taken from the modelling results of the EIA);
- Stations split up into three impact zones, Zone 1 = Pit Impact Area (12 stations), Zone 2 = Perimeter (16 stations), Zone 3 = Predicted Plume Area (12 stations); and
- Increased replication in reference areas to improve statistical rigour of the dataset.

Sampling will also be carried out at each of the three stations added as the cap is placed on each pit (*Figure 2.1e*) and at the twelve stations located in the two reference areas (*Figure 2.1d*).

Five replicate samples will be collected from each station. A composite sample from the five replicate samples will be prepared and the full list of contaminants in *Table 1.5a* analysed. Sediment sampling protocols are summarised in *Table 3.1a*.

Table 3.1a

Summary Table for Sediment Quality Monitoring Methodology

Monitoring	Pit Specific Impact		Cumulative Impact	
Programme	Stations	Parameters	Stations	Parameters
Sediment Quality Routine Monitoring	10 stations located around the active Pit. Five replicates using top 5cm. Monthly	Analysis of contaminants in Table 1.5a and TOC.	40 impact stations, located in three zones radiating out from CMP IV. Zone 1: Pit Impact Area. Zone 2: Perimeter. Zone 3: Plume Area. 12 stations located in each of the 2 reference areas. Five replicates using top 5cm to obtain 1 composite sample. 4 times per year in the dry & wet seasons.	Analysis of contaminants in Table 1.6b and TOC Plus silt/clay % content for each composite sample.
	10 stations located around the active Pit. One replicate using top 5cm. Monthly.	Percentage content of silt/clay		

3.2

MONITORING EQUIPMENT

For sediment sampling, sea bed grab samplers deployed in a custom-built cluster will be used to collect sediment samples. They will be lowered with a high speed electric winch. Generators, trawling equipment, sampling screens and sea water supply will also be available on deck. Silt meters will be used to measure the silt content. Ice and ice boxes will be available on board the survey vessel to cool samples as soon as they have been collected.

3.3

LABORATORY ANALYSIS

Existing, established and validated analytical procedures will be used for the determination of these parameters (Table 3.3a).

Table 3.3a

Analytical Procedures to be used for Analysis of Marine Sediments

Sample Type	Analyte	Method Reference
Marine Sediment	Particulate phase heavy metals	EPA 3050 Acid Digestion of Sediments EPA 7000 Atomic Adsorption Methods
	Elutriate Heavy metals	EPA 3050 and EPA 7000
	Total Organic Carbon	BS 1377
	%<63 μm	UK Standing Committee of Analysts Blue Book Method: 'Sampling and Initial Preparation of Soil, Sediment and Plant Material etc. Prior to Analysis;
	Trace Organic Compounds	Gas chromatography with electron capture detection or mass spectrometry identification

4.1 GENERAL REQUIREMENTS

The following key components should be monitored:

Uptake of contaminants into the food chain will be assessed by sampling deposit-feeding animals, of restricted mobility, at varied distances from the pit. Benthic grab, trawl or other gear suited to the capture of such organisms will be employed. The contaminant body burden of sampled animals should be monitored in both the wet season and dry season. Two replicates in time should be taken in each season, however if regular sediment quality sampling indicates a deterioration in sediment quality, sample frequency should be increased. Specific biota to be sampled will be governed by the availability of sufficient biomass for assay procedures but should include representatives of at least three phyla.

Population size and composition of benthic infaunal and epifaunal communities will be monitored in the vicinity of the pits and on the capped pits. Methodology will be based, as appropriate, on that currently employed to study benthic infauna for CED's Seabed Ecology Studies.

Sediment Toxicity testing should be conducted annually for a subset of stations sampled during the biannual sediment quality sampling. Standard reference organism and standard procedures will be used.

The following sections provide the present programmes for monitoring the three components described above. Adjustments to these indicative programmes may be made over time based on identification of more appropriate techniques or practices.

4.2 MONITORING METHODOLOGY

In order to monitor the uptake of contaminants into the food chain, body burden analysis will be carried out. The contaminants to be measured are those listed in *Table 1.5a*. Species lists will vary depending on whether tissue or whole body analysis is to be carried out (*Table 4.1a*).

Table 4.1a List of Target Species for Tissue Analysis and Whole Body Analysis

Type	Tissue Analysis		Whole Body Analysis	
	Target Species ¹	Alternative Species ²	Target Species ¹	Alternative Species ²
Prawn	<i>Metapenaeus ensis</i>	<i>Metapenaeus joyneri</i>	<i>Metapenaeus</i> sp.	<i>Metapenaeopsis</i> spp.
	<i>Metapenaeus affinis</i>	<i>Metapenaeopsis</i> spp.		
Mantis Shrimp	<i>Oratosquilla oratoria</i>	<i>Oratosquilla nepa</i>	<i>Oratosquilla</i> sp.	
		<i>Oratosquilla anomala</i>		

Type	Tissue Analysis		Whole Body Analysis		
	Target Species ¹	Alternative Species ²	Target Species ¹	Alternative Species ²	
Swimming Crab	<i>Charybdis cruciata</i>	<i>Portunus sanguinolentus</i>			
Flatfish	<i>Cynoglossus macrolepidotus</i>	<i>Platycephalus indicus</i>			
Burrowing Fish	<i>Trypauchen vagina</i>	<i>Oxyurichthys tentacularis</i>			
Demersal/ Pelagic Fish	<i>Leiognathus brevisrostris</i>	<i>Collichthys lucida</i>	<i>Leiognathus</i> sp.		
				<i>Collichthys lucida</i>	<i>Johnius belengeri</i>
					Other Sciaenidae
				<i>Mugil</i> sp.	
				<i>Thrissa</i> sp.	
Gastropod	<i>Turritella terebra</i>				
Cephalopod			Lolingid squid	Sepiid cuttlefish	
Non-commercial Crab			<i>Charybdis</i> sp.	<i>Charybdis</i> sp.	

Notes: ¹In case sufficient samples of the target species cannot be obtained, analysis of the alternative species should be carried out.

²The alternative species are listed in order of priority.

Three organisms (priority given to larger individuals with no more than 2 fold difference in length) will be taken to form a composite sample for testing. Lengths of individuals selected for tissue and whole body analysis will be recorded. Samples for tissue analysis and whole body analysis will be taken four times per year with two sampling events during the dry and wet seasons respectively.

4.3 MONITORING METHODOLOGY

4.3.1 Trawl Sampling

Trawl sampling will be conducted four times per year, with two sampling events in the dry and wet seasons respectively, using a local shrimp trawler fishing simultaneously with 6 nets. The trawler will have a GPS system to ensure accurate positioning of the trawl transect, to within 50 m. For each sampling at each station, 5 trawls of 10 minutes each will be carried out. Subsequent trawls at each station will be shifted slightly to ensure that repetitive sampling does not occur along a single track of seabed. A minimum of 6 standard beam trawl nets will be set per tow, and a minimum of 5 nets per tow should be retrieved undamaged. If less than 5 nets per tow are undamaged, the tow must be repeated.

Trawling will be carried out during daylight hours. No more than three trawls will be taken successively at each station before progressing to another station. Further trawls will only begin at a station once a two hour period since the previous trawling has passed. The first station to be sampled on each sampling

trip will be selected at random in order to minimise diurnal influences on catches.

All taxa which cumulatively comprise not less than 2/3 of the total expected commercial biomass will be sorted and identified to Species or Generic level. Remaining taxa will be identified to at least Family level for fish and to Order for invertebrates except that individuals exceeding 100g weight will be processed as for other taxa (ie to species or generic level). Each commercial taxon will be counted and its gross weight recorded. The target species will be sorted, bagged and packed in ice aboard the trawler and sent to the laboratory for analysis. The need for relative abundance estimates will be reassessed after a review of the data collected under CE 66/95.

4.3.2 *Benthic Grab Sampling for Macro-Infauna*

One replicate sample will be taken four times per year, with two sampling events in the dry and wet seasons respectively, from each station using a modified Van Veen Grab (dimensions 30cm x 30cm x 15cm). Samples will be analysed for species composition, trophic structure and relative abundance to determine colonization characteristics of the area. Organisms are to be sorted and identified to Family and Species level where practical. Macro-infauna will be sieved through a 0.5 mm sieve and retained fauna sorted and preserved in 5% buffered formalin for identification in the laboratory.

4.3.3 *Sediment Toxicity Testing*

Sediment toxicity testing will be carried out for three marine species to determine potential impacts to survival, behaviour, growth, reproduction and development. The test species will include a representative epibenthic amphipod (eg *Eohaustorius estuarius*), burrowing worm (eg *Neanthes arenaceodentata*) and bivalve larva (eg *Crassostrea gigas*). The procedure is similar to that for seabed sampling, except that only the top 5 cm of the replicate is used. The 5 replicate grabs will be washed carefully with sea water and checked for cleanliness before each sample collection. Sampling is to be carried out at the same time as sediment quality sampling events and will be undertaken at the stations indicated in *Figure 4.2a*.

Table 4.2 *Summary Table for Biomonitoring Methodology*

Monitoring	Cumulative Impact	
Programme	Stations	Parameters
Trawl Sampling	4 Impact Trawl Transects and 4 Reference Trawl Transects. 5 replicate trawls each with 6 nets. 4 times per year with two sampling events in the dry & wet seasons.	Analysis of contaminants listed in <i>Table 1.5a</i> for faunal species listed in <i>Table 4.1a</i> .
Benthic Infauna Grabs	40 impact stations as for sediment sampling. 12 stations located in each of the 2 reference areas. One replicate per station. 4 times per year with two sampling events in the dry & wet seasons.	Species composition, trophic structure and relative abundance.
Sediment Toxicity	1 station from each of the 2 reference areas. 10 impact stations. 5 replicate grabs from each station composited to form one sample for analysis. 4 times per year with two sampling events in the dry & wet seasons.	Survival, behaviour, growth, reproduction and development of species listed in Section 4.2.3.

The protocols for the toxicology tests are given in *Table 4.3a*.

Table 4.3a *Protocols used for Toxicology Testing*

Tests	Species tested	Protocol
Amphipod	<i>Eohaustorius estuarius</i>	ASTM protocol "Standard Guide for Conducting 10-day Static Toxicity Tests with Marine and Estuarine Amphipods"; Designation: E 1367-92
Polychaete	<i>Neanthes arenaceodentata</i>	Puget Sound Estuary Program protocol document titled "Recommended Guidelines for Conducting Laboratory Bioassays on Puget Sounds Sediments, July, 1991"
Bivalve larvae	<i>Crassostrea gigas</i>	ASTM protocol "Standard Guide for Conducting Static Acute Toxicity Tests with Embryos of Four Species of Saltwater Bivalve Molluscs; Designation: E 724-89

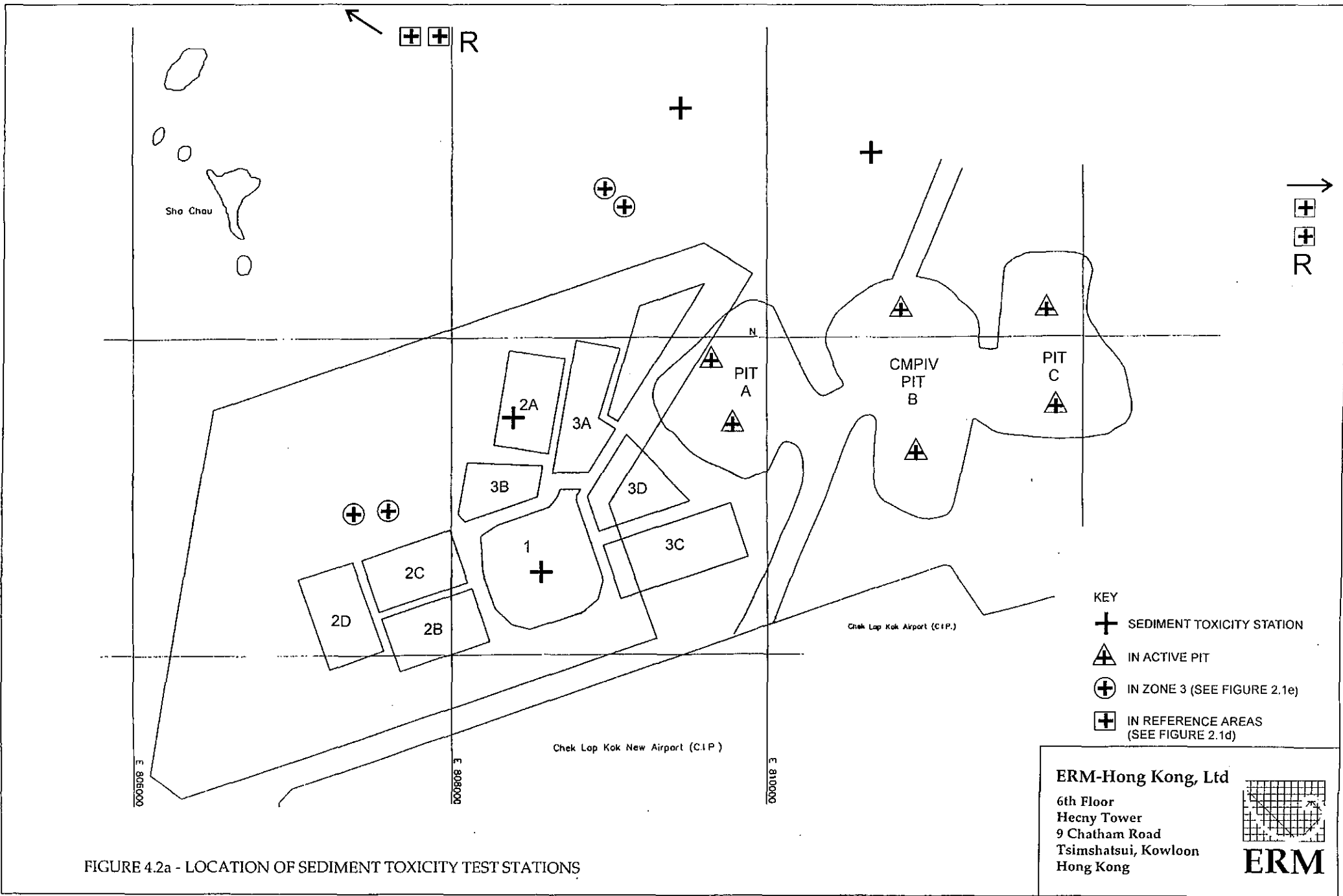



FIGURE 4.2a - LOCATION OF SEDIMENT TOXICITY TEST STATIONS

ERM-Hong Kong, Ltd
 6th Floor
 Hecny Tower
 9 Chatham Road
 Tsimshatsui, Kowloon
 Hong Kong



5 *SITE ENVIRONMENTAL AUDIT*

5.1 *ENVIRONMENTAL AUDIT REQUIREMENTS*

Environmental auditing is recommended to test the adequacy and effectiveness of the environmental monitoring programme.

These audits should be carried out on a regular basis, for example at monthly intervals. The audit should cover the following:

- Review and verification of information available in records generated through the monitoring programme;
- Identification of specific issues of non-compliance and recommendations to meet them; and
- Checking the effectiveness of operational controls and mitigation measures and reviewing the need for further mitigatory measures.

In addition, an audit of the environmental complaints handling procedures should be carried out to verify that complaints are properly channelled and addressed. The results of the environmental auditing shall be reported in the subsequent monthly EM&A Report.

5.2 *ENVIRONMENTAL COMPLAINTS PROCEDURES*

Complaints shall be referred to the Environmental Team Leader for carrying out complaint investigation procedures. The Environmental Team Leader shall undertake the following procedures upon receipt of the complaints:

- log complaint and date of receipt on to the complaint database;
- investigate the complaint to determine its validity, and to assess whether the source of the problem is due to works activities;
- if a complaint is valid and due to works, identify mitigation measures;
- if mitigation measures are required, advise the Contractor accordingly;
- review the Contractor's response on the identified mitigation measures; and the updated situation;
- if the complaint is transferred from EPD, submit interim report to EPD on status of the complaint investigation and follow-up action within the time frame assigned by EPD;
- undertake additional monitoring and audit to verify the situation if necessary, and review that any valid reason for complaint does not recur;

- report the investigation results and the subsequent actions to the source of complaint for responding to complainant (If the source of complaint is EPD, the results should be reported within the time frame assigned by EPD); and
- record the complaint, investigation, the subsequent actions and the results in the monthly EM&A reports.

A flow chart of the complaint response procedures is shown in *Figure 5.2a*.

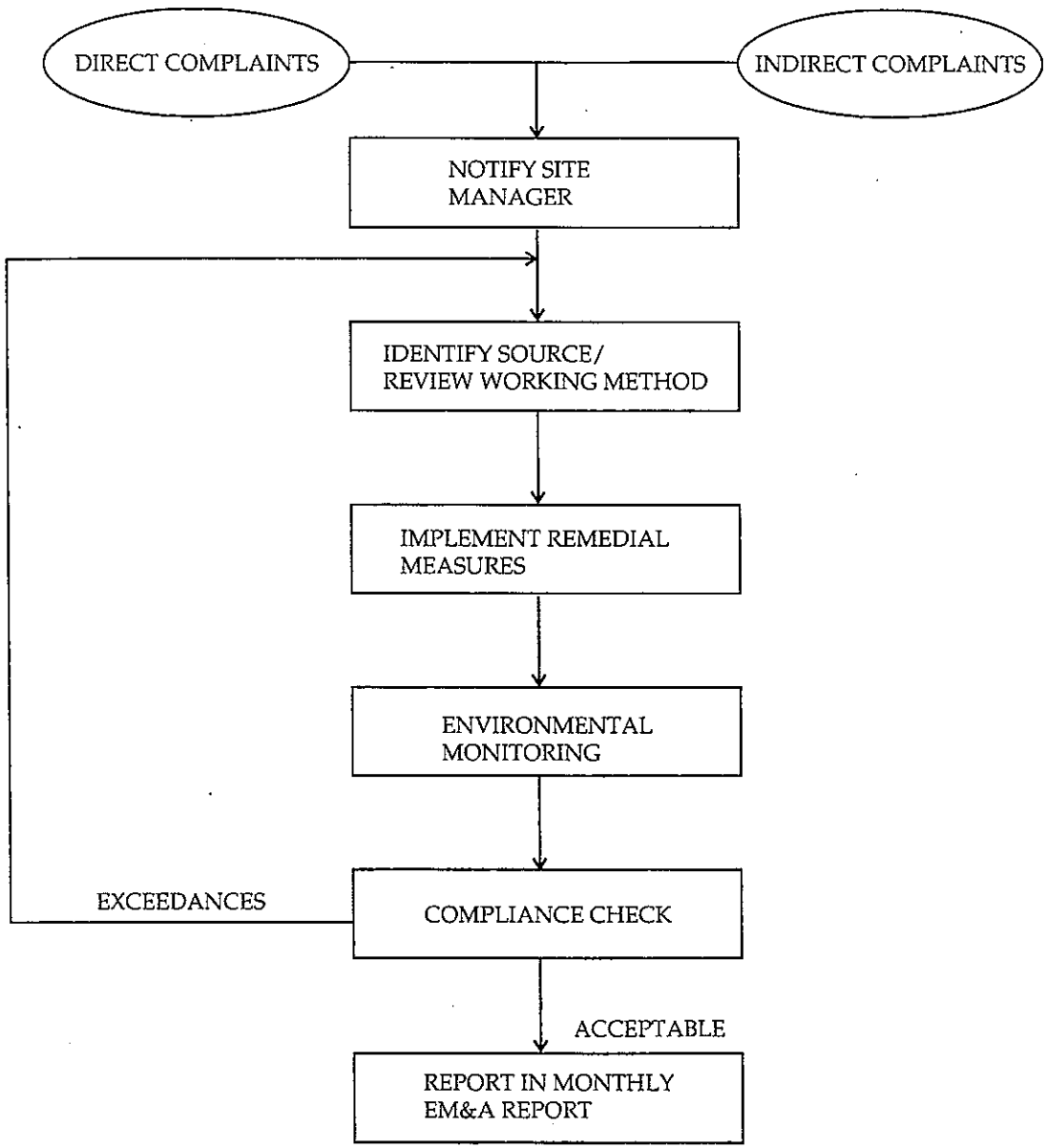


FIGURE 5.2a - COMPLAINTS HANDLING PROCEDURE

6 REPORTING

6.1 INTRODUCTION

The proposed reporting requirements for the backfilling operations are discussed below. This reporting structure includes the methodology for recording data, the treatment of exceedances and the format of the monthly and quarterly (3-monthly) progress reports. The audit requirements set out the procedures to ensure the efficacy of the environmental management and monitoring systems.

6.2 MONITORING RESULTS

Monitoring data shall be reported on standardised record sheets and shall contain the following information, as appropriate:

- sampling point(s);
- sampling depth(s);
- sampling parameter(s);
- number of measurements;
- weather conditions;
- brief description of the disposal activities (eg, location of dumping operations, rates of disposal, backfill level, operational restrictions); and
- checks on compliance.

6.3 ENVIRONMENTAL EXCEEDANCES

In the event of environmental exceedances, the appropriate plan should be adopted. The Environmental Consultant should notify the Site Manager immediately if any exceedances occur. In addition, in the event of non-compliances, the Site Manager should inform EPD by fax. Action(s) taken should be reported immediately to the EPD, as well as reported in the monthly progress report. If any of non-compliances are recorded on more than two consecutive days, EPD shall be informed by a report which summarizes the monitoring data, describes implemented mitigation measures and proposes actions to avoid further occurrences of non-compliance.

6.4 MONTHLY EM&A PROGRESS REPORT

A monthly EM&A progress report should be prepared and submitted to the Site Manager on the tenth working day of each month in an agreed format (printed and/or magnetic media form). The report should include the following:

- summary of major points and the month's disposal activities;
- monitoring data and audit/review of these monitoring results;
- compliance check and report on exceedances;
- remedial measures adopted to mitigate any adverse impacts;
- record of complaints and remedial measures;
- forecast of work programme and monitoring schedule;
- proposal for changes to monitoring requirements, as appropriate; and,
- comments and conclusions.

QUARTERLY EM&A PROGRESS REPORT

A quarterly EM&A Report should also be prepared and submitted to the Site Manager on the tenth working day following the subject 3 month period, in an agreed format. The report should include:

- past 3 months data;
- trend analysis of environmental conditions over the monitoring period;
- annotated figures of events (environmental conditions, non-compliances, etc);
and
- remedial measures undertaken and the efficacy of these measures.

This quarterly report will be made publicly available, in accordance with the draft Technical Circular on EM&A currently being assessed by SPEL, which will be in line with PELB's General Circular No. 2/94 on the Public Access to Environmental Impact Assessment (EIA) Reports.

