FINAL REPORT

China Light and Power Company Limited

EIA of the Proposed 6000MW Thermal Power Station at Black Point: *Initial Assessment Report*

Volume 3 : Operational Phase

& Response to Government Comments

November 1992

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Initial Assessment Report

Volume 3 : Operational Phase EIA

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EXECUTIVE SUMMARY

The China Light and Power Company Ltd (CLP) proposes to develop a large thermal power station (LTPS) in Hong Kong to meet forecast electricity demand during the late 1990s and into the next century.

In November 1989 CLP commissioned ERL (Asia) Ltd to lead a team of consultants to undertake a Site Search Study and Environmental Impact Assessment for the LTPS. The purpose, scope and objectives of the study were agreed between CLP and the Hong Kong Government Planning, Environment and Lands Branch (PELB) which set up an interdepartmental Study Management Group to assist in and monitor the progress of the study and to make recommendations to the Secretary for Planning, Environment and Lands at appropriate stages of the study.

The three phase Site Search study, comprising the identification of potential areas, the identification of potential sites and a comparative assessment of sites, resulted in the selection of Black Point.

The findings of the Site Search Report were accepted by the Study Management Group in August 1990 and following scrutiny by the Development Progress Committee (DPC) were submitted for approval to the Land Department Planning Committee (LDPC). The findings were endorsed by the LDPC on 7th December 1990.

Following the endorsement of the recommendation of the Black Point site, the Environmental Impact Assessment for the LTPS at the Black Point location was initiated, comprising two elements; the Initial Environmental Assessment, and the Key Issue Assessments.

The Initial Environmental Assessment provides an assessment and evaluation of the net environmental impacts and cumulative effects of the development, defines measurable parameters likely to be affected by the LTPS, and identifies environmental monitoring requirements.

The Key Issue Assessments provide detailed examinations of those environmental issues which could not be resolved at the initial assessment stage because of their complexity and need for detailed study as a result of their particular importance to the environmental acceptibility of the LTPS.

The need for two such Key Issue Assessments was identified at the commencement of the EIA, both of which were required to start at the same time as the Initial Assessment to ensure completion in line with the project programming. These were:

- the Stack Emissions (ie Air Quality) Key Issue Assessment; and
- the Water Quality Key Issue Assessment

The scope of work for these studies were agreed with the HK Environmental Protection Department, and the studies proceeded in parallel with the Initial Environmental Assessment. The findings of these studies are to be reported separately, in the Key Issue Assessment Reports.

During the discussion of the Draft of the Initial Assessment Report, the need for a third Key Issue Assessment was identified, dealing with the generation of solid byproducts. As with the two other Key Issue Assessments, the scope of the study was agreed with the EPD, and the findings are to be reported separately, in the Solid Byproducts Key Issue Report.

A summary listing of the issues considered in the Key Issue Assessments is provided at the end of this summary.

The findings of the Initial Assessment Report for the construction and operational phases of the LTPS are :

CONSTRUCTION PHASE

Air Quality Impacts

Good site dust practices in addition to careful siting of dust generating activities can effectively reduce the generation of dust by up to 90% and will ensure that adverse impacts on the environment and workforce are minimised. Construction impacts upon air quality both on and off site are therefore not considered to be significant.

Noise

Daytime noise levels during construction works are predicted to be well within the background plus 10 dB(A) criterion for receptors in the Black Point area.

Exceedances ranging from 2 – 9 dB(A) of the night–time noise criterion of 45 dB(A) are predicted at four of the five sensitive receivers, caused by nighttime dredging and marine support activities. It is recommended that where practicable, dredging activities be rescheduled to daytime hours, and the quietest type of dredger and silenced equipment used wherever possible.

Water Quality

Impacts arising from general construction activities will be minor and controlled by good construction site practice. Sediment plume modelling conducted at the Site Search stage indicates that the elevation in suspended solids at the nearest sensitive recievers during the dredging of marine muds will be insignificant when compared to the natural range of conditions in Deep Bay. Monitoring will be required during dredging works to ensure compliance with the Deep Bay Guidelines. Results obtained during initial dredging for the seawall should be used to assess the possible need for controls during the dredging for the access channel and turning basin.

Waste Disposal

Significant impacts from the disposal of construction wastes are not anticipated. Overburden and site debris can be disposed of at the adjacent WENT landfill, whilst chemical wastes will be taken to the Chemical Waste Treatment Facility on Tsing Yi. Marine sediments dredged from the site will require disposal at Gazetted Dump Sites. The need for additional disposal capacity has been recognised by FMC and sites such as disused borrow pits appear attractive. Suitability for dump site disposal will be confirmed by further sampling and analysis once the exact dredging area is known.

Traffic

It is anticipated that no significant traffic impacts need occur from LTPS construction. Road traffic impacts can be minimised by using marine transport for plant, materials and the workforce, by scheduling road deliveries outside peak hours and by careful design of site exits. Marine traffic, even at peak, involving 20 vessel movements per day, will only add approximately 5% to existing levels in the area and is thus not predicted to be significant.

Ecology

The site is of relatively low terrestrial ecological conservation value, and any fauna present are expected to escape during initial site clearance. Specimens or seeds of the two protected plant species found within the site can be relocated, either to AFD gardens or within the landscaping for the LTPS. The impact of construction activities on terrestrial ecology is thus not predicted to be significant.

Sampling of the marine ecology to date has not revealed any rare species. The sampling programme will be continuing in order to obtain data for all seasons and results will be considered in the Water Quality key issue report. The Chinese White (Pearl River) Dolphin is known to use the Urmston Road area, and the construction works may disturb the dolphins habitat; whilst the LTPS construction works will only be a part of the overall development planned for the shores of the Brothers Channel and Urmston Road, this is considered a potentially significant marine ecological impact associated with the construction of the LTPS.

Civil Aviation

Consultation with CAD and the New Airport Master Plan Study Consultants indicates that the construction activities will not violate the obstacle limitation surfaces associated with the future Chek Lap Kok airport or the existing Kai Tak flight paths. No impacts are therefore predicted.

Socio-Economics

The construction of the LTPS will provide a significant source of employment, which in turn will lead to the development of other goods and service related industries which will have a positive effect on the area. The site is located sufficiently far from population centres such that reduction in property value as result of disturbance from the LTPS construction work is unlikely to be of concern.

Cultural Heritage and Fung Shui

The Black Point area has been identified by the Antiques and Monuments Office (AMO) as an important archaeological site. A full mitigation plan for the investigation of these resources will be devised to the satisfaction of AMO.

Recreational and Visual Amenity

Yung Long beach will be removed by LTPS construction, although it is planned, in any event to be lost to PADS development.

Siting the LTPS to the north of Black Point substantially limits visual impacts during the construction period, although receptors to the south will be visually aware of the construction of the coal-fired unit stacks.

Decommissioning

Decommissioning of the LTPS is likely to begin around 2030 for Phase 1 of the station, and 2040 for Phase 2. Whilst CLP will be required to comply with the environmental legislation in force at that time, the broad issues which will need to be addressed have been identified, and generic mitigation measures to minimise impacts recommended; specific mitigation measures should be agreed with EPD (or its future equivalent) prior to the works commencing.

OPERATIONAL PHASE

Air Quality

Assuming that the EPD's BPM for emissions control are implemented, it is considered that the potential for human health impacts is only possibly significant with respect to the short term, i.e. 1-hour average concentrations. The extent and type of mitigation measures required cannot be determined at this stage, however, because of the uncertainty attached to the predictions made so far. This will be resolved during the Stack Emissions Key Issue Assessment.

The power station emissions are unlikely to cause significant dry acid deposition impacts however, the contribution of wet deposition requires further investigation in the Stack Emissions Key Issue Assessment.

Noise

Detailed assessment of noise impacts from the operation of the LTPS indicates that no significant impact will result either during the daytime or at night, from the operation of LTPS plant.

Water Quality

The operation of the LTPS is expected to be acceptable with regard to marine water quality. The following two key issues have be identified as requiring further study:

- Effect of sea flow patterns and the extent of the cooling water discharge thermal plume
- Dispersion of toxic metal discharges

The results of the mathematical modelling of these will be carried out as part of the Water Quality Key Issue Assessment.

Waste Disposal

Appropriate disposal locations for MARPOL and general operational wastes are available and will not give rise to significant impacts. Beneficial uses of PFA, FBA and gypsum have been identified and options which avoid the generation of solid byproducts (gypsum dissolution in seawater and seawater scrubbing suggested). However, these issues are to be studied further, and the findings presented in the Solid Byproducts Key Issue Report.

Traffic

No significant impacts are predicted to arise from operational road and marine traffic related to the LTPS.

Ecology

No significant impacts on terrestrial vegetation as a result of particulate, metal or dry acid species deposition are predicted. Potential impacts relating to wet acid deposition require further study and will be reported in the Stack Emissions Key Issue Report.

The marine ecological assessment is continuing, to allow the full annual seasonal range to be reported. The Chinese White (Pearl River) Dolphin makes use of the Urmston Road channel, and the development and operation of the LTPS, in conjunction with other deep waterfront industrial activities has the potential to affect the dolphins' environment. Further assessment on marine ecological issues will be presented in the Water Quality Key Issue Report.

Civil Aviation

The stacks for coal fired units will project above the anticipated obstacle limiting surface of the new airport at Chek Lap Kok. This is not considered significant due to the shielding effect of the Castle Peak range to the east, and will be discussed with CAD and the consultants for the new airport. The LTPS is not considered to pose any significant risks to aircraft from thermal or cloud generation effects.

Socio Economics

Operation of the LTPS will provide positive socio-economic impacts by enabling a future power shortfall in Hong Kong to be avoided, and providing direct and spin-off employment. The possibility of adverse impacts on commercial mariculture in Deep Bay is being addressed in the Water Quality Key Issue Assessment.

Cultural Heritage and Fung Shui

No significant cultural impacts are anticipated. Fung Shui impacts and mitigation requirements to be incorporated into the detailed design and layout of the LTPS are under investigation by CLP and local experts.

Visual

In the context of the semi-industrialised nature of the area, the visual impact of the LTPS is considered to be moderate. Should PADS developments proceed, the LTPS will be compatible.

Risk

The nearest population centres are under no significant hazard from the consequences of gas or oil incidents at the LTPS. Risks to potential PADS users immediately south of Black Point may be avoided by locating the gas pipeline route and oil berthing facilities such that the hazard distances involved lie wholly within the LTPS site.

A list of Key Issues to be addressed in specific Key Issue Reports is presented below.

Report	Issue
Stack Emissions - KIA	– Mitigation measures for emission control with respect to short term exposure (1-Hour AQO) and NO_2 – Recommend stack heights for coal, combined cycle and OCGT units – Assessment of contributions from LTPS to wet acid deposition
Water Quality - KIA	– Assessment of seaflow pattern and extent of thermal plume from cooling water discharge – Assessment of the dispersion of toxic metals from cooling water discharge – Assessment of impacts to marine ecology
Solid By-Product - KIA	– Confirm quantity of solid byproduct arisings from LTPS and Territory -wide over the next 20 years – Propose technically practical, economically feasible and environmentally acceptable management strategies for the byproducts (FBA,PFA,FGD gypsum and wastewater treatment sludges) over the same period

CONTENTS

1. INTRODUCTION

1.1 Background to the EIA

1.1.1 The Proposed Development

The China Light and Power Company Ltd (CLP) proposes to develop a large thermal power station (LTPS) in Hong Kong to meet forecast electricity demand during the late 1990s and into the next century. It is anticipated that the LTPS would ultimately provide 6000MW of power. Studies to date have assumed that approximately 5000MW would be generated from coal-fired units and upto 1000MW from gas turbine units fired on oil. Natural gas firing of part of the plant has also been considered and a site chosen so as not to preclude this option. The question of fuel type is one that is under active consideration by CLP as are options regarding the type of plant to be installed.

The implications for the extent and nature of environmental impacts resulting from fuel and plant choices require that two alternative fuel options be considered by the present study. These options are presented in Section V3/1.3.

1.1.2 Project History

In November 1989 CLP commissioned ERL (Asia) Ltd to lead a team of consultants to undertake a Site Search Study for the LTPS, based upon investigation of the following main issues:

- engineering feasibility;
- security of marine fuel supply;
- security of the transmission system;
- operational requirements;
- environmental protection;
- compatability with government planning;
- costs.

The purpose, scope and objectives of the study were agreed between CLP and the Hong Kong Government Planning, Environment and Lands Branch (PELB) which set up an interdepartmental Study Management Group (SMG) in order to:

- provide appropriate information for the consultants and advise on Government's opinions and concerns;
- monitor the progress of the study and review its findings;
- make recommendations to the Secretary for Planning, Environment and Lands at appropriate stages of the study.

The study consisted of three phases, as outlined below:

- o **Phase 1: Identification of Potential Areas**; wherein possible areas for location of the LTPS were identified on the basis of adequate marine access for fuel delivery and avoidance of conflict with strategic development plans e.g. PADS. A shortlist of 9 general areas was agreed with the SMG and were taken forward to Phase 2.

- **Phase 2: Identification of Potential Sites**; during which civil engineering, transmission issues and strategic planning conflicts received more detailed attention. A shortlist of sites at the following areas:

  - Black Point;
  - Southwest Lantau;
  - Soko Islands;
  - Artificial Island area (south of Lantau);
  - Po Toi Island;

  was identified for comparative assessment in Phase 3.

- **Phase 3: Comparative Assessment of Sites**; this was undertaken emphasising environmental issues and resulted in an overall ranking of the sites and recommendations regarding site selection.

Details of the site selection process, including the sites considered, the methodology devised and the selection criteria adopted were presented in the Site Search Report[1] and the Site Search Executive Summary[2].

The study resulted in the selection of Black Point for the following reasons:

- The **Black Point** sites were assessed as acceptable on all issues, although it was noted that significant engineering and navigation issues are required to be resolved to achieve this situation.

  The Black Point site was judged to have considerable advantages over the others in the following areas:

  - the technological and environmental impact aspects of transmission lines;

  - PFA (and possibly FGD by-product) storage potential at existing Tsang Tsui Lagoons;

  - planning and amenity aspects;

  - the technological aspects of air pollution control.

- The choice of the **Artificial Island** site would have incurred an unacceptably high-risk transmission system, a significant strain on the Territory's fill resources, a delay of one year to the project programme and likely unacceptable impacts on the Territory's solid waste management strategy.

- Sites at **Po Toi** would have required the acceptance of an uproven transmission link configuration resulting in an unacceptability high-risk transmission system with a probable delay of one year to the project programme.

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1 ERL (1990) 6000MW Thermal Power Station Site Search Report. ERL (Asia) Ltd September 1990 for CLP.

2 ERL (1990) 6000MW Thermal Power Station Site Search Executive Summary ERL (Asia) Ltd September 1990 for CLP.

- o The site at **Siu A Chau** would probably have involved unacceptable impacts on the Territory's solid waste management strategy and possibly unacceptable air quality impacts affecting upto 50% of the Lantau Country Parks.

- o The sites at **Southwest Lantau**, although the best on security of supply grounds, were unacceptable because short-term and severe air quality impacts could not be avoided over much of western Lantau on occasions. In addition, the siting of the power station itself would have caused substantial degradation of the landscape and would have represented an unprecedented level of conflict with the Country Parks Ordinance.

The final recommendation of the Black Point site for the LTPS was, therefore, conditional upon:

- the possible need for additional emissions control at the nearby Castle Peak Power Station (CPPS) to be investigated in detail during the EIA study;

- design of the cooling water system to prevent adverse effects on Deep Bay, to the north of the site;

- agreement with the Civil Aviation Department on the compatability of the LTPS chimney stacks with the requirements of the new airport at Chek Lap Kok;

- agreement on transmission lines separate from those serving CPPS and preferably across the Castle Peak Firing Range;

- agreement on modifications to the passage practices in the Ma Wan Channel.

The findings of the Site Search Report were accepted by the SMG in August 1990 and following scrutiny by the Development Progress Committee (DPC) were submitted for approval to the Land Development Planning Committee (LDPC). The findings were endorsed by LDPC on 7th December 1990. The location of Black Point within the Territory of Hong Kong is illustrated in Figure V3/1.1(a).

1.2 Objectives of the EIA and Initial Assessment Report

The objectives of the EIA, following identification of the (Black Point) site, were defined in the study brief and are as follows.

- o to describe the characteristics of the LTPS and related facilities;

- o to identify and describe the elements of the community and environment likely to affect or be affected by the LTPS including potential impacts on marine activities, obstacles in the environment from an aeronautical point of view, visibility reduction effects, updrafts caused by generation of hot air and effects on performance of radio navigational aids;

- o to minimise pollution, environmental disturbance and nuisance arising from the total development and its construction, operation and decommissioning;

- o to identify, predict and evaluate the net environmental impacts and the cumulative effects, including transboundary pollution, if any, expected to arise due to the construction, operation and decommissioning of the proposed development and any associated facilities;

- o to identify and specify methods, measures and standards to be included in the detailed design, which are necessary to mitigate these impacts and reduce them to acceptable levels;

- o to design and specify the environmental monitoring requirements for background, impact and compliance monitoring to ensure that the conditions mentioned above are met;

- o to design and specify environmental audit requirements for compliance and post-project audit, which will review the data from the monitoring programme to ensure that statutory requirements, policies and standards are met and that the necessary remedial works are identified to remedy any unacceptable consequential or unforeseen environmental impacts of the works.

The structure of the study requires that this Initial Assessment Report (IAR) should:

- o provide an initial assessment and evaluation of the net environmental impacts and cumulative effects of the development located at the site identified in the **Site Search Report**, including any transboundary pollution arising from the total development, sufficient to identify those issues of key concern during the construction, operating and decommissioning phases of the LTPS, which are likely to influence decisions on the LTPS;

- o define measurable parameters likely to be affected by the LTPS and identify any environmental monitoring studies which are required both to provide a baseline profile of existing environmental conditions and to monitor impact and compliance during implementation, commissioning, operation and future decommissioning of the LTPS;

- o provide an initial definition of environmental audit requirements for compliance and post-project audit, which shall include a review of the monitoring data both to identify compliance with regulatory requirements, policies and standards and to define any remedial works required to redress unanticipated or unacceptable consequential environmental impacts; and

- o propose a detailed programme of investigation and reporting able to meet all other objectives of the assessment.

In addition, two **Key Issues** were identified at the commencement of the EIA, which required an immediate start in order to ensure completion in line with project programming. These were:

- Stack Emissions;
- Water – both cooling water and the effects of reclamations.

It is anticipated that a need for further KIRs may arise from the study and consideration of the findings of this report. The EPD have indicated that a Key Issue Report is needed on Solid By-Product Management.

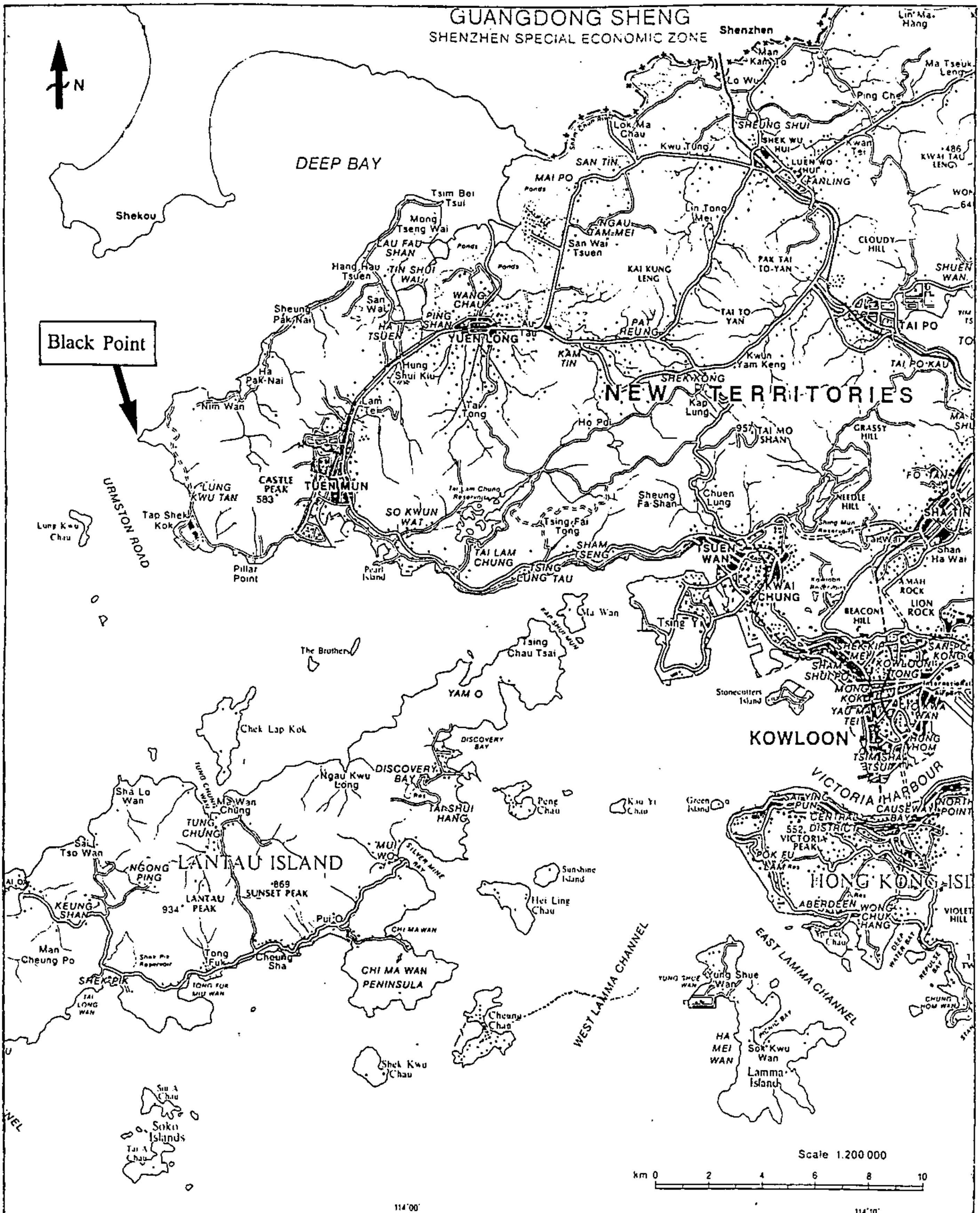

Figure V3/1.1 (a)

The Location of Black Point within the Territory of Hong Kong

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The programme of EIA study report submissions identified to date is indicated in Figure V3/1.2(a).

Figure V3/1.2(a)
Programme of EIA Study and Report Submissions

Report	October	1990 N D J F M A M J	1991 J A S O
IAR	●------------------------------------	------------------------------------ ▸*	
Stack Emissions KIR	●------------------------------------	--	------------------ ▸*
Water Quality KIR	●------------------------------------	--	------------------ ▸*

● = start-up
* = completion

1.3 Scope of the Study

The scope of the study was outlined in the brief. The IAR presents the results of the assessment of the project and identifies a number of Key Issues which will address specific areas of impact in sufficient detail to determine their sigificance. As a consequence of the possibility that some units of the LTPS may be gas-fired it was necessary to consider the likely impacts to be associated with a firing scenario other than the coal base-case. CLP, therefore, directed ERL to consider two alternative firing scenarios, the outlines of which are presented in Table V3/1.3(a). It should be noted, however, that it is not the purpose of the EIA to compare these options on environmental grounds; gas-firing can only be undertaken if economically viable and if a secure supply can be ensured.

The IAR has considered oil firing only as an operational contingency. The effects of oil firing on a more frequent basis will be considered as part of the Stack Emissions Key Issue Assessment.

Table V3/1.3(a)
Alternative Firing Scenarios for the LTPS

Scenario	1996	97	98	99	00	01	02	03	04	05	06	07	08
		PHASE 1							PHASE 2				
I Coal	680	680			680	680		680	680			680	680
II Gas and Coal													
Gas	600	600			600	600							
Coal								680	680			680	680

All figures are Megawatts.
April commissioning assumed in each case.

The IAR addresses the following:

- o **Construction**: Quantification of impacts where appropriate, assessment of the mitigation effects of proposed control measures, evaluation of effects on the existing environment, assessment in view of current statutory requirements and an evaluation of control procedures for construction of the LTPS. Discussion of impacts includes the following:

  - analysis of the method of construction and identification of potential major sources of dust and noise;

  - assessment of the impact of dust and noise producing processes, plant, vehicles and machinery on adjacent air and noise sensitive receivers;

  - consideration of the impacts of construction activities on the aquatic environment including effects of reclamation, jetty, berth, pipeline, intake, outfall and seawall construction and effects from silty runoff on water quality and circulation;

  - evaluation of the land and marine access requirements, including the environmental impacts related to the movement of borrow material, dredging and maintaining marine access;

  - consideration of the impacts from construction of fuel storage facilities including impacts on the landscape character, visual impact and erosion and runoff during construction;

  - identification of the socio-economic impacts upon existing villages, cultural impacts upon places of worship and any identifyable fung shui implications; and

  - consideration of the impacts of construction activities, such as the use of tower cranes, on the aeronautical environment.

- o **Operation** : For the operation of the LTPS the following were assessed for each of the two firing scenarios :

  - the cumulative impact of noise producing plant, vehicles and machinery associated with the operation of the site on adjacent noise sensitive receivers;

  - the direct and indirect enviromental impacts and cumulative effects on a local and a regional scale, due to aerial emissions from the proposed power station and associated facilities including the effects of sulphur oxides, nitrogen oxides, acid deposition, hydrocarbons, total suspended particulates, respirable suspended particulates, odour, toxic metals and chemicals, visibility and photochemical reactions, taking into account discharge and ambient standards as advised by the Director of Environmental Protection. Studies are continuing as part of the Stack Emissions Key Issue;

  - aqueous emissions (in terms of process effluents, cooling water, surface drainage, furnace bottom ash (FBA) pulverised fuel ash (PFA) and flue gas desulphurisation (FGD) wastes, leachate and on-site sewage & sullage) are identified and quantified with consideration for adequate interception, handling, treatment and disposal in order to comply with discharge and disposal guidelines approved by the Director of Environmental Protection. The necessary controls to minimise marine pollution are scoped. Studies are continuing as part of the Water Quality Key Issue;

- the effects of marine transport requirements on marine traffic, both those generated in or trading with Hong Kong and those to/from Chinese ports in the Pearl estuary, and water quality;

- transboundary pollution impacts;

- the effects of land transportation requirements on traffic congestion and road safety together with potential noise and dust impacts along proposed transportation routes;

- the disposal of any solid wastes in an integrated plant lifetime strategy, and the various possible methods of disposal and/or utilisation. Studies are continuing as part of the Solid By-products Key Issue study;

- the environmental impacts associated with the installation and operation of fuel supply and storage systems;

- visual impact of the installation;

- environmental monitoring requirements including baseline, impact and compliance monitoring;

- environmental audit requirements including compliance and post-project audit which will review the environmental monitoring data to identify compliance with regulatory requirements, policies and standards and any remedial works required to redress unacceptable consequential or unanticipated environmental impacts;

- the impact of construction activities, associated with the installation of later units, occuring concurrently with the operation of the plant.

1.4 Structure of the IAR

1.4.1 This report is organised in three volumes, as follows:

- Volume 1: The Surrounding Environment;
- Volume 2: The Construction Phase EIA;
- Volume 3: The Operational Phase EIA.

The scope of these volumes is outlined in the following sections.

1.4.2 Volume 1: The Surrounding Environment

This volume concentrates on the characteristics of the surrounding environment, describing both its present state and the manner in which it is anticipated to develop during the lifetime of the LTPS. The purpose is to define the receiving environment into which the LTPS will be placed. The lifetime of its operation and the planned development of the area are such that major changes are likely to occur. The impact of the LTPS can only be realistically assessed against an appreciation of the likely state of the surrounding environment during the project's lifetime. This volume is organised as follows:

o **Section 1**: An introduction outlining the background to the study, its scope and objectives and an indication of its outputs.

- o **Section 2**: Planning and Landuse; in which relevant aspects of the existing environment are described both in their present state and in the way they are anticipated to change during the lifetime of the project.

- o **Section 3**: Summary and Interpretation of Environmental Baseline Data; in which the baseline data collection programme is described and ambient air, water, sediment, noise and ecological conditions are summarised on the basis of initial site specific monitoring results and other existing relevant information. This section is supported by a presentation of data contained in the following annexes.

  - Annex V1/A – Meteorological Data
  - Annex V1/B – Air Quality Data
  - Annex V1/C – Marine Water Quality and Sediment Data
  - Annex V1/D – Groundwater Quality Data
  - Annex V1/E – Noise Environment Data
  - Annex V1/F – Terrestrial Ecology Data
  - Annex V1/G – Marine and Littoral Ecology Data

1.4.3 Volume 2: Construction Phase EIA

This volume describes the planned construction of the LTPS and predicts the likely associated impacts. Its organisation is as follows.

- o **Section 1**: Introduction (as for Vol.1)

- o **Section 2**: Contains a description of the proposed development including its main features, and phasing and programming details. In addition, a summary of the precise site layout development process is presented.

- o **Section 3**: describes the construction activities that will be required during the course of the development, both for initial site formation and installation of the first units and for subsequent construction periods when additional units are added to the LTPS.

- o **Section 4**: Describes the likely effects on Air Quality by identifying potential impact sources and sensitive receptors that may be affected; allowing prediction of likely levels of air pollution, which are assessed against existing criteria and anticipated changes in background levels.

- o **Section 5**: Noise impacts are predicted, based on assumptions of the plant to be used and their associated sound power levels, together with the location of noise sensitive receivers. Likely changes in ambient noise levels are also considered and the resulting predictions are assessed against knowledge of the existing noise levels obtained from the monitoring programme and relevant criteria contained in the Noise Control Ordinance.

- o **Section 6**: The impacts of construction activities on water quality will result primarily from dredging of marine sediments and the formation of reclaimed areas and the construction of the cooling water outfall and natural gas pipeline. The likely impacts associated with these activities are the subject of a detailed modelling exercise currently underway. It is expected that the result of this exercise will be presented in the Key Issue Report on Water Quality. The IAR is confined to a review of previous work undertaken in the area, together with the results of water quality and marine ecology sampling carried out for the study.

- **Section 7**: Waste disposal requirements during the construction phase are addressed in this section. Potential waste sources are identified from knowledge of construction activities and the necessary disposal arrangements are indicated.

- **Section 8**: Road and marine traffic generated by construction activity is estimated. Discussion of traffic impacts is confined in this section to severance and disturbance/nuisance effects. Air quality and noise impacts associated with site traffic are covered under Sections 4 and 5 respectively.

- **Section 9**: Both Marine and Terrestrial ecology impacts arising from construction are considered in this section. Terrestrial ecological impacts include both immediate site effects, and impacts on areas surrounding the site that may be affected by noise and dust. Marine ecology effects that may occur as a consequence of water quality impacts, will be examined via the modelling exercises in the Key Issue Report on water.

- **Section 10**: Possible impacts with regard to civil aviation are outlined in this section. Specifically, the height of construction equipment such as cranes is considered.

- **Section 11**: The socio-economic effects of plant construction are considered in this section. In particular, levels of local employment generation are considered.

- **Section 12**: The implications for cultural heritage in the area and potential Fung Shui effects are addressed in this section, on the basis of available recorded information.

- **Section 13**: Details impacts on recreation and visual amenity resulting from construction, based on preliminary plant layout.

- **Section 14**: Presents Conclusions and Recommendations.

- **Annex V2/A**: Contains a series of figures which illustrate the site development process which resulted in the present layouts.

- **Annex V2/B**: Contains Requirements for Environmental Monitoring to gauge impacts and test compliance during the Construction Phase.

- **Annex V2/C**: Considers impacts that will occur in the event that a coal conveyor is constructed between the existing CPPS and the LTPS at Black Point.

- **Annex V2/D**: Presents the current Construction Profile.

1.4.4 Volume 3: Operational Phase EIA

This volume describes the operational and decommissioning phases of the LTPS, and associated impacts. Impacts resulting from concurrent construction activities necessary for the installation of subsequent units are also detailed in this volume, which is organised as follows:

- **Section 1**: Introduction (as for Vol.1)

- **Section 2**: (as for Vol.2)

- **Section 3**: Presents an initial assessment of air quality impacts including an inventory of atmospheric emissions, identification of potentially sensitive receptors and appropriate criteria against which to identify impact significance. Alternative scenarios resulting from the two possible firing strategies are outlined. The effect of likely changes in background air quality (particularly SO_2 and NO_x) is a critical aspect of this. The air quality study will continue toward submission of a Stack Emissions Key Issue Report in October 1991.

- **Section 4**: Consideration of operational noise impacts involves an inventory of noise sources for each of the two fuel scenarios. Sensitive receivers are located and the effect upon them is modelled. These impacts are assessed against a predicted increase in background noise levels to allow impact identification and the development of mitigation proposals.

- **Section 5**: Presents the progress in the Water Quality Key Issue Studies. This proceeds from an inventory of effluent sources and likely discharges for both fuel scenarios, together with identification of sensitive receptors, to an indication of the likely effects of hydraulic changes and cooling water impacts. Consideration is given to likely changes in background concentrations when assessing the potential significance of impacts and the need for mitigation.

- **Section 6**: Solid by-product disposal requirements are predicted from an inventory of solid by-product sources and a preliminary solid by-product disposal strategy is developed. Both limestone/gypsum and seawater FGD systems are considered.

- **Section 7**: Operational road and marine traffic are predicted, the latter taking account of the two fuel scenarios. Severance and disturbance that may be associated with these movements are described. Noise and air quality impacts resulting from traffic are assessed in Sections 3 and 4 respectively.

- **Section 8**: Data outputs from the air quality study (Section V3/3) and the water quality study (Section V3/5) are used as a start point for the assessment of ecological impacts, with further input from preliminary marine and terrestrial ecological surveys. Potentially beneficial effects from proposed landscape planting and habitat provision are also considered.

- **Section 9**: Civil aviation implications, related to building heights and thermal plumes from stacks are explored.

- **Section 10**: Potential Socio-economic impacts are considered, in particular the generation of employment opportunities by LTPS development.

- **Section 11**: The cultural heritage and Fung Shui implications of the operation are assessed.

- **Section 12**: The visual impact is described, on the basis of the site location and the preliminary design layout of the plant. Zones of visual influence diagrams and montage illustrations are presented. Macro-scale mitigation potential is indicated.

- **Section 13**: This is a Risk Assessment of Scenario II concerning the supply and use of natural gas (NG) at the LTPS.

- **Section 14**: Key findings are presented, both definitive for the completed studies and preliminary for those areas of study that are the subject of Key Issue Reports.
- **Annex V3/A**: Illustrative figures of the site development process.
- **Annex V3/B**: Presents operational noise data.
- **Annex V3/C**: Investigates the likely impacts associated with the provision of a coal conveyor between the existing CPPS and LTPS.
- **Annex V3/D**: Illustrates pathways of trace elements through coal-fired units and FGD systems.
- **Annex V3/E**: Presents requirements for Environmental Monitoring to gauge impacts and test compliance during the operational phase.
- **Annex V3/F**: Indicates Environmental Audit requirements.

2. THE PROPOSED DEVELOPMENT

2.1 General Description of the LTPS

The Environmental Assessment for the LTPS has been based on two distinct development scenarios located within the same site envelope at Black Point in the North West New Territories. These scenarios represent two possible alternative developments depending on the availability of gas as a fuel option. The LTPS will also include up to 10 gas turbine units in open cycle for peak lopping and emergency standby.

Other major facilities which are required in addition to the power plant itself include three 400kV transmission links to distribute the generated power and a marine berth for the fuel and limestone vessels and the possibility of a cooling water discharge outfall that extends beyond the site envelope.

The LTPS is a phased development that will be built over a period of years starting with ground breaking in late 1991 and ending with commissioning of the final units in 2008. The concept is to have the first 2 units operating by 1 April 1997 and keep under review the need for and timing of subsequent units. A simplified programme for the two developments is shown in Figure V3/2.1(a). Ultimately it is envisaged that the LTPS will produce some 6000 MW of electricity.

A site area of about 120 hectares is required for 6000MW of generating capacity for Scenario I, including provision for the coal stockpile and storage of reagents and by-products from any FGD process which is required. Although the figures indicate a similar area is required for each Scenario this may be reduced for Scenario II to about 80 hectares due to a reduction in coal, FGD reagent and by-product storage requirements. Ideally, 40 ha of the site should be located on rock for both Scenarios in order to support the heavy power blocks. In the absence of unweathered rock at formation level, piled foundations or other substructures extending into the underlying rock will be required.

The site area does not include space for ash storage lagoons. It is proposed that the present lagoons at Tsang Tsui will accomodate the ash from the early years of operation. This is one of the advantages of the Black Point location in that new lagoons are not needed from the outset. This provides time for other ash utilisation routes to be developed.

It is preferable for the LTPS to be located at a coastal site for two reasons. Firstly, to allow coal and limestone delivery by large bulk carriers direct to the plant; the EIA has assumed a minimum requirement for the marine facility is the capability to berth vessels of 180,000 - 200,000 deadweight tonnage (dwt). A 20m channel depth would provide an underkeel clearance of 10% of the ship's draught. This was a key consideration in identifying potential site areas in the early stages of the Site Search for the LTPS. Secondly, the need for large quantities of cooling water advocates a coastal position.

It is assumed that the first main unit will be commissioned by April 1996. Programming is discussed further in the following section in relation to specific construction activities.

2.2 The Two Fuel Scenarios

The Site Search Study was conducted on the premise that the LTPS will have conventional, external-combustion, steam-cycle generating units, fired by coal. The technical suitability and hazard implications for accepting natural gas as a fuel was however also included as a siting criterion.

Now, two specific fuel scenarios are being used in the environmental initial assessment study (and in any Key Issues work). These are, all coal and a combination of natural gas and coal. The purpose of this is not to discover which is environmentally preferable but to assess the environmental implications of each so that an informed decision can be made by CLP that covers all the necessary elements of security of supply, operability and costs as well as environment and planning.

The two fuel Scenarios are given in Table V3/2.2(a). In Scenario I coal is the sole fuel through the whole development. In Scenario II natural gas is the sole fuel in Phase 1, that is for the first half of the ultimate station and coal is used for Phase 2, the second half. In both Scenarios back-up fuel (in the form of oil) is required. Also in both Scenarios up to 1000MW of open cycle gas-turbine capacity would be installed.

The consumption of fuels under these two Scenarios and the generation of solid by-products are shown in Tables V3/2.2(b) and (c) for Scenarios I and II respectively. These characteristics of the two Scenarios have profound influence on what facilities are provided and when.

Scenario I : All Coal

This Scenario comprises a LTPS of 8 x 680 MW (nominal) conventional external combustion steam cycle generating units fired by coal, combined with up to 10 x 100 MW (nominal) gas turbine units in open cycle fired by distillate. Figures V3/2.2(a) and (b) indicate the extent of development for this Scenario in Phase 1 and Phase 2.

Scenario II : Gas/Coal

This scenario comprises a LTPS of 4 power trains each consisting of 2 or 3 Gas Turbines with a waste heat recovery boiler and steam turbine, together with 4 x 680 MW (nominal) conventional external-combustion, steam cycle generating units fired by coal and 10 x 100 MW gas (nominal) turbine units in open cycle fired by natural gas. The gas units would be installed in Phase 1 and the coal units in Phase 2. Figures V3/2.2(c) and (d) indicate the extent of development for this Scenario in Phase 1 and Phase 2.

2.3 Project Programme

Introduction

This section summarises the civil works which will need to be undertaken to develop the LTPS Scenarios from a greenfield site. Specific details are given in Section V3/3.0.

The work described is that which is required to develop the power station to a point where the major items of the plant can be installed inside the buildings. Activities are described broadly in the order in which they take place.

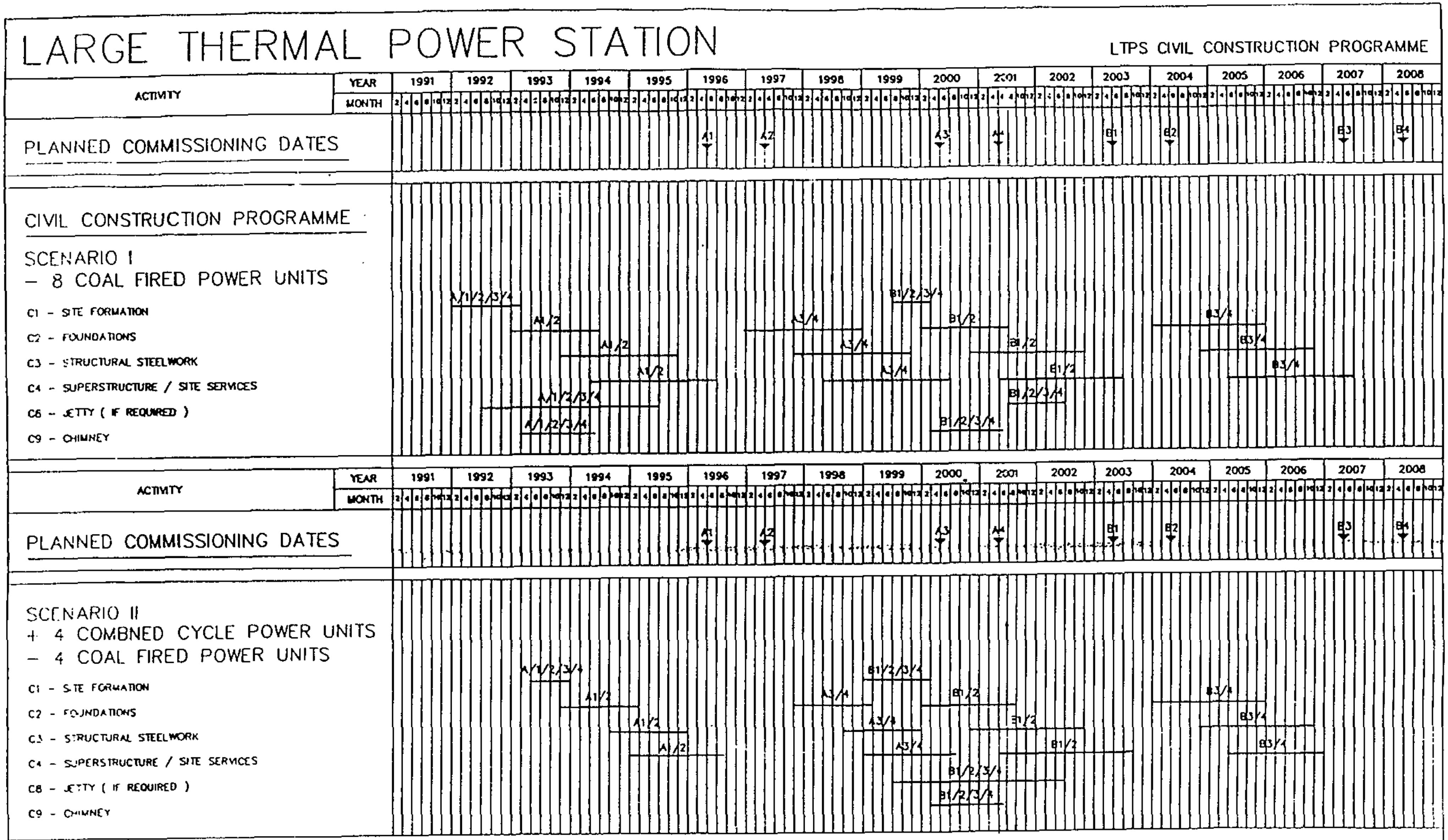

Figure V3/2.1(a) LTPS Civil Construction Programme

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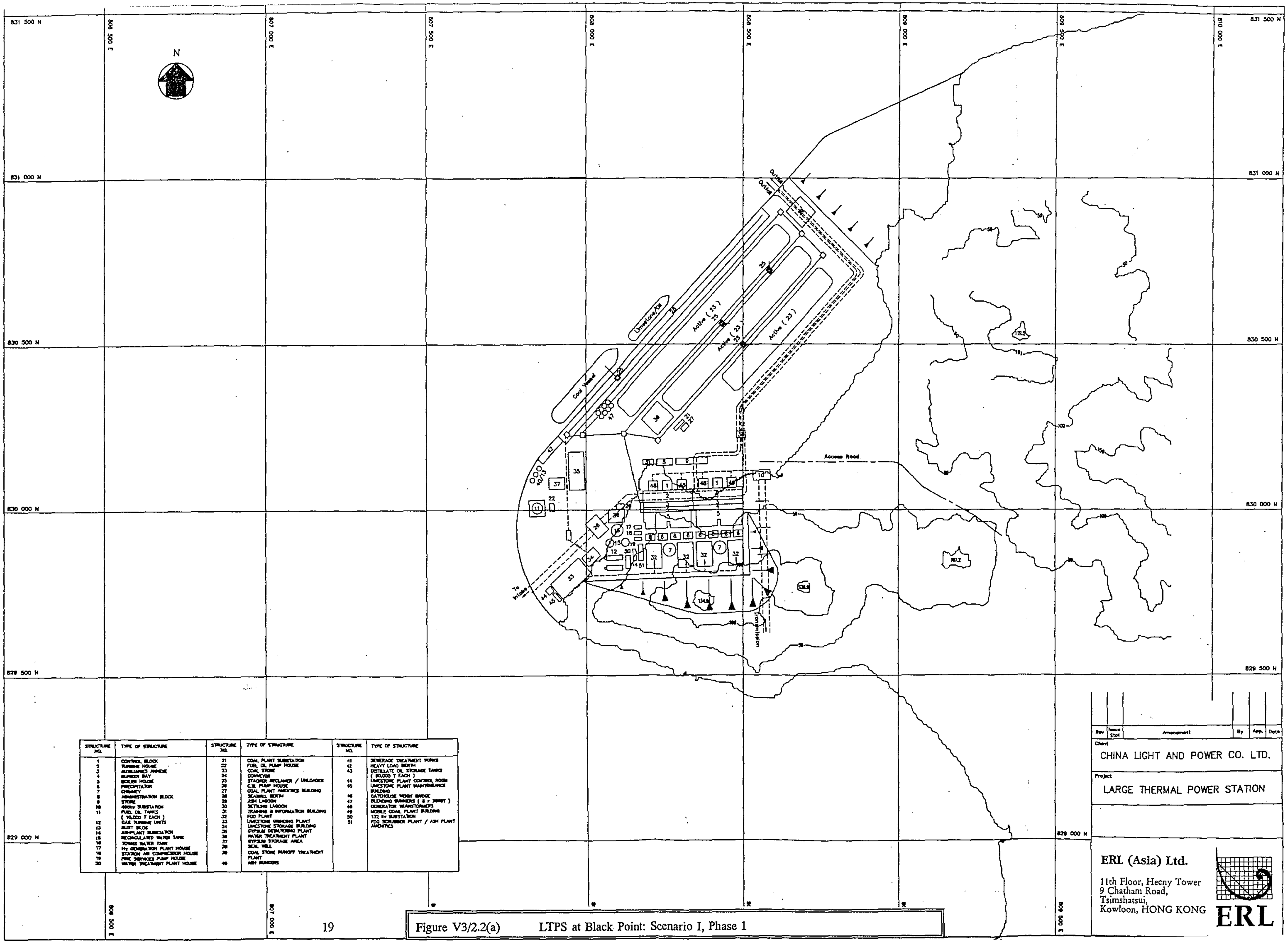

STRUCTURE NO.	TYPE OF STRUCTURE	STRUCTURE NO.	TYPE OF STRUCTURE	STRUCTURE NO.	TYPE OF STRUCTURE
1	CONTROL BLOCK	21	COAL PLANT SUBSTATION	41	SEWERAGE TREATMENT WORKS
2	TURBINE HOUSE	22	FUEL OIL PUMP HOUSE	42	HEAVY LOAD BERTH
3	AUXILIARIES ANNEXE	23	COAL STORE	43	DISTILLATE OIL STORAGE TANKS (80,000 T EACH)
4	BUNKER BAY	24	CONVEYOR		
5	BOILER HOUSE	25	STACKER RECLAMER / UNLOADER	44	LIMESTONE PLANT CONTROL ROOM
6	PRECIPITATOR	26	C.W. PUMP HOUSE	45	LIMESTONE PLANT MAINTENANCE BUILDING
7	CHIMNEY	27	COAL PLANT AMENITIES BUILDING		
8	ADMINISTRATION BLOCK	28	SEAWALL BERTH	46	GATEHOUSE WEIGH BRIDGE
9	STORE	29	ASH LAGOON	47	BLENDING BUNKERS (8 x 3000T)
10	400kv SUBSTATION	30	SETTLING LAGOON	48	GENERATOR TRANSFORMERS
11	FUEL OIL TANKS (10,000 T EACH)	31	TRAINING & INFORMATION BUILDING	49	MOBILE COAL PLANT BUILDING
		32	FGD PLANT	50	132 kv SUBSTATION
12	GAS TURBINE UNITS	33	LIMESTONE GRINDING PLANT	51	FGD SCRUBBER PLANT / ASH PLANT AMENITIES
13	DUST SILOS	34	LIMESTONE STORAGE BUILDING		
14	ASHPLANT SUBSTATION	35	GYPSUM DEWATERING PLANT		
15	RECIRCULATED WATER TANK	36	WATER TREATMENT PLANT		
16	TOWNS WATER TANK	37	GYPSUM STORAGE AREA		
17	H_2 GENERATION PLANT HOUSE	38	SEAL WELL		
18	STATION AIR COMPRESSOR HOUSE	39	COAL STORE RUNOFF TREATMENT PLANT		
19	FIRE SERVICES PUMP HOUSE				
20	WATER TREATMENT PLANT HOUSE	40	ASH BUNKERS		

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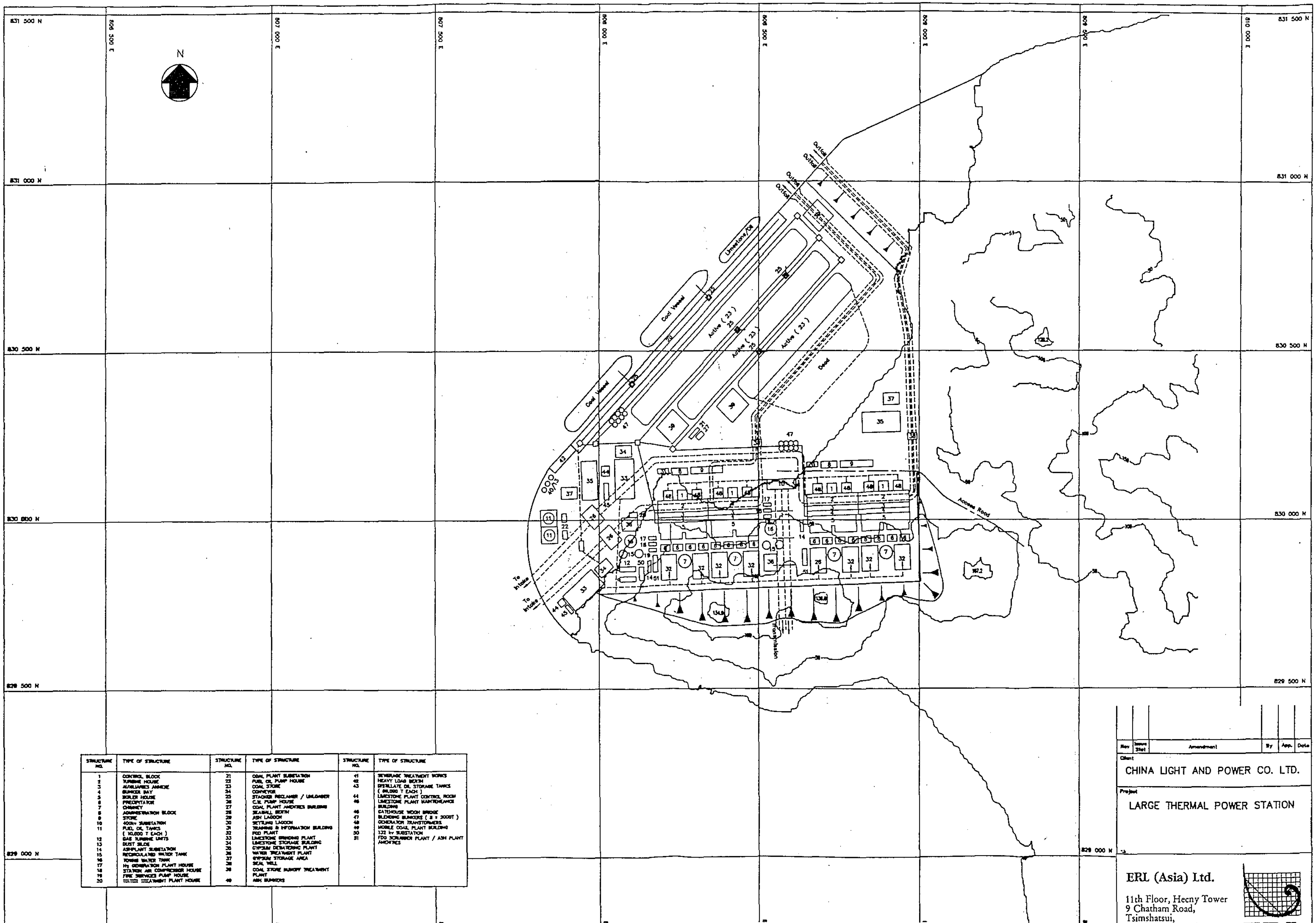
Figure V3/2.2(a) LTPS at Black Point: Scenario I, Phase 1



STRUCTURE NO.	TYPE OF STRUCTURE	STRUCTURE NO.	TYPE OF STRUCTURE	STRUCTURE NO.	TYPE OF STRUCTURE
1	CONTROL BLOCK	21	COAL PLANT SUBSTATION	41	SEWERAGE TREATMENT WORKS
2	TURBINE HOUSE	22	FUEL OIL PUMP HOUSE	42	HEAVY LOAD BERTH
3	AUXILIARIES ANNEXE	23	COAL STORE	43	DISTILLATE OIL STORAGE TANKS (80,000 T EACH)
4	BUNKER BAY	24	CONVEYOR	44	LIMESTONE PLANT CONTROL ROOM
5	BOILER HOUSE	25	STACKER RECLAIMER / UNLOADER	45	LIMESTONE PLANT MAINTENANCE BUILDING
6	PRECIPITATOR	26	C.W. PUMP HOUSE	46	GATEHOUSE WOOH BRIDGE
7	CHIMNEY	27	COAL PLANT AMENITIES BUILDING	47	BLENDING BUNKERS (8 x 2000T)
8	ADMINISTRATION BLOCK	28	SEAWALL BERTH	48	GENERATOR TRANSFORMERS
9	STORE	29	ASH LAGOON	49	MOBILE COAL PLANT BUILDING
10	400kv SUBSTATION	30	SETTLING LAGOON	50	132 kv SUBSTATION
11	FUEL OIL TANKS (10,000 T EACH)	31	TRAINING & INFORMATION BUILDING	51	FDG SCRUBBER PLANT / ASH PLANT AMENITIES
12	GAS TURBINE UNITS	32	FGD PLANT		
13	DUST SILOS	33	LIMESTONE GRINDING PLANT		
14	ASHPLANT SUBSTATION	34	LIMESTONE STORAGE BUILDING		
15	RECIRCULATED WATER TANK	35	GYPSUM DEWATERING PLANT		
16	TOWNS WATER TANK	36	WATER TREATMENT PLANT		
17	H_2 GENERATION PLANT HOUSE	37	GYPSUM STORAGE AREA		
18	STATION AIR COMPRESSOR HOUSE	38	SEAL WELL		
19	FIRE SERVICES PUMP HOUSE	39	COAL STORE RUNOFF TREATMENT PLANT		
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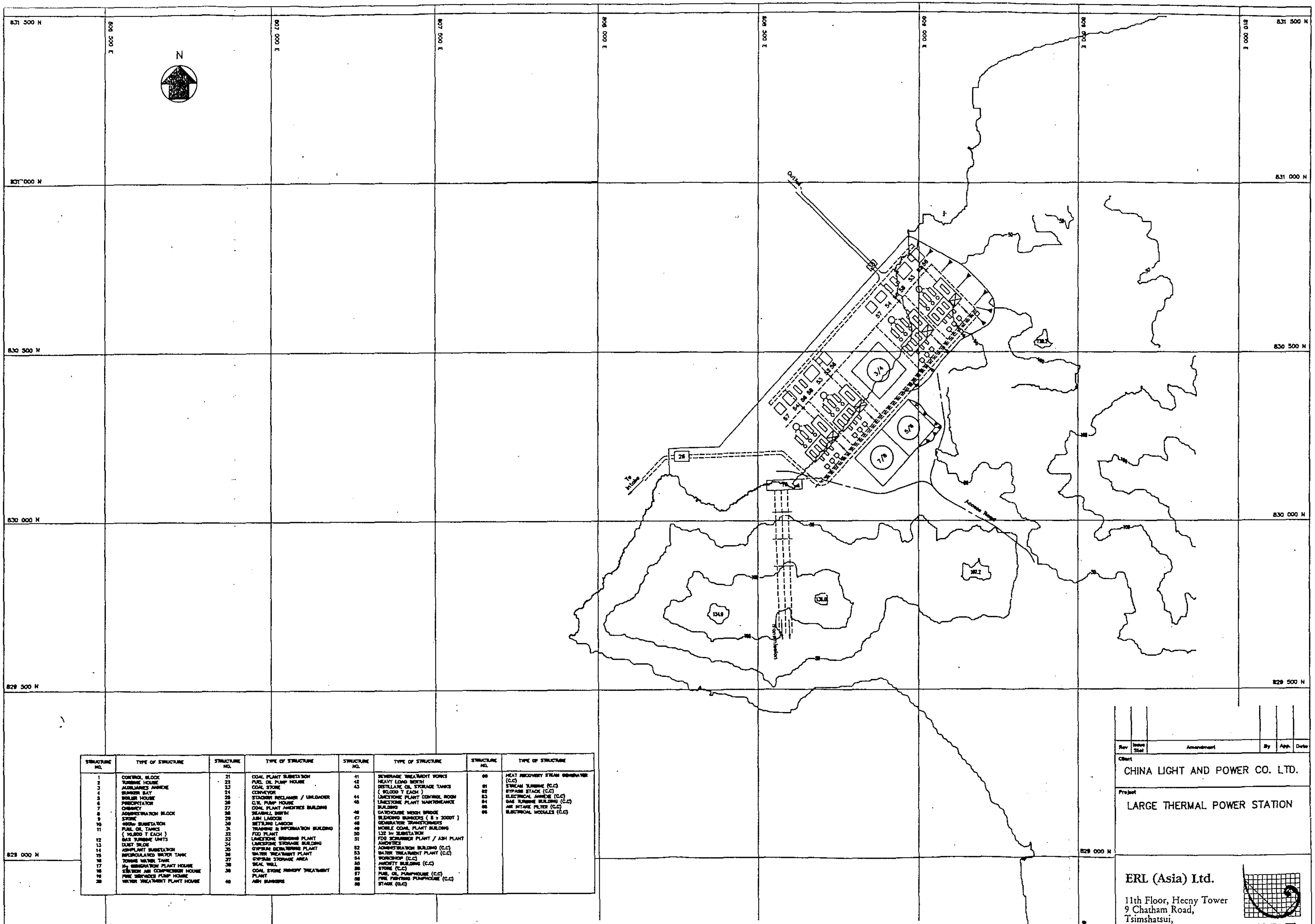
Figure V3/2.2(b) LTPS at Black Point: Scenario I, Phase 2



STRUCTURE NO.	TYPE OF STRUCTURE	STRUCTURE NO.	TYPE OF STRUCTURE	STRUCTURE NO.	TYPE OF STRUCTURE	STRUCTURE NO.	TYPE OF STRUCTURE
1	CONTROL BLOCK	21	COAL PLANT SUBSTATION	41	SEWERAGE TREATMENT WORKS	60	HEAT RECOVERY STEAM GENERATOR (C.C)
2	TURBINE HOUSE	22	FUEL OIL PUMP HOUSE	42	HEAVY LOAD BERTH	61	STEAM TURBINE (C.C)
3	AUXILIARIES ANNEXE	23	COAL STORE	43	DISTILLATE OIL STORAGE TANKS (90,000 T EACH)	62	BYPASS STACK (C.C)
4	BUNKER BAY	24	CONVEYOR	44	LIMESTONE PLANT CONTROL ROOM	63	ELECTRICAL ANNEXE (C.C)
5	BOILER HOUSE	25	STACKER RECLAIMER / UNLOADER	45	LIMESTONE PLANT MAINTENANCE BUILDING	64	GAS TURBINE BUILDING (C.C)
6	PRECIPITATOR	26	C.W. PUMP HOUSE	46	GATEHOUSE WEIGH BRIDGE	65	AIR INTAKE FILTER (C.C)
7	CHIMNEY	27	COAL PLANT AMENITIES BUILDING	47	BLENDING BUNKERS (8 x 2000T)	66	ELECTRICAL MODULES (C.C)
8	ADMINISTRATION BLOCK	28	SEAWALL BERTH	48	GENERATOR TRANSFORMERS		
9	STORE	29	ASH LAGOON	49	MOBILE COAL PLANT BUILDING		
10	400kv SUBSTATION	30	SETTLING LAGOON	50	132 kv SUBSTATION		
11	FUEL OIL TANKS (10,000 T EACH)	31	TRAINING & INFORMATION BUILDING	51	FGD SCRUBBER PLANT / ASH PLANT AMENITIES		
12	GAS TURBINE UNITS	32	FGD PLANT	52	ADMINISTRATION BUILDING (C.C)		
13	DUST SILOS	33	LIMESTONE GRINDING PLANT	53	WATER TREATMENT PLANT (C.C)		
14	ASHPLANT SUBSTATION	34	LIMESTONE STORAGE BUILDING	54	WORKSHOP (C.C)		
15	RECIRCULATED WATER TANK	35	GYPSUM DEWATERING PLANT	55	AMENITY BUILDING (C.C)		
16	TOWNS WATER TANK	36	WATER TREATMENT PLANT	56	STORE (C.C)		
17	N_2 GENERATION PLANT HOUSE	37	GYPSUM STORAGE AREA	57	FUEL OIL PUMPHOUSE (C.C)		
18	STATION AIR COMPRESSOR HOUSE	38	SEAL WELL	58	FIRE FIGHTING PUMPHOUSE (C.C)		
19	FIRE SERVICES PUMP HOUSE	39	COAL STORE RUNOFF TREATMENT PLANT	59	STACK (C.C)		
20	WATER TREATMENT PLANT HOUSE	40	ASH BUNKERS				

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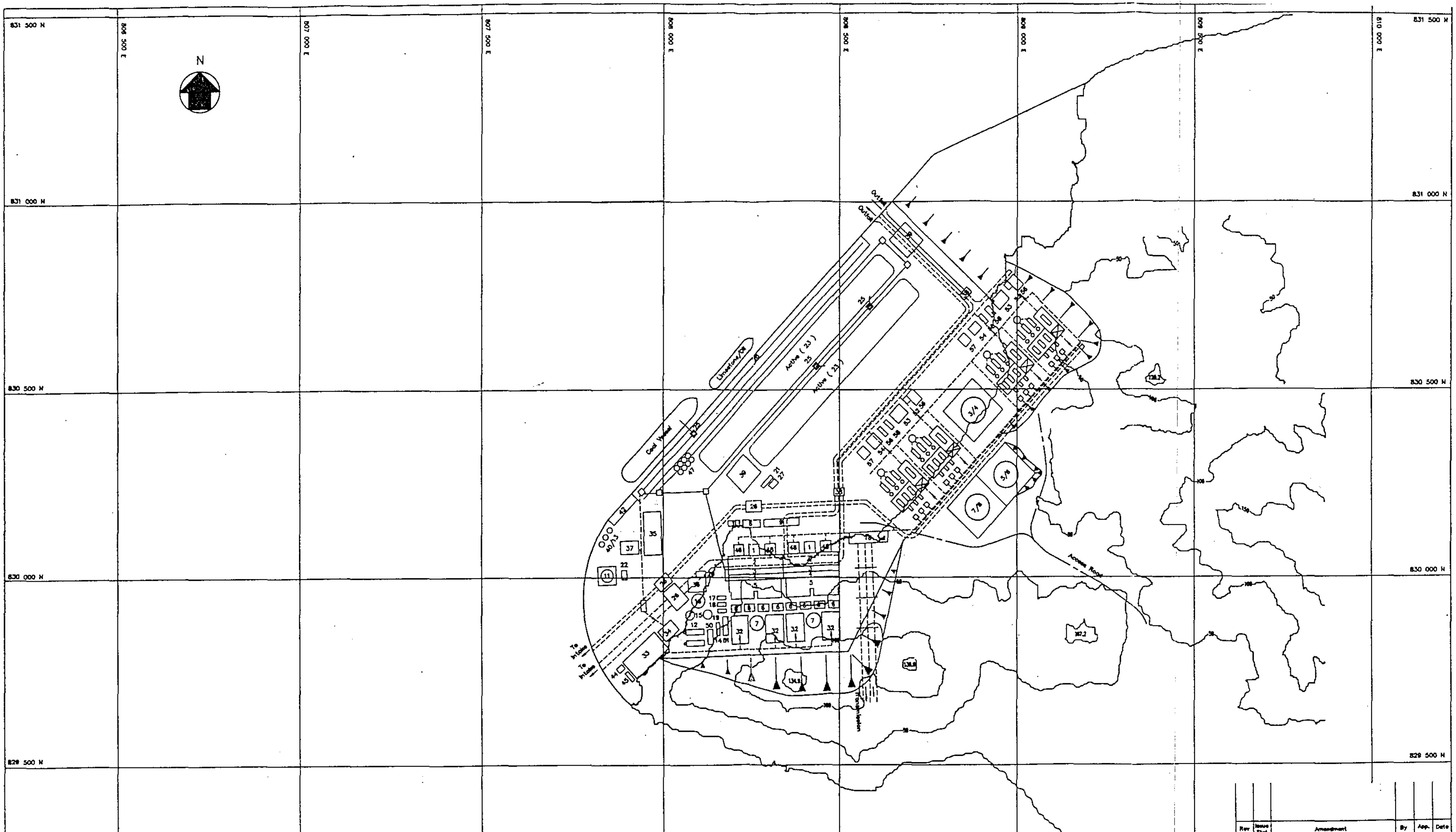
Figure V3/2.2(c) LTPS at Black Point: Scenario II, Phase 1



STRUCTURE NO.	TYPE OF STRUCTURE	STRUCTURE NO.	TYPE OF STRUCTURE	STRUCTURE NO.	TYPE OF STRUCTURE	STRUCTURE NO.	TYPE OF STRUCTURE
1	CONTROL BLOCK	21	COAL PLANT SUBSTATION	41	SEWERAGE TREATMENT WORKS	60	HEAT RECOVERY STEAM GENERATOR (C.C)
2	TURBINE HOUSE	22	FUEL OIL PUMP HOUSE	42	HEAVY LOAD BERTH	61	STREAM TURBINE (C.C)
3	AUXILIARIES ANNEXE	23	COAL STORE	43	DISTILLATE OIL STORAGE TANKS (80,000 T EACH)	62	BYPASS STACK (C.C)
4	BUNKER BAY	24	CONVEYOR	44	LIMESTONE PLANT CONTROL ROOM	63	ELECTRICAL ANNEXE (C.C)
5	BOILER HOUSE	25	STACKER RECLAIMER / UNLOADER	45	LIMESTONE PLANT MAINTENANCE BUILDING	64	GAS TURBINE BUILDING (C.C)
6	PRECIPITATOR	26	C.W. PUMP HOUSE	46	GATEHOUSE WEIGH BRIDGE	65	AIR INTAKE FILTER (C.C)
7	CHIMNEY	27	COAL PLANT AMENITIES BUILDING	47	BLENDING BUNKERS (8 x 2000T)	66	ELECTRICAL MODULES (C.C)
8	ADMINISTRATION BLOCK	28	SEAWALL BERTH	48	GENERATOR TRANSFORMERS		
9	STORE	29	ASH LAGOON	49	MOBILE COAL PLANT BUILDING		
10	400kv SUBSTATION	30	SETTLING LAGOON	50	132 kv SUBSTATION		
11	FUEL OIL TANKS (10,000 T EACH)	31	TRAINING & INFORMATION BUILDING	51	FDG SCRUBBER PLANT / ASH PLANT AMENITIES		
12	GAS TURBINE UNITS	32	FGD PLANT	52	ADMINISTRATION BUILDING (C.C)		
13	DUST SILOS	33	LIMESTONE GRINDING PLANT	53	WATER TREATMENT PLANT (C.C)		
14	ASHPLANT SUBSTATION	34	LIMESTONE STORAGE BUILDING	54	WORKSHOP (C.C)		
15	RECIRCULATED WATER TANK	35	GYPSUM DEWATERING PLANT	55	AMENITY BUILDING (C.C)		
16	TOWNS WATER TANK	36	WATER TREATMENT PLANT	56	STORE (C.C)		
17	H_2 GENERATION PLANT HOUSE	37	GYPSUM STORAGE AREA	57	FUEL OIL PUMPHOUSE (C.C)		
18	STATION AIR COMPRESSOR HOUSE	38	SEAL WELL	58	FIRE FIGHTING PUMPHOUSE (C.C)		
19	FIRE SERVICES PUMP HOUSE	39	COAL STORE RUNOFF TREATMENT PLANT	59	STACK (C.C)		
20	WATER TREATMENT PLANT HOUSE	40	ASH BUNKERS				

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Figure V3/2.2(d) LTPS at Black Point: Scenario II, Phase 2

Table V3/2.2(a)
The 2 Fuel Scenarios

	Phase 1						**Phase 2**						
1 April STS	96	97	98	99	00	01	02	03	04	05	06	07	08
Unit No.	Unit 1	Unit 2			Unit 3	Unit 4		Unit 5	Unit 6			Unit 7	Unit 8
SCENARIO I													
– Coal only	680	680			680	680		680	680			680	680
SCENARIO II													
– Natural Gas	600	600			600	600		–	–			–	–
	c/c	c/c			c/c	c/c							
and													
Coal	–	–			–	–		680	680			680	680

STS – Steam to set (start)
c/c – combined cycle

Table V3/2.2(b)
Scenario I – Fuel Consumption and Solid By-product Generation

Annual Fuel Consumption	98/99	2002	2005/06	2010	Comments
Coal x 10^6 tonnes					
LMR	1.00	2.00	4.00	6.00	Lower Merit Ranking[1]
HMR	3.60	7.20	10.80	14.40	Higher Merit Ranking[1]
0.87 HMR	3.12	6.24	9.36	12.50	a 5% up-lift is included to take account of energy needs for FGD.
Oil tonnes	18,750	37,500	56,250	15,000	
Natural Gas	0	0	0	0	
Annual Ash Production					
PFA tonnes	393,000	786,000	1,179,000	1,571,000	assuming 14% ash content in HMR coal (average)
FBA tonnes	44,000	87,000	131,000	175,000	
Cumulative Ash Production	end of March 2000	end of March 2003	end of March 2007	end of March 2010	
PFA x10^6 tonnes	1.38	3.54	8.06	12.57	
FBA x10^6 tonnes	0.14	0.39	0.9	1.37	
Limestone/Gypsum FGD					
Annual limestone required tonnes per year	140,000	280,000	420,000	560,000	from limestone/gypsum FGD system (disposal grade gypsum)
Annual gypsum produced tonnes per year	156,600	313,200	469,800	626,400	
Cumulative Gypsum Production x 10^6 tonnes	0.39	1.33	2.51	5.40	

Note: These figures may be revised with the Solid By-Product Key Issue Report.

[1] For definition; see Final Site Search Report, p.20, 3.5.2

Table V3/2.2(c)
Scenario II – Fuel Consumption and Solid By-product Generation

Annual Fuel Consumption	98/99	2002	2005/06	2010	Comments
Coal x 10^6 tonnes					
LMR	–	–	1.00	2.00	Lower Merit Ranking
HMR	–	–	3.60	7.20	Higher merit ranking
0.87 HMR	–	–	3.12	6.24	a 5% up lift is included to take account of energy needs for FGD.
Oil tonnes	18,750	37,500	56,250	15,000	
Natural Gas /m^3	1.5 x 10^9	3 x 10^9	3 x 10^9	3 x 10^9	
Annual Ash Production					
PFA tonnes	–	–	393,000	786,000	assuming 14% ash content in coal (average)
FBA tonnes	–	–	44,000	87,000	
Cumulative Ash Production	end of March 2000	end of March 2003	end of March 2007	end of March 2010	assuming 14% ash content (average)
PFA x10^6 tonnes	–	–	1.38	3.54	
FBA x10^6 tonnes	–	–	0.14	0.39	
Limestone/Gypsum FGD					
Annual limestone required tonnes per year	–	–	140,000	280,000	from limestone/gypsum FGD system (disposal grade gypsum)
Annual gypsum produced tonnes per year	–	–	240,000	480,000	
Cumulative gypsum production x 10^6 tonnes	–	–	0.84	2.16	

2.3.1 Site Formation

This involves excavation of soil and rock from the land based section of the site and formation of the reclamation and seawall.

- **Site Excavation**

  An attempt has been made to balance the cut volume with the fill requirement for the reclamation. Cut and fill volumes are detailed in Section V2/3.1 together with the area located on rock. This area is predominantly reserved for the power blocks which have strict settlement criteria.

  Material generated by the cutting will be available for filling operations. A 15% bulking factor has been included in estimating the quantity of material available for fill. Any excess fill generated for the reclamation may be either stored in an area adjacent to the reclamation or sold in the market place; however no account has been taken at this stage of the market potential for the sale of this excess fill. Since construction work on the power station occurs at a time of peak demand for fill, this could be seen as contributing to the Territory's available fill resources.

  Site formation will require the creation of significant backslopes. These slopes will require protection from the elements; typically this is done by a combination of sprayed concrete, rock bolting, grassing and planting. Run off and groundwater from these backslopes and the catchment area external to the site will require drainage to accommodate the natural water flow and prevent flooding. Provision must be made to accommodate flow from the valley between Black Point and the firing range as the natural path of this run off will be obstructed by the development.

  Similarly, provision must be made for diverting or protecting the route of the existing ash pipeline from Castle Peak to Tsang Tsui as this at present runs across the proposed development.

- **Site formation**; essentially consists of the following activities:

  - dredging a trench for the perimeter seawall of the reclaimed area and dredging within the area to be reclaimed if required, and subsequent disposal of the dredged material;

  - levelling of the land-based part of the site to about +7mPD and the generation of fill material;

  - construction of the seawall;

  - filling inside the seawall to create the reclamation, using fill material generated by site levelling wherever possible.

  It is considered uneconomic and unnecessary to remove the marine mud internally to the seawall to the same depth as beneath the seawall. Existing borehole information indicates that there may be up to 15m of marine mud in certain locations within the site perimeter. Experience gained from trial embankments at Chek Lap Kok indicates that if a layer of marine mud of about 10m is left and drained with proprietary vertical drains to a capping layer above, approximately 90% of the expected consolidation will occur within the first year. With careful programming and controlled filling operations, the construction of the foundations for those buildings which are located on the reclaimed area (the ancillary buildings) need not commence until the majority of this consolidation has taken place. Therefore it is assumed that only marine mud above a thickness of 10m will be removed from the area within the seawall boundary.

The seawall around the reclamation will have considerable weight of its own in addition to the lateral forces acting on it from the retained material. For this reason, it is necessary to found the seawall on strata with a higher bearing capacity than that of typical marine mud. The marine mud will therefore be dredged along the line of the seawall down to the underlying alluvium or sand.

2.3.2 Berthing Facilities

The timing of berth construction is contingent upon which development Scenario is adopted. The main difference is that with Scenario II, Phase 1 will not require a large berth for coal vessels. Gas for the combined cycle units would be supplied by a pipeline probably from Lung Kwu Chau where an isolating valve station would be constructed.

However for Scenario I a berth will be required for Phase 1 with a water depth requirement of 20 metres. (During Phase 2 of Scenario II a berth will be constructed similar to that provided in Phase 1 of Scenario I). The berth would be extended for a further 180,000 dwt vessel when needed. It is also possible that a conveyor will be provided from Castle Peak to transport coal..

Irrespective of which Scenario is developed and prior to construction of any permanent berth for the carriers, a shallow berth would be established to allow access to the site for plant and materials.

Berthing facilities will be provided by either a seawall or jetty :-

- **Seawall berth**

  The conventional seawall provided for the reclamation must be modified for a seawall berth to form a vertical face instead of the conventional 1 in 3 slope of a perimeter seawall. The vertical face is likely to be formed using pre-cast concrete caissons which must be of sufficient mass and suitably restrained to resist the lateral forces of ships berthing against it, in addition to the forces imposed by the fill material retained behind the wall. Vessel protection from berthing impact is required in the form of an extensive fender system along the length of the seawall berth.

- **Jetty berth**

  In order to provide a berthing structure at some distance from the site a finger jetty would be built out from the perimeter seawall to deeper water. This would terminate in a jetty head against which the ships will berth. It is likely that the entire structure would be open piled and similar to that at the CPPS or formed from caissons in the same manner as a seawall berth. The jetty approach would be an open piled trestle structure with a reinforced concrete desk.

The general principle adopted is to align the berthing face parallel to the predominant current regime, in so far as this is indicated by marine contours and existing flow information.

At each of the berth locations a certain amount of dredging would be required for the carriers to gain access. For coal carriers a turning circle of 600m diameter near the berth and a channel width of up to 300m on the approach has been assumed as a typical requirement; this is likely to be sufficient for a carrier in the 180,000 dwt class. These are not intended as design criteria but are representative of typical dimensions. In the course of the detailed design, account will need to be taken of the marine environment prevailing along the channel length and in the manoeuvreing area.

2.3.3 Road Access

Road access has been identified from the WENT southern access road to the eastern edge of the site. Road construction will immediately precede site formation, and be by conventional construction methods. It is not anticipated that the WENT access road to the temporary unloading jetty will be used as a main access for the LTPS.

The alignment of this road is shown in Figures V3/2.2(a–d).

2.3.4 Foundation Construction

The depth of weathering of the rock on the site has been estimated from existing geological information as 20m. Those buildings on unweathered rock will have shallow concrete foundations and those on weathered rock or on the reclaimed area may have piled foundations. Foundation construction will be carried out by conventional construction techniques. The time required to construct the building foundations is on the critical path for meeting the programme for commissioning of the first two units.

2.3.5 Cooling Water System

The cooling water (CW) system will have a capacity of approximately 15 million m^3/day. The system comprises an intake structure, requiring a water depth of at least 10–15m, leading to the CW pumphouse, from where the water is pumped to the main power block.

During operation of the power station, the cooling water will flow through the condensers in the turbine hall via a system of underground culverts; these culverts must be established during the early stages of site construction. The CW system terminates at the marine outfall, for which typically a minimum water depth of 5m is required.

The correct location of the CW intake and outfall is critical to the operation of the power station and for minimising the environmental impacts of the cooling water discharge. The system should be designed to minimise recirculation of the discharged water to the intake and to avoid situations where high levels of suspended solids in the intake water could lead to problems of deposition in the condensers. Similarly any effects on the CPPS must be assessed. Preliminary locations of the CW intake and outfall have been defined based on what is currently known of the local current regime and are shown on Figures V3/2.2(a–d). Detailed assessment and optimisation will be carried out in the preliminary design stage.

2.3.6 Erection of Structures on Site

Once construction of the foundations for the buildings and other structures on site has progressed sufficiently, erection of the structural framework for the buildings can begin. Erection may then proceed progressively as the foundations are completed. The frames for the main building housing the power blocks, and for most of the ancillary buildings are likely to be of structural steelwork. Some of the smaller ancillary buildings may have a structural frame of reinforced concrete rather than steel.

Structural steelwork will be clad generally in profiled metal roof and wall sheeting, the treatment of which will be designed to minimise the visual intrusion of the LTPS. In most cases buildings with a reinforced concrete frame will be clad in brickwork, or concrete blockwork, and then rendered or tiled.

As the buildings are erected, installation of the LTPS plant and equipment will also commence. Some large items of equipment will be installed before the cladding is added to the building framework. Items of plant will generally arrive in pre-fabricated units to minimise the amount of assembly required on-site.

2.3.7 Chimneys

There will be two distinct types of chimney to be constructed for each Scenario. The chimneys associated with gas turbines both in open and closed cycle with be of steel. Due to the increase in temperature and lower levels of pollutants in flue gases associated with gas-firing, the heights of these chimneys are far less (60 - 80m) than for the coal-fired system.

For the conventional coal-fired units it is likely that the chimney height will be of the order of 250m. These generally comprise a reinforced concrete windshield enclosing the flues which carry the flue gases.

2.3.8 Ash Storage Facilities

The LTPS site is adjacent to the Tsang Tsui ash lagoons which currently serve CPPS. Depending on the extent to which alternative means of ash marketing are permitted, and their success, additional lagoon capacity may have to be provided to serve both power stations. The lifetime of the existing lagoon, and timing and size of any additional facilities would thus depend very much on Government's future strategy for utilisation of PFA in construction materials and the active promotion of its use in reclamations.

2.4 Evolution of LTPS Site Location and Layout

2.4.1 Introduction

With Government endorsement of the location of CLPs LTPS (LDPC 7th December 1990) at Black Point, the focus of the study shifted towards definition of a precise location and layout. In order to do this, a number of constraints which had been considered during the Site Search Study were applied in a more specific manner to the Black Point area. The section that follows indicates the various options that were considered and the criteria that were used to differentiate between them.

In order to explore the various site location and layout criteria meetings were held involving CLP and their consultants for the LTPS design. The participants and their areas of responsibility in the project development were as follows:

-	CLP	:	Operational requirements and plant engineering
-	Mouchel Asia Limited	:	Civil Engineering
-	BMT (Peter Fraenkel)	:	Marine Issues
-	Sandwells	:	Materials Handling
-	Black and Veatch	:	FGD by-products and fly ash disposal
-	RMJM	:	Architectural treatments and landscaping
and	ERL (Asia) Ltd	:	Environmental Issues

2.4.2 Stage 1

Major constraints to site location at Black Point were identified as:

- the need for access to 20m water depth to allow berthing of large coal carriers either by dredging or a long sea jetty;
- the need to avoid the North-West New Territories Sewage outfall, currently under construction to the south of Black Point;
- the requirement for a secure 400 KV supply route;
- compatibility with PADS guidelines;
- land ownership issues;
- the environmental benefits of retaining part of the Black Point ridge.

A number of site locations and layouts were subsequently developed for consideration.

2.4.3 Stage 2

Five preliminary site options emerged. These are depicted in Annex V3/A and Figures 1 to 5. Each site was considered in turn on the basis of engineering, marine, mechanical and electrical, and environmental issues, the findings of which are summarised in Table V3/2.4(a). Site design was complicated by the need to consider two Phases of development and to accept the possibility that the second Phase would not necessarily be developed. Potential conflicts were identified between reclamation phasing and landforms and operational requirements; for example the need to provide a transmission corridor across the Phase 2 area at Phase 1 stage. Suggestions for improvements to each of the sites in these respects were incorporated into the next stage. In addition, a sixth option was developed, intended to incorporate the most suitable features of options 4 and 5.

At this stage key location considerations were the following:

- the compatibility or otherwise of the option with PADS proposals; both for full site development and for Phase 1 only;

- the need to locate the power blocks and stacks on solid rock foundations, which confined them to the Black Point promontory; site options were thus primarily concerned with the location of the coal stockyards;
- the need to minimise dredging costs; both capital and operational and the quantities of marine sediment for disposal;
- concern to minimise the length of any open-piled structure connecting the site with a jetty berth; both to minimise any inconvenience to shipping and to re ce the risk to security of coal supply resulting from impact damage;
- compatibility between Phase 1 and Phase 2 outlines in order to minimi changes in hydraulic flow conditions and facilitate practical jetty location and alignment;
- sensitive receptors to noise and air quality impacts located south of the site would be benefitted by location of the site to the north of the point. Particularly as it was considered unlikely at this time that a residual portion of the Black Point ridge would be available for shielding;
- the need to avoid the sewage outfall and its reserve, for existing and future pipelines;
- the desire to avoid the need for large lengths of seawall to be constructed in deep water.

The six stage 2 options are presented in Annex V3/A, Figures 6 to 11.

2.4.4 Stage 3

The six options to emerge from stage 2 incorporated suggested modifications as far as was practicable. The subsequent site location meeting considered the results and found that a modified Option 4 presented the best option for development to the north of Black Point and that Option 6 should be considered as a basis for site location to the south of the point.

At this stage it emerged that the issue of seawall berthing and high dredging costs versus long finger jetty berthing and jetty security was one that could be considered almost independently of site options ie. that each of the main options could be modified to take a seawall or a jetty, once financial considerations regarding the costs of dredging and jetty construction and maintenance had been made and the results of hydraulic modelling at Black Point were known. It also became clear that the optimal layouts for development of both the northerly and the southerly options enabled a fringe of the Point to be left in place. This was considered to be of considerable benefit in terms of reducing both noise and visual impact to the residents of Lung Kwu Tan in the event that the site to the north of the point was chosen. The retention of part of Black Point was adopted as a main design aim.

Stage 3 Options 4 and 6 are illustrated in Annex V3/A, Figures 12 and 13. It was considered that the phasing of these two favoured options could be further refined and that, for option 6 in particular, the layout and development of the coal stockyard could be further developed.

Table V3/2.4(a)
BLACK POINT SITE DEVELOPMENT: STAGE 2 CONSIDERATIONS

OPTION	CONSTRAINTS AND SUGGESTIONS			
	CIVIL ENGINEERING	**MARINE**	**MECHANICAL/ELECTRICAL**	**ENVIRONMENTAL**
1	- Phasing is in line with PADS proposals; - Phase 2 stockyard requires a separate and additional handling system; - Without Phase 2 reclamation has a strange shape; - Compatible with drainage reserve for NWNT outfall; - Will cause siltation in bay to south; - Phase 2 buildings and stockyard separate (no logical progressive development); - Little dredging required; - Vulnerable finger jetty.	- Jetty location bad for Deep Bay currents, suggest move further south; - Flow changes between Phases 1 and 2 make jetty alignment difficult; - Phase 2 stockyard could use mobile plant, thus removing shape restrictions; - Phase 1 outline should be made compatible with PADS; - no obvious routing for coal.	- Complicated cooling water (C.W.) system with Phase 2; - 400 kV substation to be moved to southern end of Gas Turbines; - Suggest phase I units moved north and Phase 2 south so that chimneys are in line. - Chimney and FGD locations to be reversed.	- Shape of reclamation intrusive if no PADS; - Bay to south risks high siltation + possible effects from sewage outfall; - Noise impacts possible for Lung Kwu Tan; - Visual impacts at Lung Kwu Tan; - Siltation leads to change in marine + littoral habitats; - coal stacks perpendicular to wind for Phase I which could increase fire risk; - Coal surrounds site; station has no 'clean face'.
2	- More progressive and logically phased than option 1; - Not compatible with PADS planning line; - Encroaches on NWNT outfall drainage reserve; - Form of reclamation strange without Phase 2; - Will cause siltation of Bay.	- Stockyard extension easier and more logical; - Western face should be pulled into coast more; - Common coal/limestone unloader can be used; - If seawall is at 10m contour then limestone and oil unloading at seawall may be possible; - No change in water flows with phasing; - Jetty should be moved further south.	- 400 KV substation requires better location; - fewer problems with cooling water on phasing than option 1.	- Shape of reclamation intrusive with PADS; - Bay to south risks high siltation + possible effects from sewage outfall; - Noise and visual impacts possible from ships and gantries but probably better than option 1; - Siltation leads to change in marine and littoral habitats; - No direct take of archaeology on terrestrial ecology in bays.

Table V3/2.4(a) – (continued)
BLACK POINT SITE DEVELOPMENT: STAGE 2 CONSIDERATIONS

OPTION	CONSTRAINTS AND SUGGESTIONS			
	CIVIL ENGINEERING	**MARINE**	**MECHANICAL/ELECTRICAL**	**ENVIRONMENTAL**
3	– fits fairly well with PADS; – two coal handling areas but phase 2 could be used as dead storage and thus mobile plant; – long deep seawall is expensive.	– Change flows on jetty significantly with Phase 2 stockyard, suggest change stockyard and shape; – would require training wall to the beach on N/E site.	– Cooling water problems with phasing; – 400 kV substation should be moved; – Uses reversing conveyors, therefore outward.	– surrounded by stockyard; – noise, visual and siltation problems unlikely to be as bad as for options 1 and 2; – no direct take of archaeology or terrestrial ecology in bays.
4	– progressive phasing of coal stockyard; – fits with PADS/no PADS scenarios; – problem with drainage of valley to north.	– very long jetty (could be shortened); – rotates stockyard and move inline with contour; – reclaim stockyard lengthways; – long vulnerable jetty would need to be well lit with buoys upstream. Move jetty south and reorientate in line with contour; – compatible with current flows; – gets coal stockyard drainage nearer PFA lagoons for possible disposal.	– Good arrangement for C.W. discharge; – rotate main blocks through 180°	– Doesn't extend beyond Black Point; – Obliterates beach to north which is currently an amenity and could remain so, even with Black Point P.S.; – Archaeological site destroyed; – Sensitive receptors at Lung Kau Tan get degree of shielding from noise and visual impacts; – suggest aligning chimneys parallel to old B.P. ridge line; – suggest retention of southern coastal fringe of B.P. upto 20 or 30m to facilitate noise + visual shield.
5	– Better alignment of stockyard; – try longitudinal phased reclamation of stockyard; – Very high dredging costs approx. HK$286m capital and annual HK$13.5m.	– Seawall berth is not affected by currents; – Reverse limestone and coal vessels; – Reduce width of channel and monoeuvre remote from berth; – direct channel round to south in line with flows; – May be self-scouring reducing dredging costs.	– rotate blocks through 180°	– Sensitive receptors to the south are shielded; – suggest retention of part of B.P. ridge, as for option 4; – suggest further option to be developed as a hybrid of 4 and 5.

2.4.5 Stage 4

The subsequent editions of Options 4 and 6 were considered by the design group. At this stage it was determined that Option 4 was the most likely to proceed to detailed design. CLP, therefore, instructed ERL to proceed with the IAR assuming that a variation on Option 4, with either a sea wall or a jetty, would be built. It was stressed, however that the IAR should also indicate the environmental impacts that would occur in the event that Option 4 was ruled out and a variant of Option 6, to the south of the point, was adopted.

Also at this stage, two new options were presented. They were Options 7 and 8 (presented Annex V3/A, Figures 14 and 15 and were the first to be developed for Scenario II, the gas/coal scenario. Essentially the same site location criteria as used for the coal only sites were applied to these new options. The main differences with the coal only option relating to site features were as follows:

- reduced size of coal stockyards;
- a maximum of two high stacks;
- potentially a much smaller site if Phase 2 were not developed, and one with a much reduced visual aspect due to the absence of high stacks;
- a phased jetty construction.

Of the two gas/coal sites it was considered that option 8, to the north of Black Point, represented the best alternative on environmental grounds (mainly noise and visual issues).

2.4.6 Stage 5

Further refinements were made to site designs located to the north of Black Point, two for Scenario I coal and two for Scenario II and these are illustrated in Annex V3/A, Figures 16 to 19. Comments suggested that stockyard orientation in option 4D should be rotated to be more in line with the prevailing wind direction. In addition, Mouchel Asia Limited were requested to develop Scenario II with flexibility for either all CCGT or CCGT and coal combined. It was at this stage in site development that CLP's requirement for complete fueling flexibility was introduced. Whilst the EIA process continued with the two scenarios originally defined, actual site design attempted to keep all options open regarding each successive set of units so that, theoretically, any fueling combination of coal and gas for the four pairs of units could be easily achieved within the site boundary. A feature of this was that the first CCGT units, in the event of gas-firing, would be located as far north as possible.

Gazetted areas for the borrow pit boundary and the Island East Transfer Station (IETS) jetty and road access to Western New Territories Landfill (WENT) required consideration. It was understood from discussions with EPD that encroachment onto this area would only be acceptable if alternative access to WENT were provided by CLP. Other considerations included the need to optimise the site level and the cut and fill balance, as well as developing initial cost estimates of the layouts. The intention was to firmly establish an outline reclamation shape which would represent the final development of the various "northern" options, and which could the be used as an input to hydraulic and water quality modelling.

2.4.7 Site Envelope and ongoing refinements

Site development and refinement continued, with the aim of exploring all layout and location possibilities. The prime objective was to fix a site 'envelope' within which complete LTPS development flexibility was possible, without compromising environmental considerations or constraining the construction process or plant operability. Principal considerations at this stage included:

- the aim of balancing cut and fill at all stages of the development
- the location of heavy plant on areas of hard rock
- minimisation of dredging requirements
- preservation of a significant portion of the Black Point ridge

The resulting layouts, at the time of writing are indicated in Figures V3/2.2(a–d). Fill balancing and appropriate plant foundation have been achieved by polarising the plant locations, such that Black Point itself is reserved for coal units, whilst CCGT units can be developed on the rock to the north of the existing Yung Long beach. This arrangement maintains development flexibility. Seawall alignment is a product of the cut and fill balance and dredging minimisation. A substantial part of Black Point ridge is maintained.

The site refinement process will continue. Of particular concern are the Cooling Water system arrangements. The environmental assessment of this aspect will be addressed in the Water Quality Key Issue Report.

2.4.8 Summary

The preference for development of a site to the north of Black Point inevitably involves a trade–off between different types of environmental impact. The key environmental factors considered in this trade–off, and reasons for the choice of the northern option can be summarised as follows:

- noise impacts to the village of Lung Kwu Tan, during both construction and operation will be lower due to:

  - maximising the distance between site activities and the village;

  - shielding obtained by retention of a substantial part of the Black Point ridge.

- visual impacts will be reduced as follows:

  - stockyards will not be visible from Lung Kwu Tan;

  - jetties, if used, will be less conspicuous;

  - retention of the southern fringe of Black Point will act as a substantial screen. Although some of the development (tops of boiler houses, stacks) will still be visible, visual intrusion will be minimised.

- Flow characteristics are unlikely to be greatly modified around Black Point (a major operational design requirement).

- o There is no indication that siltation rates in the bays to the south of Black Point would be increased in the long–term.

- o Avoids conflicts with the PADS boundaries for other developments.

- o Visual and recreational amenity beach at Yung Long is lost.

- o Archaeological site at Yung Long affected, although organisation of an investigation and excavation programme should be acceptable mitigation.

- o Two beaches to the south of Black Point (Lung Kwu Tan) and Lung Kwu Sheung Tan, the only known breeding sites of the giant King Crab (Tachypleus gigas) in Hong Kong should remain unaffected, providing a suitable cooling water outfall location is achieved.

3. AIR QUALITY

3.1 Introduction

3.1.1 General Sources of Impact

The operation of the LTPS will involve a number of activities and processes which will result in emissions of a range of pollutants to the atmosphere. These source categories can be summarised as follows:

- gaseous and particulate by-products of fuel combustion;
- fugitive dust emissions from the coal stockyard, storage of any limestone (if used for FGD[1]) and solid by-products storage;
- fugitive hydrocarbon emissions from delivery, storage and distribution of liquid fuels and lube oils.

In this section the potential for off-site impacts arising from these sources is assessed and recommendations are made either for appropriate mitigation measures or for more detailed study. It should be noted that air quality impacts were recognised at the beginning of the study to be an important concern and so a Key Issue Assessment (KIA) of stack emissions was started at the same time as the Initial Assessment. The two studies have been proceeding in parallel and, although the KIA is not yet finished, the main output of the study to date is summarised in this section, together with a programme for further study.

3.1.2 Statutory Requirements

The control of emissions to atmosphere and potential impacts are regulated under the Air Pollution Control Ordinance (1987). The Ordinance sets out a number of Air Quality Objectives (AQOs), for protection of ambient air quality in Hong Kong (see Table V3/3.1(a)[2]), specifies fuel regulations which are applicable within the territory and also defines a number of Specified Processes for which particular regulations apply as licensing conditions. Electricity works are defined as a Specified Process and so the new power station at Black Point will need to be designed and operated in accordance with these regulations.

The Ordinance states that:

> "The owner of any premises used for the conduct of any specified process shall use the best practicable means for preventing the emission of noxious or offensive emissions from such premises, and for preventing the discharge, whether directly or indirectly, of such emissions into the atmosphere, and for rendering such emissions where discharged harmless and inoffensive."

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1 Flue Gas Desulphurisation

2 Table 3.1(a) presents the complete set of ambient Air Quality Objectives applicable in Hong Kong. It should be noted that only a subset of these are relevant to the LTPS -see Section 3.2.

Table V3/3.1(a). Hong Kong Air Quality Objectives

Pollutant	Ambient Concentration Limit (μg/m³)[1] for Different Averaging Times (na = not applicable)				
	1 hour[2]	8 hours[3]	24 hours[3]	3 months[4]	1 year[4]
Sulphur Dioxide (SO_2)	800	na	350	na	80
Nitrogen Dioxide (NO_2)	300	na	150	na	80
Total Suspended Particulates (TSP)	na	na	260	na	80
Respirable Suspended Particulates (RSP)[5]	na	na	180	na	55
Carbon Monoxide (CO)	30000	10000	na	na	na
Photochemical oxidants (as ozone)[6]	240	na	na	na	na
Lead	na	na	na	1.5	na

1 Measured at 298K (25°C) and 101.325 kPa (one atmosphere).
2 Not to be exceeded more than three times per year.
3 Not to be exceeded more than once per year.
4 Arithmetic mean.
5 RSP are defined as suspended particulates in air with a nominal aerodynamic diameter of 10 micrometres and smaller.
6 Photochemical oxidants are determined by measurement of ozone only.

'Best practicable means' (BPM) is defined in the Ordinance as having reference:

> "....not only to the provision and the efficient maintenance of appliances adequate for preventing such emission, but also to the manner in which such appliances are used and to the proper supervision by the owner of the premises of any operation in which such an air pollutant is evolved."

In this respect, the EPD has set BPM requirements for emissions control from new power stations, as summarised in Table V3/3.1(b). In addition the Ordinance requires that the sulphur content of fuel oil does not exceed 0.5% (weight/weight).

Table V3/3.1(b)
Hong Kong BPM[1] Requirements for Control of Emissions from the New Power Station

Pollutant	BPM Requirment
SO_2	Max sulphur content of fuel: coal 1%, oil 0.5% Flue gas desulphurisation: 90% removal
NO_x	Max flue gas concentration at stack exit: 330 ppm (by volume)at 12% CO_2, for steam turbine units; 75 ppm by volume for gas turbine units at 15% O_2
Particulates	Max flue gas concentration at stack exit: 50 mg/Nm^3
1	Best Practicable Means - see Section V3/3.1.2.

Such requirements for fuel oil sulphur contents and viscosities are designed to cater for industrial boilers and seem less appropriate for power generating plant, particularly where FGD is installed.

As well as statutory requirements, the Government provides Codes of Practice for the operation and maintenance of a Specified Process; where relevant these will be acted upon.

It should be noted that CLP has expressed concern over the consequences of the BPM stated by EPD for SO_2, in terms of its high cost, its reduction in thermal efficiency, its adverse impact on plume dispersion and its increase in other types of emission. CLP have asked ERL to examine the actual improvement in air quality that will result from this BPM.

3.1.3 Approach to the Assessment

The approach adopted for this assessment is intended to provide appropriate information within the context of the regulatory framework outlined above and is as follows:

- emissions to the atmosphere have been quantified for the power station's different operational regimes and are presented as a series of inventories in Section V3/3.2;

- potential impact categories and receptors are identified in Section V3/3.3, including categories other than human health and receptors outside Hong Kong;
- the likely impact of the power station emissions on air quality has been estimated by the use of dispersion models and other indicators and is presented in Section V3/3.4; this section includes a summary of modelling undertaken in the KIA and an assessment of the contribution of emissions from the Castle Peak power station;
- the effect of growth in background emissions is discussed in Section V3/3.5;
- the significance of the predicted air quality impacts is assessed in Section V3/3.6, making reference to the AQOs presented in Table V3/3.1(a) and other relevant criteria for pollutants and impact categories not covered by the AQOs;
- the implications of the assessment for the design and operation of the LTPS and requirements for any specific mitigation measures are presented in Section V3/3.7, together with an outline of the remainder of the KIA programme.

It should be noted that the LTPS plant design has not been finalised, and therefore the data provided in this assessment is indicative. Where predicted impacts are particularly sensitive to the assumptions made, further analysis will be undertaken within the Stack Emissions Key Issue Assessment.

3.2 Source Characteristics and Inventories of Emissions

3.2.1 (i) Main Stacks - Scenario I

The main stacks will be the major sources of emissions to the atmosphere. The emitted pollutants under Scenario 1 (all coal), which may be of local or regional concern and which require assessment are:

- nitrogen oxides (NO_x)
- sulphur dioxide (SO_2)
- particulates (TSP and RSP)
- unburnt hydrocarbons

The particulates, apart from being a pollutant in their own right, will carry with them very small quantities of certain trace metals, derived from metal impurities in the coal. These are potentially of concern with respect to direct impacts on human health (through inhalation) and impacts on soils and vegetation (following deposition) - see Section V3/3.3.

Under Scenario 1, exhaust gases and particulates from the eight generating units will be emitted to the atmosphere via four main stacks, each with two flues. The exact stack height is not yet known and will be finalised, partly, as a result of the conclusions of the EIA. However, for the purpose of initial assessment of impacts, a height of 250m has been assumed. This is the same as at the Castle Peak B station and is consistent with the preliminary findings of the site search study. A flue diameter of 6.6m has been assumed on the basis of preliminary engineering designs.

The stack–exit temperature of the exhaust gases has been taken as 80°C, on the assumption that the BPM for SO_2 control will be achieved by installing a limestone-gypsum FGD system, though this decision will actually be made following completion of the Stack Emissions KIA. This system produces exhaust gases which are, in fact, much cooler than 80°C and re–heating of the exhaust gases would be required to achieve it. However, this is likely to be necessary to eliminate any visible plume, and to provide the gases with sufficient thermal buoyancy to achieve satisfactory dispersion into the atmosphere[1].

Table V3/3.2(a) presents source characteristics and emission rates of the key pollutants (on a per–flue basis) for unit loadings of 100%, 75% and 50%. The emission rates were calculated on the assumption that the BPM measures presented in Table V3/3.1(b) will be applicable. By applying these data to current plans for the development of the power station and its operational regime, it is possible to derive estimates of pollutant emission rates at different stages of the development over a range of averaging periods. This information is presented in Table V3/3.2(b) for SO_2, NO_x, and TSP respectively for Scenario's I. In Table V3/3.2(c) seasonal information on likely operational loading of the power station and associated emission rates is presented for the completed development, i.e. from 2009 onwards.

For assessment of trace metal impacts we have made worst–case estimates of the emission rates of the various metals contained in the coal (see Table V3/3.2(d) for typical coal analysis). In calculating these emission rates (shown in Table V3/3.2(e)) a number of worst–case assumptions were made:

- an ash content of 20% was assumed together with maximum likely trace metal concentrations;

- a low dust removal rate of 20% was assumed for the FGD process, whereas 80% would be the target rate.

3.2.1 (ii) Main Stacks - Fuel Scenario II

Under Scenario II, the first 2400MW of capacity will be combined cycle gas turbine (CCGT) units, fired by natural gas as their primary fuel. Distillate oil firing will be provided as an operational contingency. The current best estimates of source characteristics and emissions data of these units, when operating at full load, are presented in Table V3/3.2(f). This information is preliminary, however, and has been assembled for the purpose of this IAR. More detailed data will be confirmed as the KIA proceeds.

It will be noted that the gas scenario results in zero SO_2 and particulate emissions from the CCGT units, the only pollutant of concern therefore being NO_x. By applying available data to current plans for the development of the power station and its operational regime, we have derived estimates of pollutant emission rates at different stages of the development over a range of averaging periods. This information is presented in Table V3/3.2(g) for SO_2, NO_x, and TSP respectively. In Table V3/3.2(h) seasonal information on likely operational loading of the power station and associated emission rates is presented for the completed development, i.e. from 2009 onwards.

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1 An exit temperature of 80°C is also consistent with BPM in the UK. Without FGD the exit temperature would be 120°C, and the plume would consequently be more buoyant.

For the coal-fired units in Scenario II we have again estimated worst-case emission rates of trace metals. The same assumptions were made as for Scenario I and the data are shown in Table V3/3.2(i).

Table V3/3.2(a)
Source Characteristics and Emission Rates Assumed for each 680MW Coal-fired Unit

Source Characteristic	100% Loading	75% Loading	50% Loading
Number of units per stack	2	2	2
Stack height (m)	250	250	250
Number of flues per stack	2	2	2
Flue diameter (m)	6.6	6.6	6.6
Gas exit temperature (°C)	80	80	80
Fuel consumption rate (kg/s)	67.3	52.4	36.7
Volumetric flow rate (m^3/s) at exit temp	729	577	384
Normal volumetric flow rate (Nm^3/s)	564	440	318
Exit velocity (m/s)	21	17	12
SO_2 emission rate (g/s)	97	77	51
NO_x emission rate[1] (g/s)	381	298	215
Total particulate emission rate (g/s)[2]	28	22	16

1 NO_x emissions are expressed as NO_2 for convenience, though the majority is likely to be in the form of NO. The ratio of NO_2 to NO is important when assessing impacts on ambient air quality, however, and this is discussed further in Section V3/3.4.

2 It is likely that the electrostatic precipitators which will be installed will remove nearly all of the particulates above 10 micrometres in diameter, so that the total emission rate given may be taken as respirable particulates as a worst case.

Table V3/3.2(b)
Estimated Emissions of SO_2, NO_x and Particulates (Scenario I) from the Main Stacks over the Development Period of the Power Station

Emissions Period		Year of Development			
		1998	2002	2005	2009
SO_2	Total annual emissions (tonnes)	2933	5866	8799	11732
	Annual average emission rate (g/s)	93	186	279	372
	Peak (summer) daily average emission rate (g/s)	108	216	324	432
	Peak (summer) 1-hour average emission rate (g/s)[1]	194	388	582	776
NO_x[2]	Total annual emissions (tonnes)	11542	23084	34626	46168
	Annual average emission rate (g/s)	366	732	1098	1464
	Peak (summer) daily average emission rate (g/s)	430	860	1290	1720
	Peak (summer 1-hour average emission rate (g/s)[1]	762	1524	2286	3048
Particulates	Total annual emission (tonnes)	851	1720	2553	3404
	Annual average emission rate (g/s)	27	54	81	108
	Peak (summer) daily average emission rate (g/s)	32	64	96	128
	Maximum (summer) 1-hour average emission rate (g/s)[1]	56	112	168	224

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1 On the assumption that the total MW capacity of the plant will be required on hourly occasions during the summer months.

2 Expressed as NO_2

Table V3/3.2(c)
Seasonal Operational Load and Total Emissions for Coal-fired Units (Scenario I) - Estimates for Completed Development

Averaging Time	Parameter	January to March	April to June	July to September	October to December
24-hour average	Load (MW)	2350	2500	2720	2000
	SO_2 emission rate (g/s)	264	272	296	240
	NO_x emission rate (g/s)	1456	1552	1592	1328
	TSP emission rate (g/s)	120	128	128	104
Normal 1-hour peak	Load (MW)	3990	5000	5320	4440
	SO_2 emission rate (g/s)	600	744	776	656
	NO_x emission rate (g/s)	2320	2848	3048	2536
	TSP emission rate (g/s)	176	216	224	192
Maximum 1-hour peak	Load (MW)	4680	5320	5320	4660
	SO_2 emission rate (g/s)	704	776	776	696
	NO_x emission rate (g/s)	2720	3048	3048	2696
	TSP emission rate (g/s)	208	224	224	208

Table V3/3.2(d) Assumptions on Trace Metal Concentrations in Coal	
Trace Metal	**Typical Composition (mg/kg)**
Arsenic (As)	5.0
Cadmium (Cd)	1.0
Chromium (Cr)	10.0
Copper (Cu)	20.0
Mercury (Hg)	0.1
Nickel (Ni)	20.0
Lead (Pb)	10.0
Zinc (Zn)	22.0
Selenium (Se)	1.0
Antimony (Sb)	1.0

Table V3/3.2(e) Estimated Worst-case Trace Metal Emission Rates (mg/s) for the Completed Coal-fired Power Station - Scenario I (high merit order)		
Trace Metal	**Per flue**	**Total from eight unit**
Arsenic (As)	3.1	24.6
Cadmium (Cd)	0.75	6.0
Chromium (Cr)	4.4	35.1
Copper (Cu)	3.9	30.9
Mercury (Hg)	2.6	20.5
Nickel (Ni)	8.8	70.2
Lead (Pb)	5.3	42.1
Zinc (Zn)	8.7	69.5
Selenium (Se)	21.2	169.4
Antimony (Sb)	0.19	1.54

Table V3/3.2(f)
Source Characteristics and Emission Rates for Combined Cycle Gas Turbine Units - Full Operational Load

	Gas	Distillate Oil
Number of stacks per 600MW of capacity	2	2
Height of stacks (m)	50	50
Number of flues per stack	1	1
Flue diameter (m)	4.0	4.0
Fuel consumption rate (tonnes/hr) per 600MW of capacity	100	100
Gas exit velocity (m/s)	66	66
Volumetric flow rate (m^3/s) at exit temperature (per stack)	775	775
Normal volumetric flow rate (Nm^3/s) (per stack)	500	500
Exit temperature (°C)	150	150
SO_2 emission rate (g/s) per stack	0	139
NO_x emission rate (g/s) per stack[1]	76	76
Total particulate emission rate (g/s) per stack	0	2.5

1 Expressed as NO_2

Table V3/3.2(g)
Estimated Emissions of SO_2, NO_x and Particulates (Scenario II) from the Main Stacks over the Development Period of the Power Station

Emissions Period		Year of Development			
		1998	2002	2005	2009
SO_2	Total annual emissions (tonnes)	0[1]	0	2933	5866
	Annual average emission rate (g/s)	0	0	93	186
	Peak (summer) daily average emission rate (g/s)	0	0	108	216
	Peak (summer) 1-hour average emission rate (g/s)[2]	0	0	194	388
NO_x[3]	Total annual emissions (tonnes)	4320	8640	12960	17280
	Annual average emission rate (g/s)	137	274	640	1006
	Peak (summer) daily average emission rate (g/s)	155	310	740	1170
	Peak (summer 1-hour average emission rate (g/s)[1]	304	608	1370	2132
Particulates	Total annual emission (tonnes)	0	0	851	1702
	Annual average emission rate (g/s)	0	0	27	54
	Peak (summer) daily average emission rate (g/s)	0	0	32	64
	Maximum (summer) 1-hour average emission rate (g/s)[1]	0	0	56	112

1 Natural gas contains trace quantities of sulphur, but these would not make a significant contribution to this analysis.

2 On the assumption that the total MW capacity of the plant will be required on hourly occasions during the summer months.

3 Expressed as NO_2

Table V3/3.2(h)
Seasonal Operational Load and Total Emissions for Gas-fired and Coal-fired Units (Scenario II) - Estimates[1] for Completed Development

Averaging Time	Parameter	January to March	April to June	July to September	October to December
24-hour average	Load (MW)	2350	2500	2720	2000
	SO_2 emission rate (g/s)	66	68	74	60
	NO_x emission rate (g/s)	632	674	808	563
	TSP emission rate (g/s)	32	32	32	28
Normal 1-hour peak	Load (MW)	3990	5000	5320	4440
	SO_2 emission rate (g/s)	150	188	196	164
	NO_x emission rate (g/s)	1036	1284	1370	1139
	TSP emission rate (g/s)	44	56	56	48
Maximum 1-hour peak	Load (MW)	4680	5320	5320	4660
	SO_2 emission rate (g/s)	176	196	196	172
	NO_x emission rate (g/s)	1215	1370	1370	1176
	TSP emission rate (g/s)	52	56	56	52

[1] Assuming that coal- and gas-fired units are used equally.

Table V3/3.2(i)
Estimated Worst-case Trace Metal Emission Rates (mg/s) for the Completed Power Station - Scenario II (high merit order)

Trace Metal	Per flue	Total from four units
Arsenic (As)	3.1	12.2
Cadmium (Cd)	0.75	3.0
Chromium (Cr)	4.4	17.5
Copper (Cu)	3.9	15.4
Mercury (Hg)	2.6	10.2
Nickel (Ni)	8.8	35.1
Lead (Pb)	5.3	21.0
Zinc (Zn)	8.7	34.7
Selenium (Se)	21.2	84.7
Antimony (Sb)	0.19	0.77

3.2.2 Open-Cycle Gas Turbine Units

Up to ten 100MW open-cycle gas turbine units will eventually provide peak-lopping capacity during the summer months and emergency back-up as necessary. These will run on distillate oil and so will generate NO_x, SO_2 and particulates. Since they will not operate throughout the year these units will not contribute significantly to long-term emissions or air quality impacts. Indeed, their prime utilisation will only be for a few hours a day when necessary during the summer (except in emergency, when longer periods of utilisation might be envisaged), and so it is only the 1-hour peak emissions which need be examined in detail. Table V3/3.2(j) presents source characteristics and emissions data for these units, assuming a 100% loading. As for all the data presented in this section, the figures given are the best estimates available and must be considered as preliminary at this stage. The KIA of stack emissions will provide essential input to the final specifications, particularly stack height.

3.2.3 Fugitive Dust Emissions

The proposed LTPS at Black Point will consume large volumes of coal annually; up to 12 million tonnes of coal will be required when the plant operates under Scenario I at full capacity. This is a vast quantity of material to handle, and fugitive dust arising from the coal handling operations is inevitable.

As the coal comes in by ocean going vessels, the coal will be unloaded by grab unloader and then transferred to the yard by conveyor. Where practicable, coal handling routes are enclosed to provide wind protection and to contain dust. The coal will then be collected by reclaimers and transported to the power plant bunkers before combustion. The major fugitive dust sources are therefore from ship unloading, and active stock yard operation. Details of these emission are discussed below.

Table V3/3.2(j)
Source Characteristics and Emissions Data for Peak Lopping Open Cycle Gas Turbine Units - Full Operational Load

Number of stacks per 100MW unit	1
Stack height (m)	50
Stack diameter (m)	4.25
Gas exit velocity (m/s)	66
Fuel consumption rate (t/hr)	28
Volumetric flow rate (m^3/s) at exit temperature	936
Normal volumetric flow rate (Nm^3/s)	313
Gas exit temperature (°C)	543
NO_x emission rate (g/s) per stack[1] (1-hour peak)	30
SO_2 emission rate (g/s) per stack (1-hour peak)	78
TSP emisssion rate (g/s) per stack (1-hour peak)	1.4

1 Expressed as NO_2

Based on CLP's past experience at Castle Peak, the majority of coal supplies are not high in fines and the moisture content of the coal is around 10%, both of which suggest that the coal will not tend to generate or release volumes of dust which would require especially stringent control measures.

Ship Unloading Operations

Grab-type unloaders are likely to be used at the proposed power station. With grab unloaders, the system can achieve unloading rates of 4,000 tonnes per hour. It is estimated that the unloading activities will only operate at about 70% of the time under Scenario I and less than 40% of the time for Scenario II. Control measures such as providing wind shields and water sprays at transfer points can effectively reduce the fugitive emissions to acceptable levels.

Active Stockyards

The imported coal will be transported to coal stockyards which are divided into active storage and dead storage to provide a stable fuel supply to the power station. Total storage capacity is likely to be 2-3 million tonnes for Scenario I, and 1-2 million tonnes for Scenario II.

It is expected that the dead coal storage will be stacked and bulldozed out. It will then be compacted and sealed to prevent oxidation and reduce wind blown dust, so that dust emissions from the dead storage will not be significant..

Dust generation will arise from the stacking and reclaiming processes for the active stock pile. There will be two principal causes of dust emission from the active stockpile; disturbance by the stacker/reclaimers, and wind erosion, particularly for wind speeds above 4 m/s. However, emissions from these sources can be minimised by good site management, and the following dust suppression measures should be adopted:

- use of water sprays at transfer points;
- minimising drop heights when stacking coal;
- water sprays and surfactant chemicals can be used from either fixed or mobile units to reduce the wind generated dust, with more frequent applications during the dry season.

With these mitigation measures for the proposed plant, the dust level at the perimeter of the coal yards is not expected to cause dust nuisance. Before the commissioning of the dust suppression system in Castle Peak "A" Power Station, a survey at five sites around the perimeter of the stockyard were taken and a mean TSP level of 1.58 mg/m^3, with a standard deviation of 2.12 mg/m^3 were recorded[1]. Most of these samples were taken over a short period of time (i.e. 30 minutes) as compared with the AQO which specifies 260 $\mu g/m^3$ over 24 hour. This makes comparison difficult, however, the Threshold Limit Value[2] for coal dust containing <5% quartz is 2 mg/m^3 (8-hour time weighted average (TWA) value). This TLV is used as a health and safety standard in the absence of relevant environmental standards and guidelines.

It is, therefore, expected that the occupational health standard will not be exceeded even before the introduction of the dust suppression system. However, with the dust suppression system installed, the level will be reduced to within the equivalent AQO level.

<u>Combustion Waste Disposal</u>

Other activities such as unloading of limestone and export of gypsum or fuel ash have the potential to cause dust emissions. Whilst the amount of such materials to be handled is significantly less than that of coal, they will probably be transported by purpose-built conveying systems.

At the present time, detailed design of the limestone/gypsum and fuel ash handling systems has not been finalised; it is therefore not possible to accurately predict the likely impact from this source.

Nevertheless, since both limestone and gypsum are soluble in water, covered storage areas are likely to be required for gypsum and powdered limestone. As a result, the dust emissions from limestone and gypsum storage will be minimised. Dust collection equipment provided to filter dust laden air at various takeoff points for limestone conveying will minimise emissions from transport of the material. On the other hand, gypsum will generate less dust than limestone due to its wet nature.

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1 Tong, R (1985), Assessment of the Effectiveness of Coal Dust suppression system in Castle Peak "A" Power Station, Pre-commissioning Report.

2 Health and Safety Executive, Occupational Exposure Limits 1987.

About 14% by weight of the coal consumed will become residual ash with the majority as pulverised fuel ash (PFA) being collected in the flue gases stream and the rest as furnace bottom ash (FBA) collected in the furnace bottom.

PFA will be collected in a dry condition in hoppers below the electrostatic precipitators and can then be pumped in slurry form to Tsang Tsui ash lagoon for disposal, unloaded into barges in dry or conditioned form, or conveyed pneumatically to local companies. Bag filters installed to remove the fly ash from the conveying air stream are expected to reduce the fugitive emissions to acceptable levels.

FBA is also expected to be sold locally for the manufacture of cement blocks. Ash will be collected hydraulically or by conveyors from the bottom of the furnace and stored in special silos for truck delivery. The wet condition of the FBA will enable emission levels to be kept to acceptable levels.

3.2.4 Concurrent Dust from Continuing Construction

The LTPS construction programme extends over 16 years, such that construction works will continue in tandem with operation of the completed units from steam to set of the first unit in 1996, to completion of the eight and final unit in 2008.

As identified in V2/4.6, dust emissions from the construction activities could be significant, in the absence of appropriate control measures. However, efficient site house keeping measures including surfacing or sealing of haul routes, damping of stock piles and the maximising of separation distances between the operating units and dusty construction equipment such as the batching plant should ensure that the efficiency of the power generation operations is not impaired. Particular emphasis on dust controls will be required during the reclamation operations associated with the Phase II works, since two thirds of overall construction dust arise from these activities.

3.2.5 Fugitive hydrocarbon emissions

Apart from coal and/or gas fuel, the power station will consume distillate oil for the open-cycle gas turbines, to provide electricity for peak-lopping and under contingency situations. Based on experience from Castle Peak Power Station, it is likely that for the LTPS some 5,000 tonnes of distillate oil will be required each year. This low level of throughput will not give rise to significant hydrocarbon emissions as distillate oil is not a very volatile liquid.

It is anticipated that two 5,000 tonne oil tanks will be used to store distillate oil and that the oil will be brought to the LTPS by 400 - 1,500 tonne barges. Based on these assumptions, typical hydrocarbon emissions are estimated to be around 0.8 kg/hr at source during barge unloading, which is not expected to have any significant impact on the surroundings area.

The heavy fuel oil required for light up, flame stabilisation and to meet operational contingencies on the coal fired boilers will generally be transported by 400 - 1,500 tonne barges on a regular basis. However, the low vapour pressure of the heavy fuel causes much lower hydrocarbon emissions of around 8 g/hr at source during unloading operations. It is, therefore, anticipated that the emissions from heavy fuel unloading will be insignificant.

Emissions from storage tank venting have also been estimated. For distillate oil used for the open-cycle gas turbine, the likely emissions will be about 0.2 kg/hr. Again, heavy fuel oil which has a much lower vapour pressure will give rise to insignificant emissions to the environment, of around 44 g/hr.

Fugitive hydrocarbon emissions are therefore not considered to be significant, in view of the limited amounts of fuel concerned.

3.3 Potential Impact Categories and Sensitive Receptors

3.3.1 Human Health and Nuisance

(a) Potential Impacts

Human health impacts due to the power station emissions may potentially arise as a result of elevated ambient concentrations of SO_2, NO_2, and RSP; Table V3/3.3(a) summarises the symptoms associated with excessive exposure to these pollutants and which the AQOs are intended to guard against. In addition, elevated levels of dust can become a nuisance, particularly in dry months when deposited dust can accumulate. NO_x, together with non-methane hydrocarbons, is a pre-cursor to the formation of ozone (which is an irritant). However, when emitted in significant quantities at some distance from a similar source of hydrocarbons (typically in rural areas, as in this case), it is likely to cause a reduction in ozone levels. It is therefore considered that elevated concentrations of ozone are unlikely to be an impact resulting from the development.

Fugitive hydrocarbon emissions are only of concern in that they may result in some odour nuisance if present in high enough concentrations.

Stack emissions of unburnt hydrocarbons, however, present the health issue related to PAHs, i.e. polynuclear aromatic hydrocarbons. These represent a large group of organic compounds, one of the major sources of which is pyrolytic processes, i.e. those resulting in chemical decomposition at high temperatures, especially the incomplete combustion of organic materials. PAHs are considered a health issue because a number of them have been shown to be carcinogenic, mainly via occupational exposure, e.g. to chimney sweeps and tar workers in the past. However, previously high levels of PAHs in some areas were due to emissions from sources with a low combustion efficiency such as domestic heating appliances using coal. Controls on smoke emissions and the virtual disappearance of the open coal fire for domestic heating purposes has reduced concentrations in the UK to only a few percent of former values over the past thirty years. In Hong Kong it is likely that diesel engined vehicles are a major source.

Unburnt hydrocarbons will be emitted from the stacks during incomplete combustion, but the high combustion efficiencies are likely to ensure that any residual hydrocarbons are present in extremely small concentrations. Studies in Italy (Sawicki E., in Rosenfeld C. and Davis E., 1976) have shown that PAH levels measured in flue gases, before dispersion, are lower than those measured in ambient air. One recent study (Ahland E. et al, 1985) reported that less than 0.5% of emissions of one PAH (benzo[a]pyrene –BaP) in the Federal Republic of Germany resulted from heating with oil and coal-fired power generation combined. It is therefore concluded that this does not represent a potential impact from the power station and need not be considered as an issue warranting further investigation.

As mentioned above, the emitted particulates will contain small amounts of certain metals which were present as impurities in the coal. These are of potential concern because they are known to be toxic to humans who are subject to certain levels of ingestion over a period of time. There are therefore two potential routes to human health impacts resulting from cumulative doses of these metals:

- respiration of particulates;
- consumption of agricultural products grown on soils contaminated with deposited metals.

Table V3/3.3(a)
Potential Human Health Impacts from Stack Emissions

Pollutant	Types of Impact at Elevated[1] Ambient Levels
Sulphur dioxide	Respiratory illness, reduced lung function, morbidity and mortality rates increase at higher levels
Nitrogen dioxide	Respiratory irritation, increased susceptibility to respiratory infection, lung development impairment
Respirable suspended particulates	Respiratory illness, reduced lung function, morbidity and mortality rates increase at higher levels

1 These impacts would occur at concentrations typically many times higher than the AQO's which themselves allow a significant safety margin.

Finally, there is the issue of acidification and contamination of fresh water reserves. Acidity in itself is not really a cause for concern since the pH of drinking water is routinely adjusted to an acceptable level before entering the distribution system. The other concern which has been raised elsewhere (more notably with respect to groundwater in Scandinavia) relates to soil acidification resulting in the elevation of toxic metals in water supplies, which would present a health risk.

(b) Potential Receptors

Sensitive receptors which may potentially be affected by the direct human health impacts outlined above range from those in the near-field, i.e. local villages within a few kilometres, to far-field and transboundary receptors, including Lantau Island and Shenzhen. In general, the low-lying, near-field receptors will be more susceptible to low-level fugitive emissions, while more distant and elevated receptors will be exposed to the effects of stack emissions. Table V3/3.3(b) categorises potential receptors according to distance, describes the possible air quality effects resulting from the development and gives estimates of the current and future populations in each category. It should be noted that the receptors in Table V3/3.3(b) are indicative only of those which should be considered in scoping the air quality impacts of a large thermal power station. The degree to which they are likely to be affected and the significance of predicted impacts are assessed in Sections V3/3.4 and V3/3.5.

The main areas of agricultural productivity which could theoretically be exposed to trace metal deposition lie in the New Territories where a range of vegetables and fruits is grown.

Finally, although most of Hong Kong's drinking water comes from China, there are a number of reservoirs within the study area (notably Tai Lam Chung in NWNT and Shek Pik on Lantau) which could be subject acid deposition in their catchment areas.

Table V3/3.3(b)
Potential Receptors - Human Health

Receptor Category	Impact Susceptibility	Key Receptors	Estimated Population[1] Current 1991	Future (1999)
Near-field (< 2km)	Low-level fugitive emissions of dust (< 500m) and hydrocarbons; impacts from stack emissions unlikely.	Lung Kwu Sheung Tan, Yung Long	68 2	68 0
Mid-field (2-15km)	Stack emissions; possible short- and long term effects.	Tuen Mun, Yuen Long, North Lantau (inc. Tung Chung, Chek Lap Kok), villages in NWNT (e.g. Deep Bay coastline, Tuen Mun Valley, south coast villages out to Brothers Point), possible PADS developments just south of Black Point	Tuen Mun : 388,000 Yuen Long : 133,000 Tin Shui Wai : 280 North Lantau : 1160 Other areas : 42,000 Total : 575,000	472,000 139,000 123,000 44,000[2] 65,000 843,000
Far-field (>15km)	Stack emissions; possible short-term (plume impingement and/or neutral/stable atmospheres[3]) and long-term effects.	South and west Lantau, central new territories, Kowloon peninsular, Hong Kong Island, Lamma Island	Total . 5,252,000	5,428,000
Transboundary	Stack emissions; possible short- and long-term impacts.	Numerous sites in the PRC, but typically Shekou (mid-field) and Shenzhen (far-field).	No data available	No data available

1 Forecasts of Population Distribution 1990-1999, WGPD Paper 7/90
2 including Tung Chung New Town
3 Discussed in Section 3.4

3.3.2 The Natural Environment

(a) Potential Impacts

After much research in Europe and North America, it is now widely recognised that air pollution has the potential to cause damage to vegetation, soils and inland waters. Apart from the detrimental effects of dust deposition on crops (including aesthetic effects and growth retardation due to loss of sunlight), the main types of impact which have been hypothesised are:

- direct effects (growth retardation, 'scorching' effects) on vegetation exposed to elevated ambient levels of pollutants, mainly SO_2, NO_2 and ozone;

- acidification of waters (threatening aquatic life and deteriorating drinking water quality) by deposition of acidic species related to emissions of SO_2 and NO_x;

- acidification (from SO_2 and NO_x emissions) of soils (also resulting in nutrient deficiency);

- indirect effects on vegetation through soil acidification.

There is still considerable uncertainty as to the the mechanisms which produce the observed effects and which of the above are more or less important. Most authorities now agree that specific damage in any one area is likely to be due to a combination of one or more of the above 'stress factors' with natural factors such as pests, disease and climate (particularly with respect to forest damage). Consequently, it has not been possible to establish agreed methods for predicting the consequences of air pollution on the natural environment which are applicable beyond the specific receptor in question. The more popular approach which has been adopted is to establish 'critical loads' and 'threshold levels', for deposition and ambient concentrations respectively, to act effectively as AQOs for the natural environment. This approach is discussed further in Section V3/3.6.2(i) when assessing the significance of the predicted air quality impacts.

(b) Potential Receptors

Little direct research on the vulnerability of native species, communities and ecosystems to acid deposition or elevated ambient concentrations has been undertaken in Hong Kong.

In Europe and North America a variety of characteristics has been considered in investigating the susceptibility of ecosystems to acid deposition. These include:

- the buffering capacity of soils (i.e. ability to neutralise acid inputs);
- the net flux of water through the system;
- the base cation generation rate of the underlying rocks.

Consideration of climatic and geological conditions in the territory provides some indication of the likely vulnerability to acid deposition on the basis of these characteristics. In general:

- the tuffs, lavas and granites which make up the bulk of the geology of Hong Kong are highly weathered, probably resulting in a low base cation generation rate;

- the resulting soils are usually yellow and red-brown and have been classified as Red-Yellow-Podsols; these are naturally acidic, but could be made more so by the addition of mineral acid via atmospheric deposition;

- annual rainfall in Hong Kong is above the amount considered to increase sensitivity to acid deposition (1200mm) and the pattern of precipitation is highly seasonal, with the bulk falling in the summer, thus exacerbating solute dissolution and leaching effects.

Generally, this would indicate that there is a higher than average sensitivity of the Hong Kong soils to acid deposition. However, this is a coarse judgement and in many areas this will not be the case because of local factors. In particular, there is a band of poorly drained soils along the southern coast of Deep Bay, stretching from Nim Wan in the south to Lok Ma Chau in the north. The sediments in these wet alluvial flats are high in sulphur and acid sulphate soil conditions can develop[3]. Although naturally alkaline when moist, if these sediments dry out (e.g. as the coastline advances or if reclaimed for agricultural purposes) the large amounts of sulphide decompose and sulphuric acid may form. For this reason the sulphur-rich mangrove swamps and mudflats have not been put

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3 Grant C. J., 1960, "Soils and Agriculture of Hong Kong".

to great agricultural use. Fishponds can and have been economically exploited, however, so long as the ponds are not allowed to dry out – e.g. when under construction or when being drained to harvest fish. In this case, the activities to which the land is being used already take account of the soil conditions and acid input to the soils from the atmosphere will have no significant effect. Neither would the ponds be seriously affected by direct acid inputs, since they are drained periodically and the effects of acid deposition (if any) would not accumulate.

Elsewhere, however, particularly in the Tai Lam and Lantau Country Parks, it should be assumed that the soils and any wooded areas upon them are likely to be quite sensitive to the cumulative effects of high acid deposition over a period of time.

Finally, there is vegetation in the study area which could be damaged if exposed to sufficiently high ambient concentrations of pollutants. It is considered that most of the grasses in Hong Kong are quite rugged and likely to be fairly resistent to direct damage. Vegetable and fruit crops in the NWNT and fruit trees in Fung Shui woods could be more sensitive, as could any exposed orchids in wooded areas of the Country Parks. In addition, conifer trees, which are found throughout the territory are generally more sensitive to toxic effects of SO_2 and NO_2 than are hardwoods. Sensitivities to pollutant levels are discussed further in Section V3/3.6.2(i).

3.3.3 Buildings

(a) Potential Impacts

It is now firmly established that air pollution, mainly SO_2 can increase the natural erosion/corrosion rates of a range of building materials, including marble and steel. These effects are far easier to monitor than the effects of acid rain on the natural environment and consequently the 'dose–response' relationship has been fairly successfully quantified. This relationship, which is discussed further in Section V3/3.6.3(i), indicates that the effect is greater in humid atmospheres, since the water provides a medium for the acidification of the surface layers of the material.

(b) Potential Receptors

This type of impact has generally only been observed in built–up, urban areas or where the accumulation of low–level point sources of emissions has resulted in very elevated annual average concentrations. This is not, therefore, an impact which would be expected from this type of development. However, if impacts on building materials were to occur the key receptors would be the areas surrounding the new towns of Tuen Mun, Yuen Long and Tung Chung (as planned under PADS). Within the new towns themselves the additional load of SO_2 due to the power station emissions, on top of the much higher urban background level (see Section V3/3.5), is unlikely to be significant in increasing the material corrosion rate. It is only on the urban fringe where the additional load from the power station emissions might feasibly result in a significant increase in the prevailing rate of corrosion.

3.4 Air Quality Modelling

3.4.1 Approach

In order to quantify the air quality impacts resulting from the emissions described in Section V3/3.2, we have used three numerical dispersion models, based on the Gaussian plume predictive method. These are:

- the Industrial Source Complex Short Term (ISCST) model;
- the Industrial Source Complex Long Term (ISCLT) model;
- the Rough Terrain Dispersion Model (RTDM).

All three were developed by the US EPA and are acknowledged as being applicable to EIA studies such as this. RTDM has been used in this case because the ISC models were not designed to take account of complex terrain lying between the source and the receptor being modelled. However, although RTDM provides a better insight to the likely effects of the terrain in the study area, it is recognised that significant uncertainties still surround the results. For this reason the KIA will involve a series of wind tunnel tests which will provide predictive results with sufficient confidence to allow appropriate decisions to be made on the design and operation of the power station.

Nevertheless, numerical modelling is useful for two purposes:

- to assist with defining a scale for the construction of the wind tunnel;

- to assist with scoping of the impact scenarios so that the wind tunnel tests can be targetted towards the most critical issues (pollutants, emissions scenarios, wind speeds, wind directions, etc).

The second point is particularly relevant to this report, since it is concerned with providing sufficient information to show that a potential impact will not be significant or recommending topics for further, more detailed study in the KIA.

We have therefore used the models to predict ambient concentrations of SO_2, NO_2 and particulates (assuming all are respirable) over a range of averaging times relevant to the AQOs which have been used as criteria for human health impacts. The results have also been used to obtain an estimate of the level of acid deposition which will be associated with the emissions. In the case of annual average predictions we have used climatological statistics from both Lau Fau Shan (on the Deep Bay coast) and Chek Lap Kok in order to test the sensitivity of the results to climate; we believe that the wind field at Black Point will have characteristics of both these sites. For 24-hour average predictions we have used detailed data from the Royal Observatory's monitoring database to investigate the likely variability of wind speed and direction over a 24-hour period during the summer (when emissions will be greatest and winds from the west-southwest are likely to carry the plumes over the New Territories.

Although potential impacts need to be investigated for all wind directions and associated receptors, the main scenario of potential concern identified during the site search study was that of the plumes from Black Point and Castle Point combining in a northwesterly wind to affect the north Lantau coast. For this reason we have included Castle Peak power station in our modelling runs. Although, as an existing installation, it effectively contributes to the background level, it represents a source of emissions which CLP have some potential to reduce over the period of development of the new power station. This control scenario was proposed as a means of mitigating the cumulative impacts of the two power stations if controls on Black Point emissions were considered to be insufficient.

This question will be answered during the KIA, which is due for completion towards the end of the year. However, the preliminary results obtained from Gaussian dispersion modelling are summarised here as a means of reporting progress. Further information can be found in the Stack Emissions KIA Phase 1 Report, February 1991.

3.4.2 (i) **Main Stacks - Scenario I**

(a) 1-hour average predictions

Figures V3/3.4(a) and (b) illustrate the predicted dilution of emitted pollutants from Black Point alone (SO_2 and NO_x) and Black Point plus Castle Peak (NO_x only) respectively, for a wind direction heading towards Lantau – this is considered the worst case (together with the converse scenario of the plumes heading towards Shekou in the PRC). The meteorological scenarios[4] shown are representative of the most-likely worst-case conditions which will apply (it will be noted that Stability C, 3m/s, whilst shown on Figure V3/3.4(a) is not shown on Figure V3/3.4(b); this is because the model could not adequately simulate the behaviour of the Castle Peak plume under these conditions (it is hotter since there is no FGD) and produced meaningless results). Although 'stable' conditions of Pasquill classes E and F can be used in the modelling, the consultants are of the opinion that such conditions at the stack height will not be observed with any significant frequency. This issue is currently being researched with the aid of data from the Royal Observatory and will be reported on in April, as part of the KIA.

The results indicate that while maximum predicted SO_2 concentrations due to Black Point are only about 10% of the 1-hour AQO (800μg/m^3), maximum concentations of NO_2 approach the AQO of 300μg/m^3. This occurs under several scenarios at a range of distances from Black Point, but only within the mid-field range defined in Section V3/3.3.1. Beyond 15km or so, in the far field, the likelihood of high concentrations decreases quite rapidly.

With both power stations running at full load, maximum predicted concentrations of NO_2 approach 600 μg/m^3 at Chek Lap Kok and 700 μg/m^3 the Lantau hills. However, this assumes that all of the emitted NO_x is in the form of NO_2. This will not be the case and it is likely that only 60% will be NO_2. This would suggest a total concentration of about 350 - 400 μg/m^3. Nevertheless, this is still very high considering that background concentations must also be taken into account – see Section V3/3.5. For this reason the short-term impacts of NO_x emissions and potential mitigation measures are being assessed as a priority in the KIA.

(b) 24-hour average predictions

Using standard deviations of wind direction and speed from Royal Observatory data a typical summer's day was characterised in terms of the range of 1-hour average conditions which might occur. This was done for a typical windflow from the west (a full day of winds from the north is not considered a realistic scenario for the summer months) and for NO_x since the short-term modelling showed this to be the most critical pollutant. The results for total emissions from Black Point and Castle Peak are summarised in Table V3/3.4(a), assuming all of the NO_x is NO_2. It is clear that, even assuming this worst case, the impacts will be very small, less than 30 μg/m^3, compared with the AQO of 150 μg/m^3. SO_2 levels would be dominated by Castle Peak emissions and would most likely be about 20 μg/m^3 compared with the AQO of 350 μg/m^3.

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4 Pasquill stability class and wind speed combination

Figure V3/3.4(a) Black Point (Coal-Fired)

NOx and SO_2 Hourly Average Ground Level Concentration

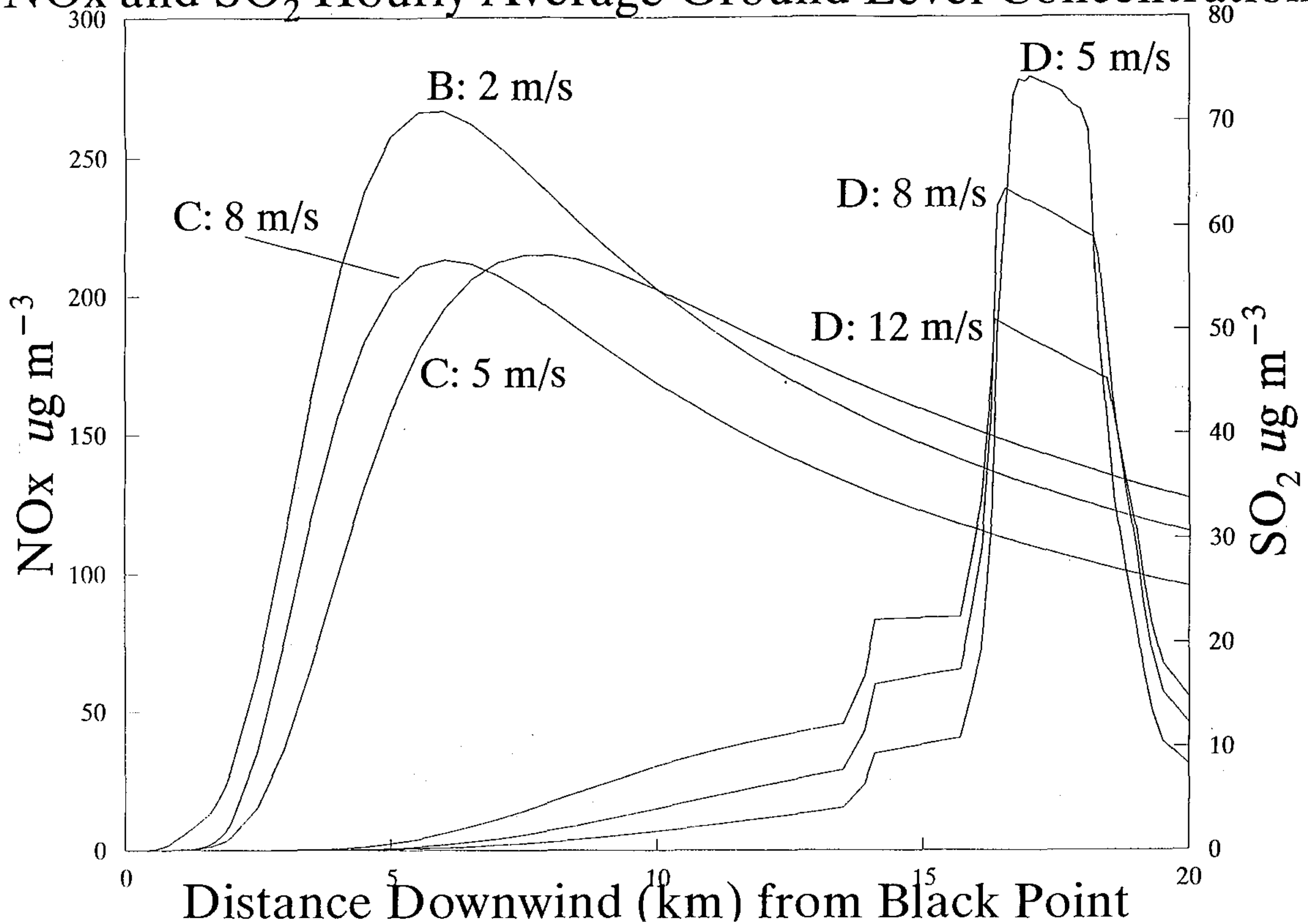


Figure V3/3.4(b)

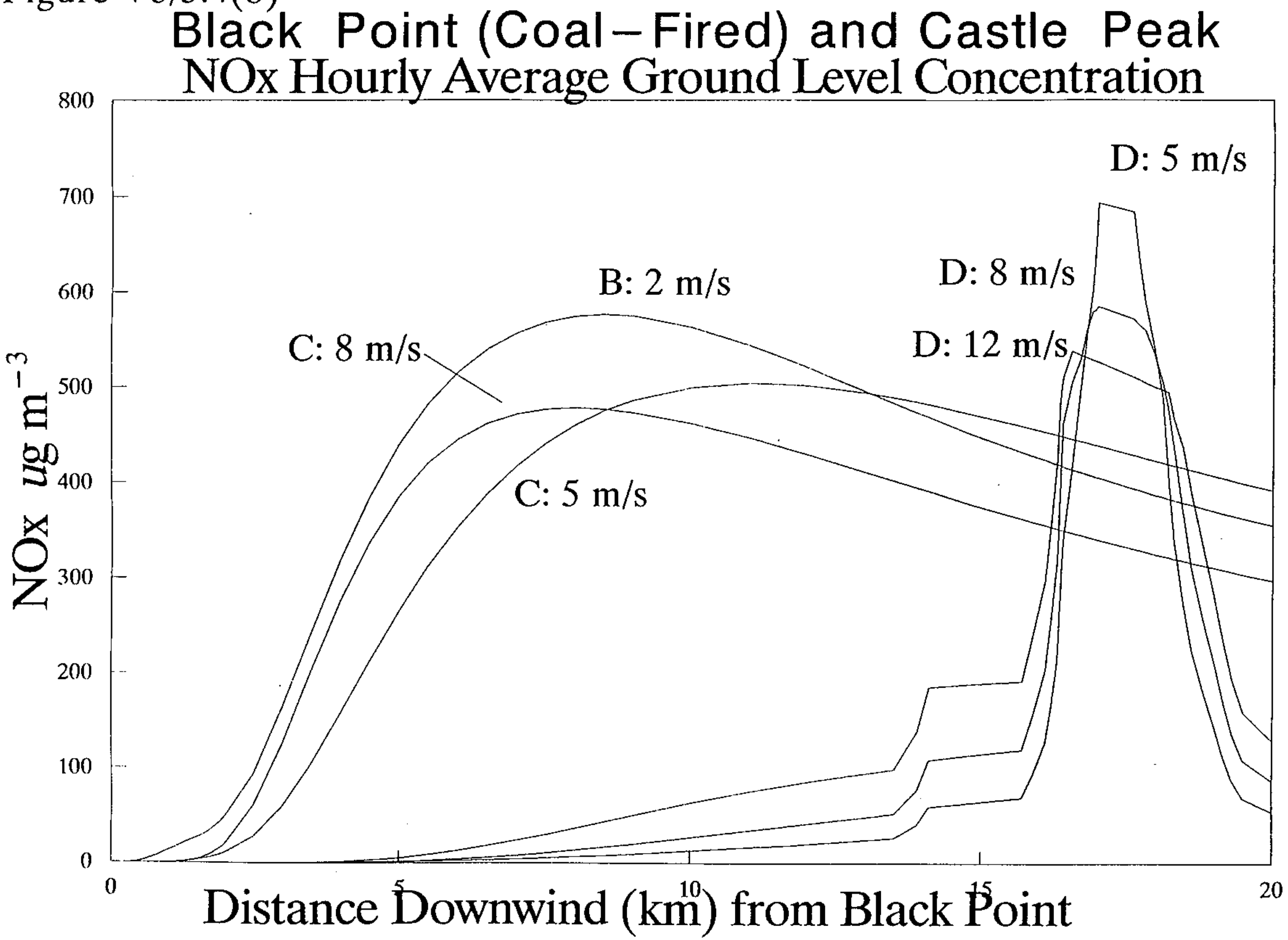


Table V3/3.4(a). Maximum Predicted 24-hour average NO_2 concentrations from the main stacks Scenario 1	
Distance Downwind (km)	NO_2 Concentration ($\mu g/m^3$)
1	0
5	2
10	5
20	15
50	29

(c) Annual average predictions

Annual average predictions were made using the seasonal emissions data presented in Section V3/3.2 in conjunction with climatological data from Lau Fau Shan. Figures V3/3.4(c)–(e) illustrate the results as contours of pollutant concentration overlayed on a map of the study area, for SO_2, NO_2 and particulates, respectively. The most immediate point to note is that in all cases the maximum concentration, about 4–5km to the northeast, is almost negligible:

- SO_2: 0.4 $\mu g/m^3$
- NO_2: 2.5 $\mu g/m^3$
- TSP: 0.2 $\mu g/m^3$

There are two important points to make here. Firstly, the maximum occurs somewhat surprisingly to the northeast (i.e. against the prevailing wind direction), and this is because the southwesterly winds which cause this effect coincide with the peak summer emissions and also with a higher proportion of unstable atmospheric conditions compared with other wind directions. This causes the plumes to disperse downwards towards the ground much earlier than for other stability classes, resulting in a higher peak concentration, nearer to the stacks.

The results obtained from modelling emissions from both Black Point and Castle Peak (see Figures V3/3.4(f)–(h) show a similar effect, although the peaks occur further away because the hotter emissions from Castle Peak result in greater plume rise. In this case, even though the concentrations are higher (up to 4 $\mu g/m^3$ of NO_2), there is still no concern that the AQOs might be exceeded.

To ilustrate the sensitivity of the modelling to various parameters, Figures V3/3.4(i)–(l) show results for the following:

- the autumn period from October to December
- the summer period from July to September
- Chek Lap Kok climatological data
- elevated receptors on Lantau and in the NWNT.

The following conclusions can be drawn:

- the seasonal variations in concentration reflect the point made above concerning the interplay between wind direction, atmospheric stability and emission rate; the summer peak of 7.5 $\mu g/m^3$ occurs to the northeast while the autumn peak of 3.5 $\mu g/m^3$ occurs to the southwest;
- the Chek Lap Kok data produce a more east-west aligned distribution, in accordance with its location, but the maximum concentration of 3.5 $\mu g/m^3$ is still well below the AQO;
- predicted concentrations at elevated receptors are inevitably higher but still no more than about 10% of the AQO.

3.4.2 **(ii) Main Stacks - Fuel Scenario 2**

(a) 1-hour average predictions

Figures V3/3.4(m) and (n) illustrate the predicted downwind profile of air quality impacts resulting from emitted NO_2 from the completed power station of Black Point alone and Black Point plus Castle Peak respectively, for a wind direction heading towards Lantau - indicative of the worst-case impact scenario, as for Scenario 1. It can be seen that maximum predicted concentrations of NO_2 due to the Black Point emissions are about 225$\mu g/m^3$. This reflects the fact that although negligible emissions of SO_2 will arise from use of gas as a fuel, significant quantities of NO_2 will be emitted.

When Castle Peak emissions are also considered, the maximum potential concentrations of NO_2 increase significantly (to 500-600$\mu g/m^3$), though not precisely in line with the increase in emissions, because of the different dispersive characteristics of the plumes from the different stacks. The range of distances over which high concentrations might occur is quite large, though this is unlikely to extend very much into the far-field, as defined in Table V3/3.3(c). Even allowing for the fact that perhaps only 60% of the pollutant will be in the form of NO_2, however, there is a potential NO_2 impact of significant concern for this fuel scenario.

(b) 24-hour average predictions

Using the same approach as that described for Scenario 1, above, estimates were made of the 24-hour average concentrations of NO which could arise from operation of Black Point and Castle Peak power stations (considering the very low 1-hour average concentrations of SO_2 which are predicted there is no potential for the Black Point emissions to add significantly to the 24-hour average levels). The results indicate that, even assuming all the pollutant to be in the form of NO_2, the maximum concentration is unlikely to be above 10$\mu g/m^3$, i.e. 7% of the AQO.

(c) Annual average predictions

Annual average predictions were made using the seasonal emissions data presented in Section V3/3.2, in conjunction with climatological data from Lau Fau Shan. Figures V3/3.4(m) and (n) illustrate the NO_2 results for emissions from just Black Point and from Black Point plus Castle Peak respectively (both SO_2 and particulate levels will be significantly less than for Scenario 1 and will therefore not be of concern). Although the maximum concentration lies further away in the latter case (about 10-12km compared with 4-6km), in both cases it is only 5-10% of the AQO.

Figure V3/3.4(c)
Annual Average Ground Level Concentration (µg m^{-3}) of SO_2 Resulting from the Operation of the Proposed Power Station at Black Point
Partial Operational Load

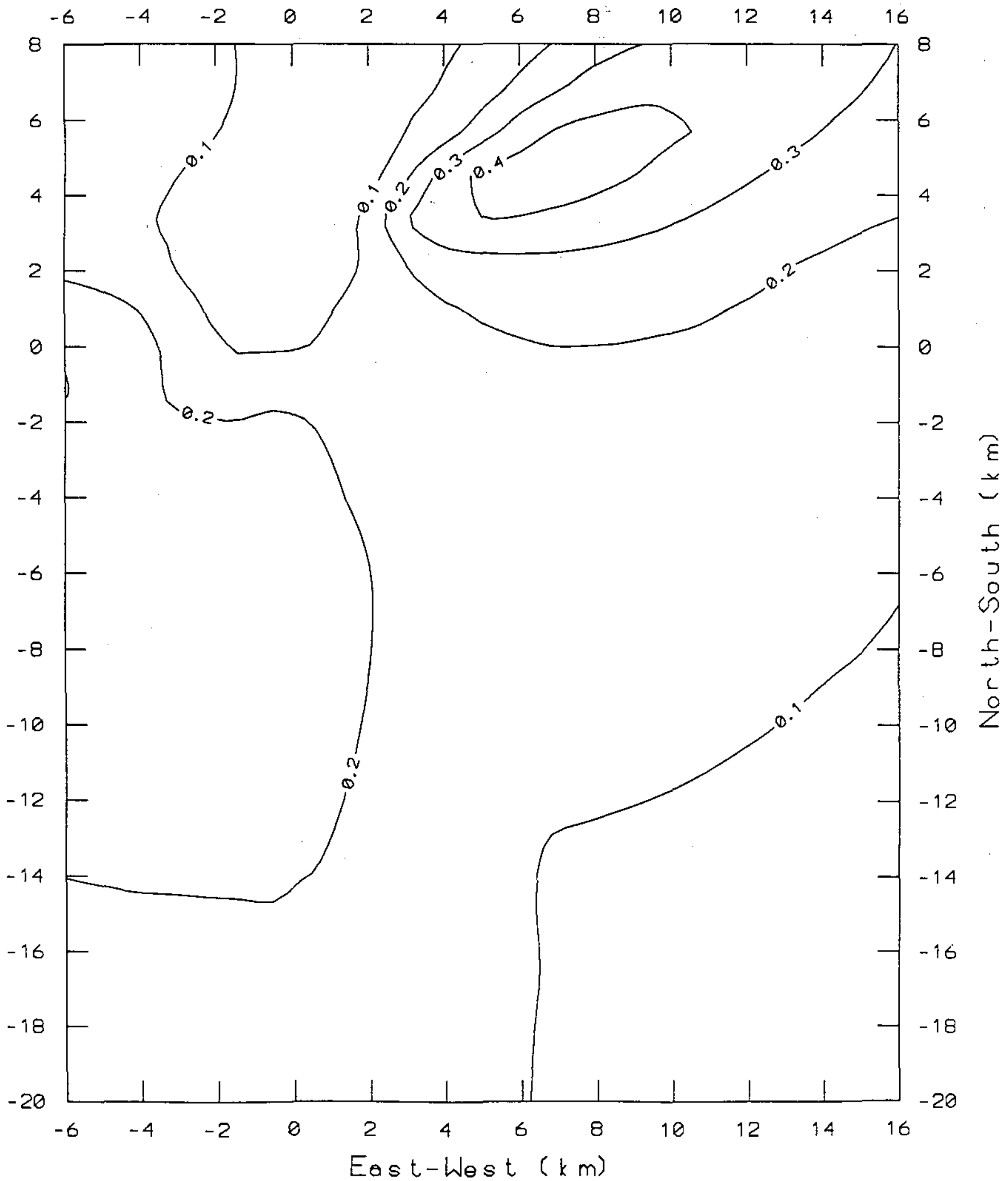


Figure V3/3.4(d)
Annual Average Ground Level Concentration (µg m^{-3}) of NO_x Resulting from the Operation of the Proposed Power Station at Black Point
Partial Operational Load

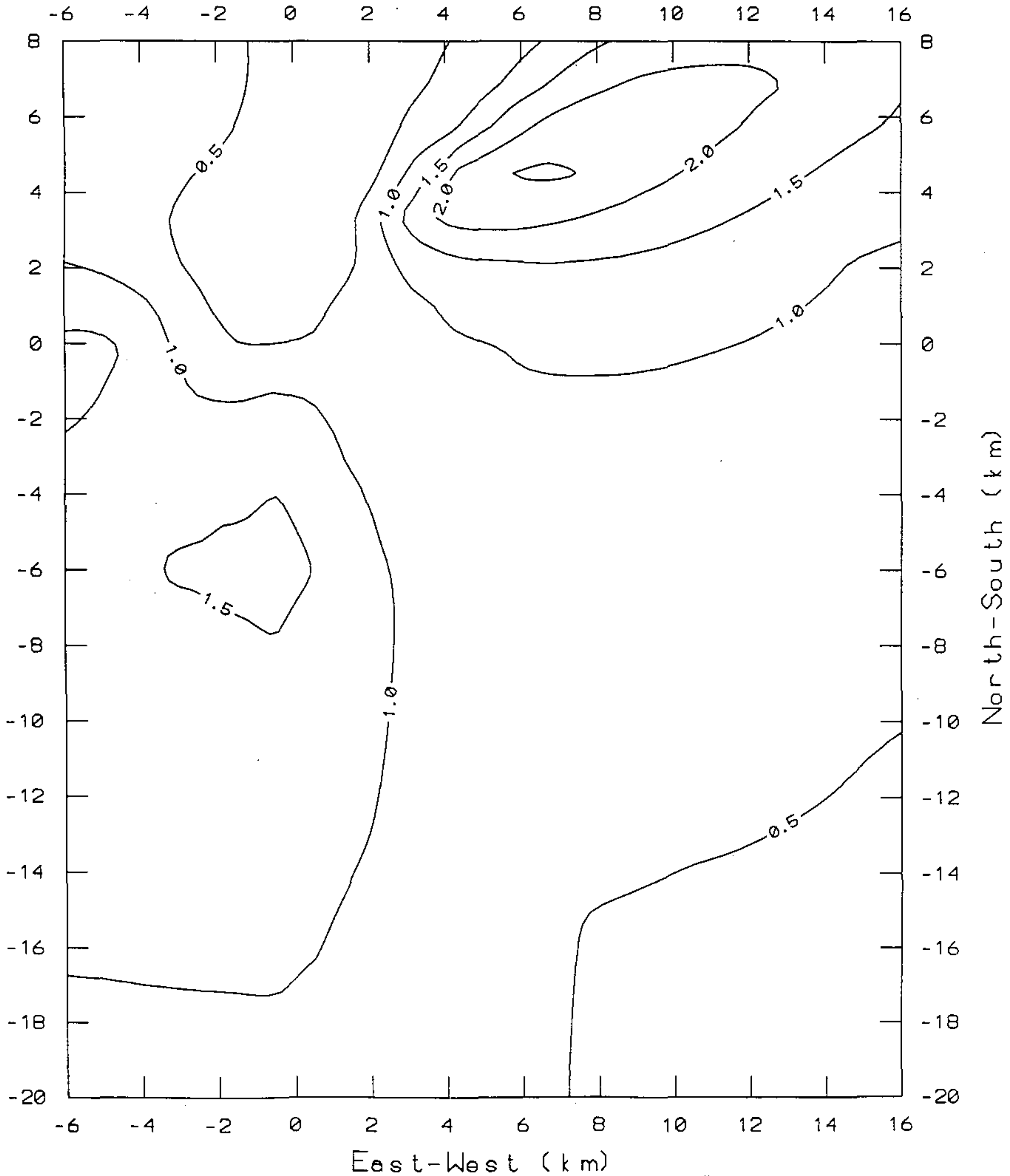


Figure V3/3.4(e)
Annual Average Ground Level Concentration ($\mu g\ m^{-3}$) of Particulates Resulting from the Operation of the Proposed Power Station at Black Point
Partial Operational Load

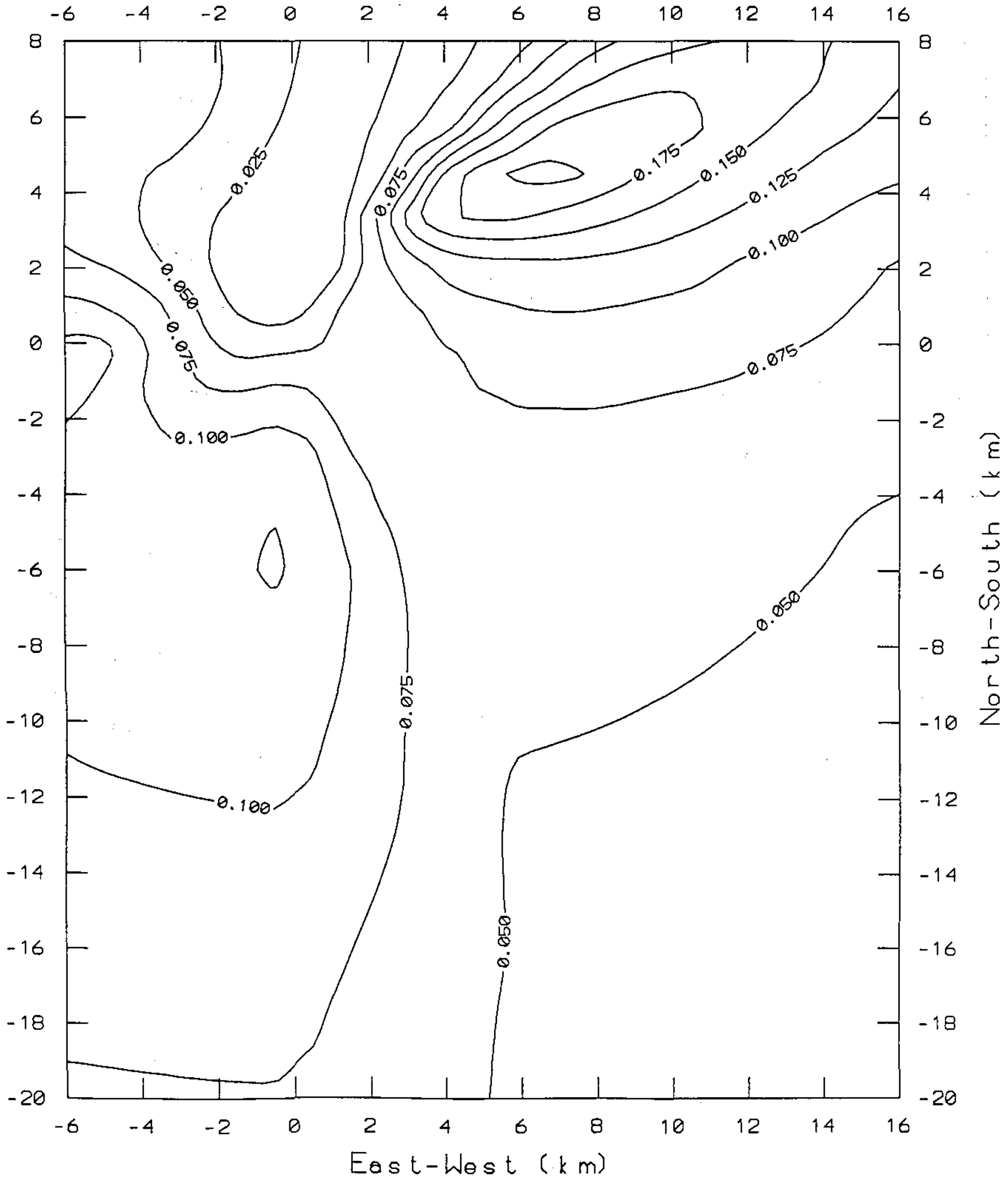


Figure V3/3.4(f)
Annual Average Ground Level Concentration (μg m^{-3}) of SO_2 Resulting from the Operation of the Proposed Power Station at Black Point and the Existing Power Station at Castle Peak
Partial Operational Load

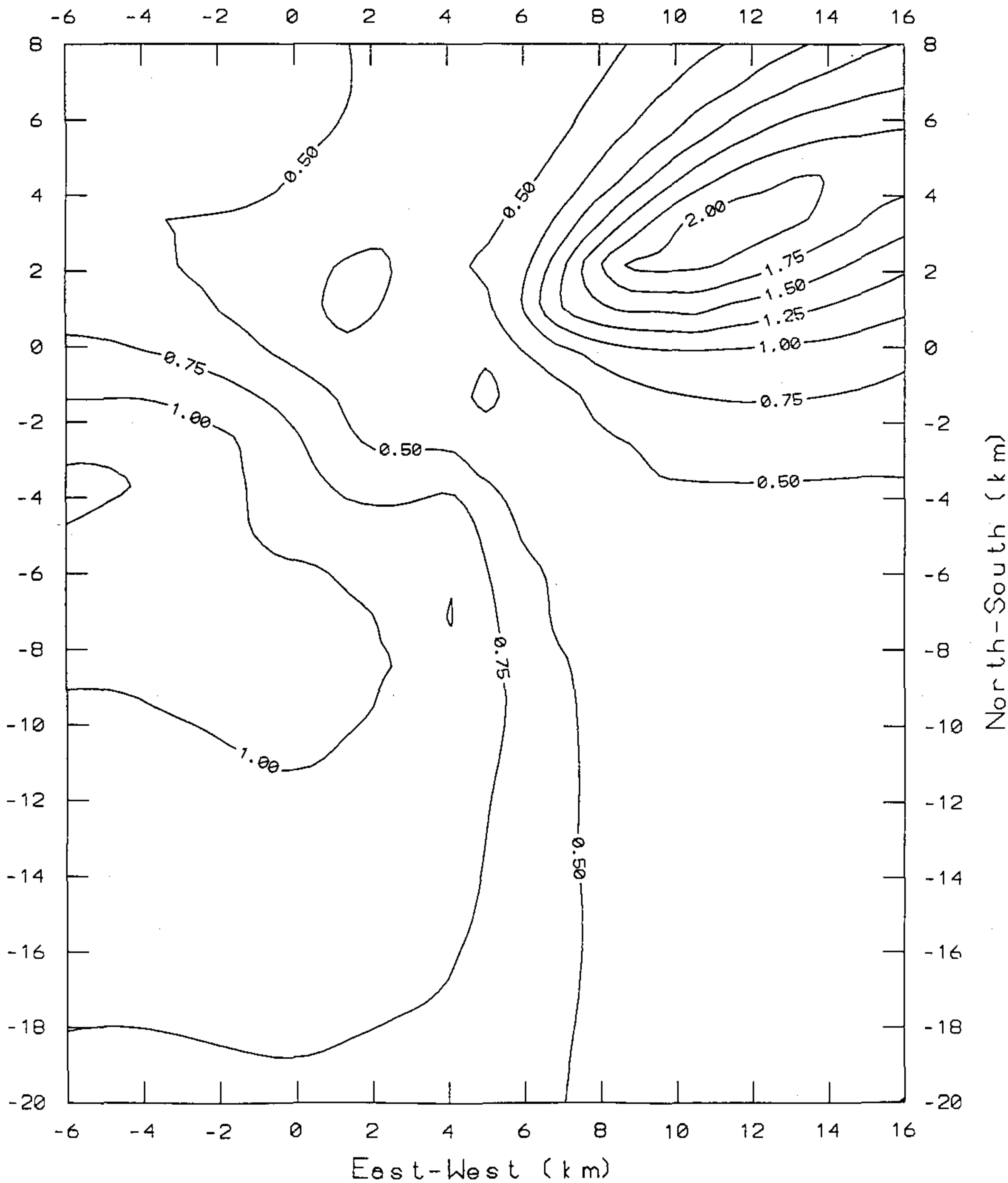


Figure V3/3.4(g)
Annual Average Ground Level Concentration (μg m^{-3}) of NO_x Resulting from the Operation of the Proposed Power Station at Black Point and the Existing Power Station at Castle Peak
Partial Operational Load

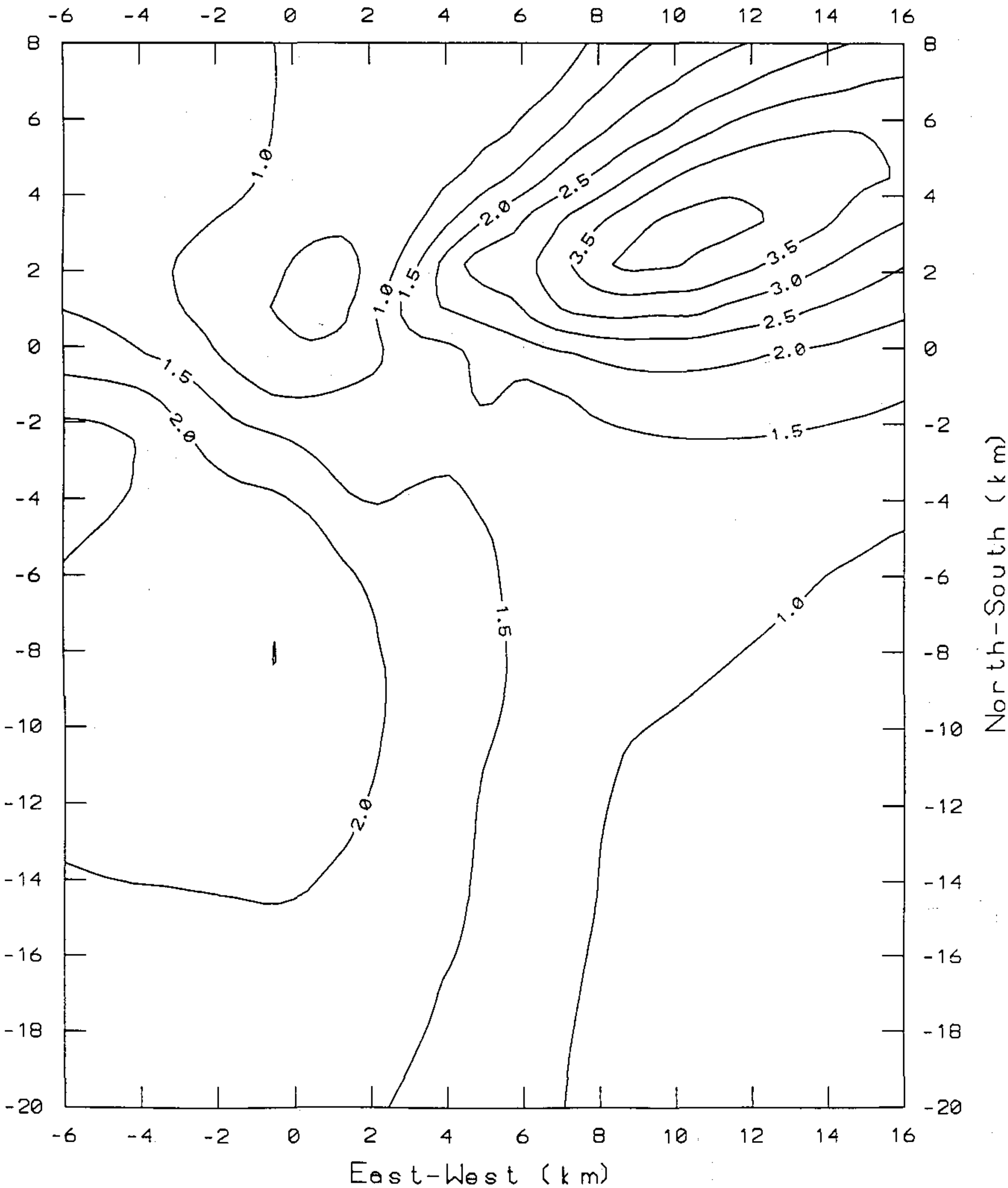


Figure V3/3.4(h)
Annual Average Ground Level Concentration ($\mu g\ m^{-3}$) of Particulates Resulting from the Operation of the Proposed Power Station at Black Point and the Existing Power Station at Castle Peak
Partial Operational Load

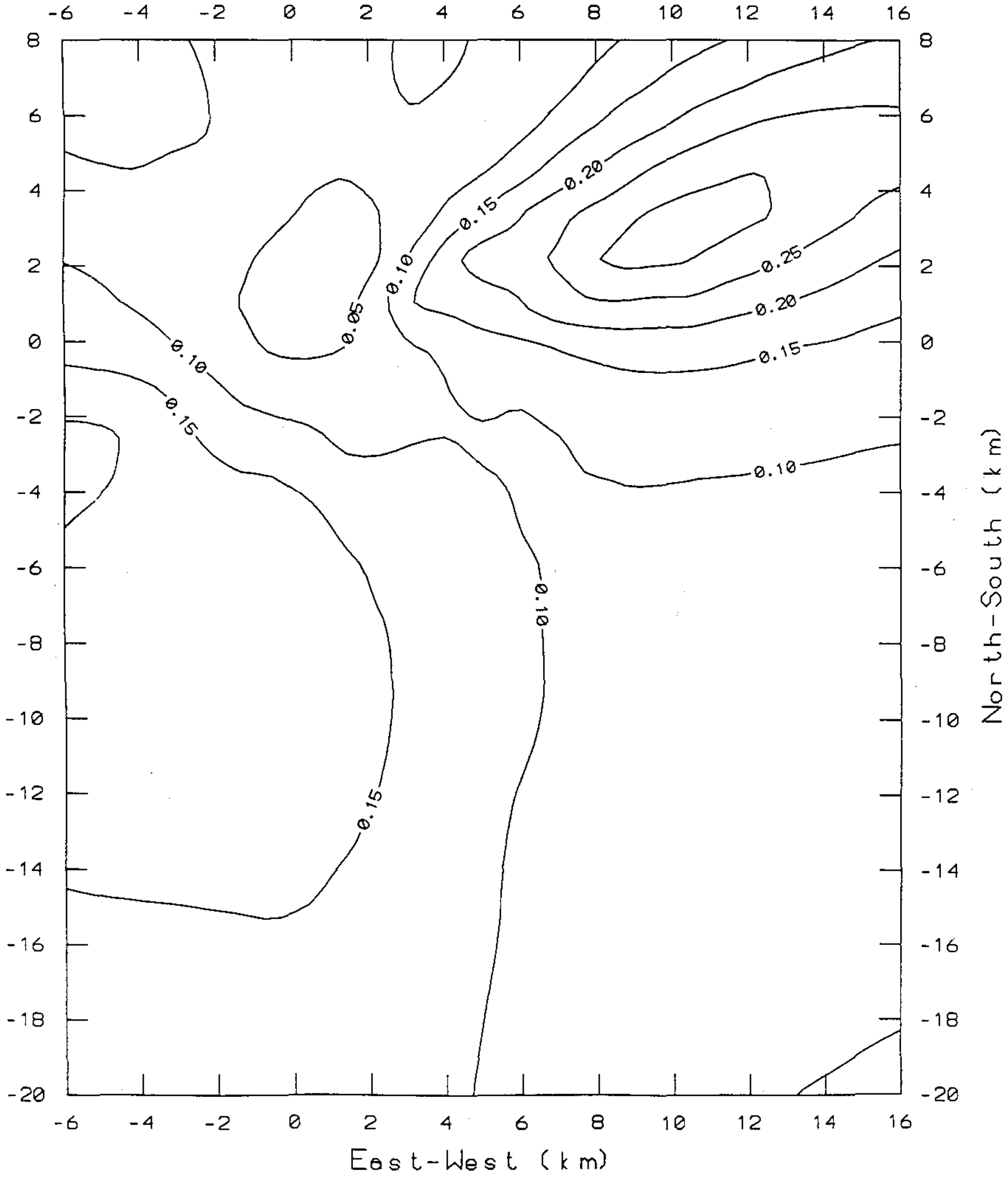


Figure V3/3.4(i)
Three Monthly Average Ground Level Concentration ($\mu g\ m^{-3}$) of NO_x Resulting from the Seasonally Adjusted Operation of the Proposed Power Station at Black Point and the Existing Power Station at Castle Peak
October to December

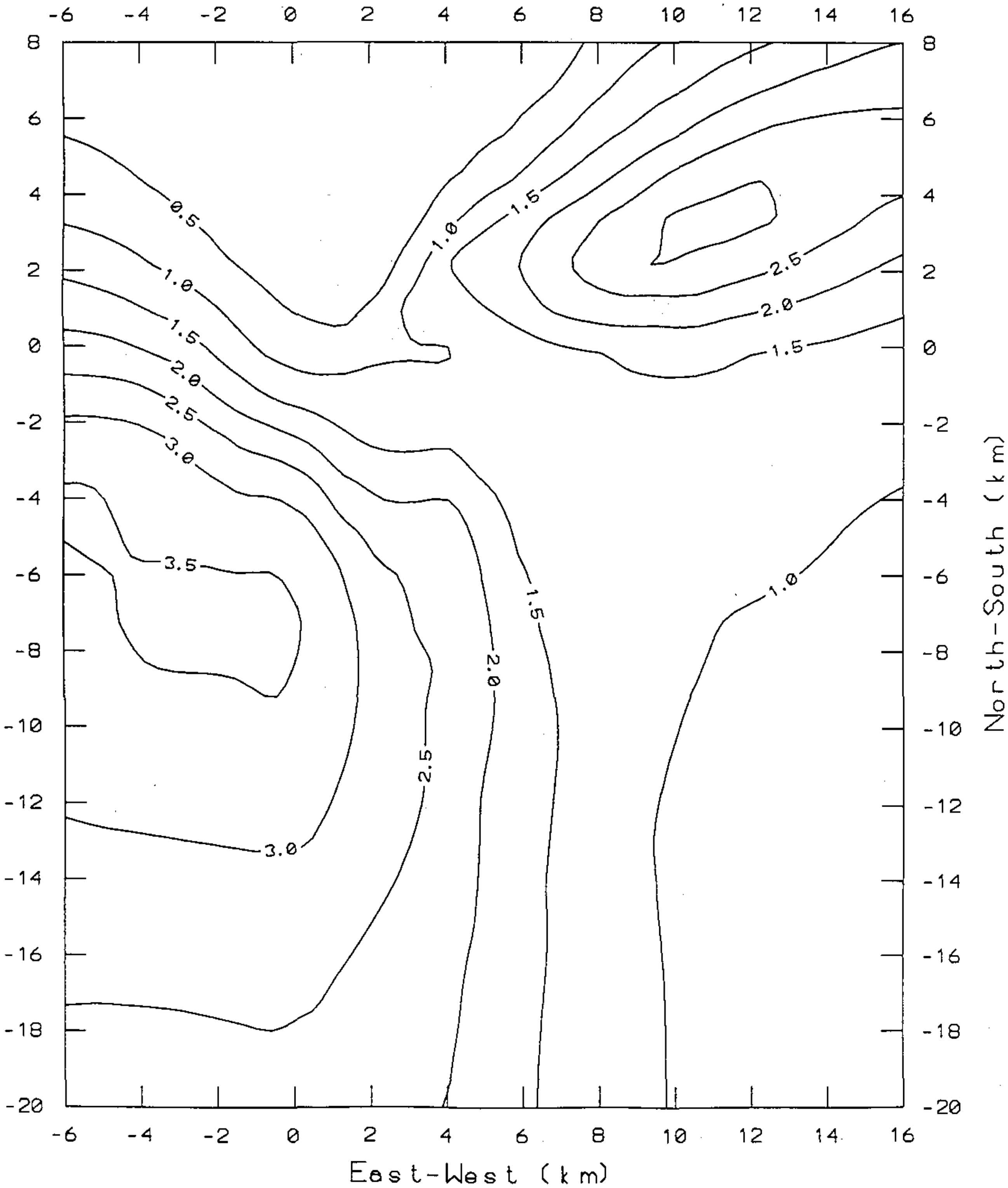


Figure V3/3.4(j)
Three Monthly Average Ground Level Concentration (μg m^{-3}) of NO_x Resulting from the Seasonally Adjusted Operation of the Proposed Power Station at Black Point and the Existing Power Station at Castle Peak
July to September

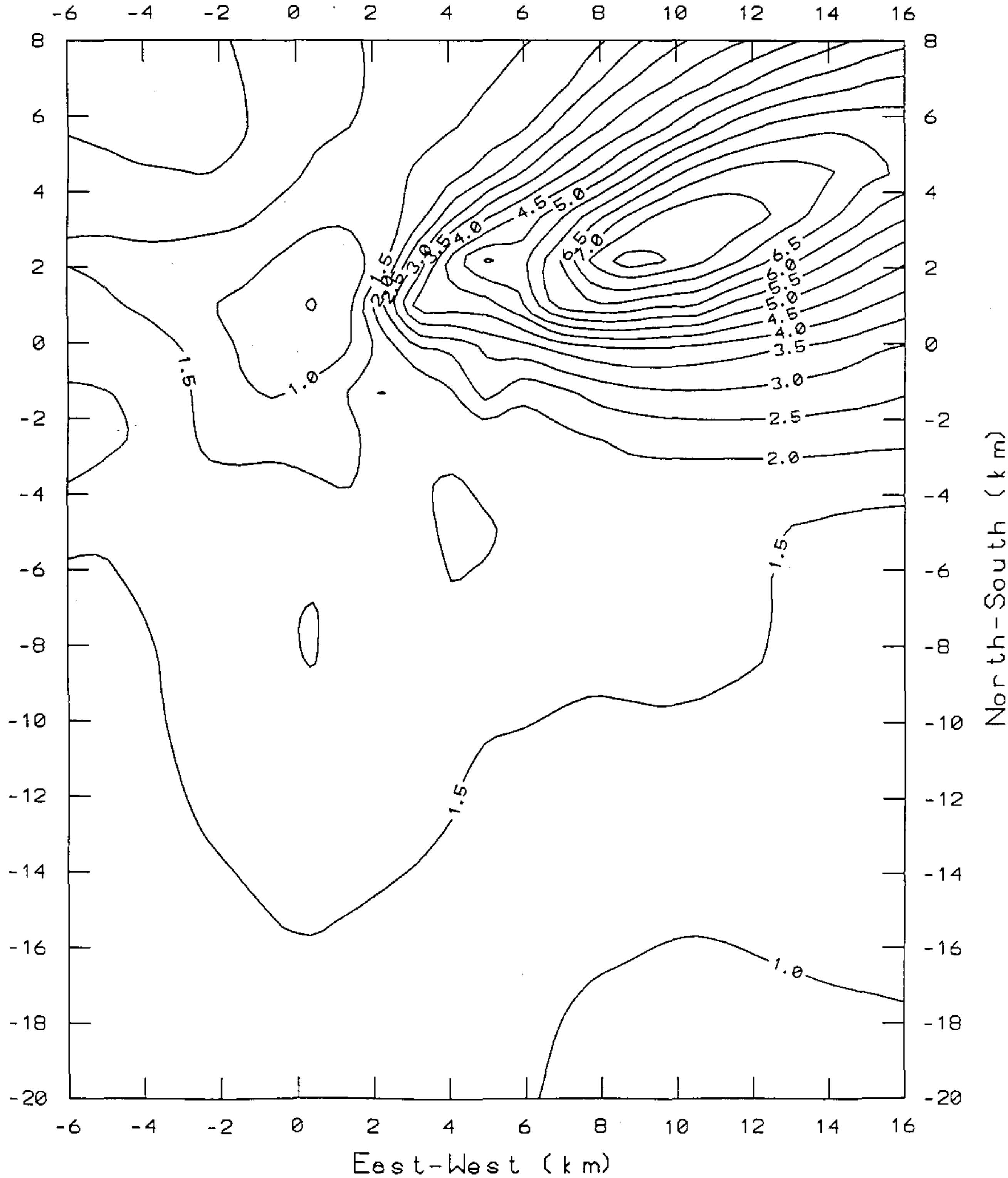


Figure V3/3.4(k)
Annual Average Ground Level Concentration (μg m^{-3}) of NO_x Resulting from the Operation of the Proposed Power Station at Black Point and the Existing Power Station at Castle Peak
Partial Operational Load - Chek Lap Kok Meteorological Data

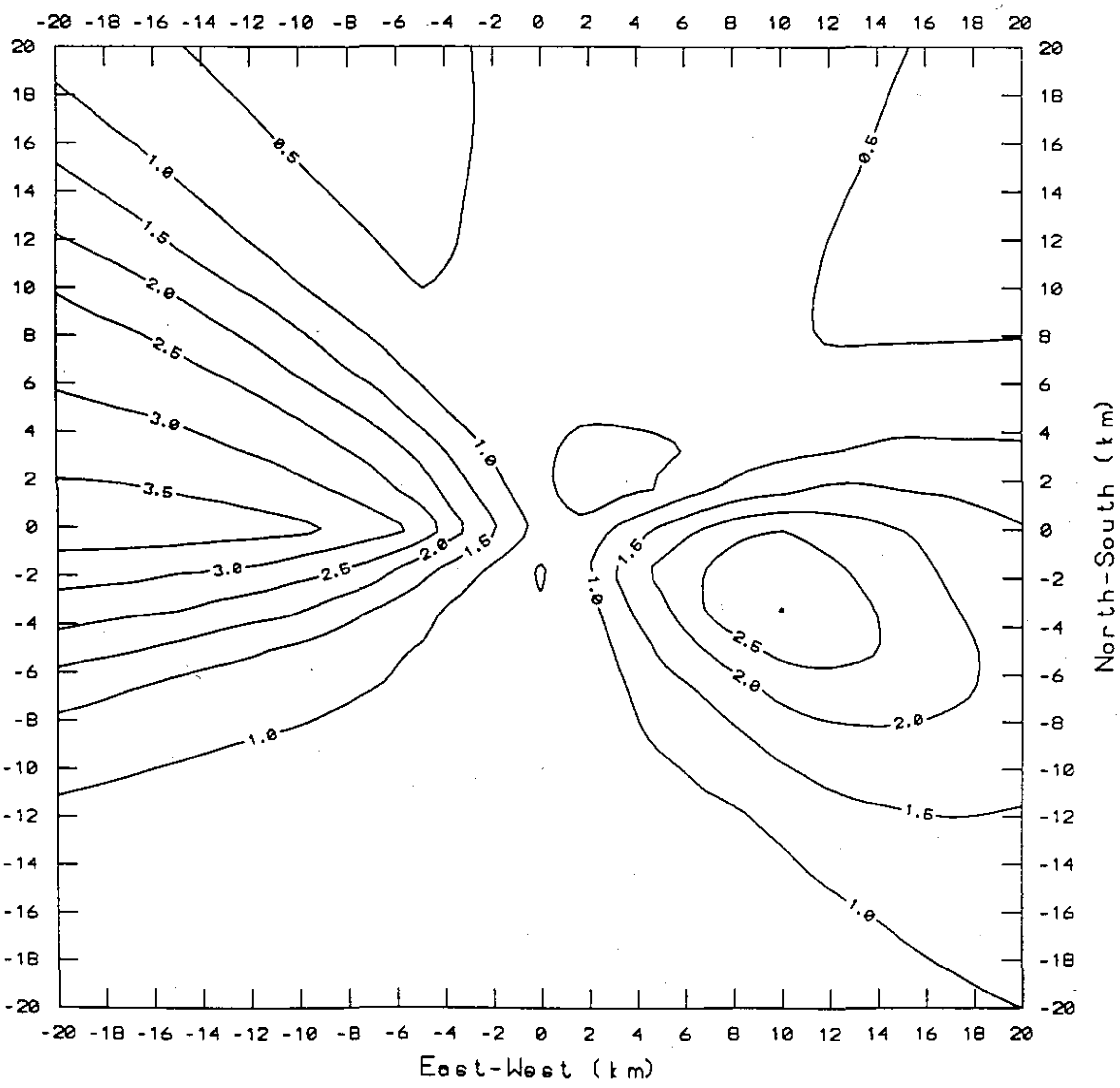


Figure V3/3.4(1)
Annual Average Ground Level Concentration (µg m^{-3}) of NO_x Resulting from the Operation of the Proposed Power Station at Black Point and the Existing Power Station at Castle Peak
Partial Operational Load - Assuming Non-Flat Terrain

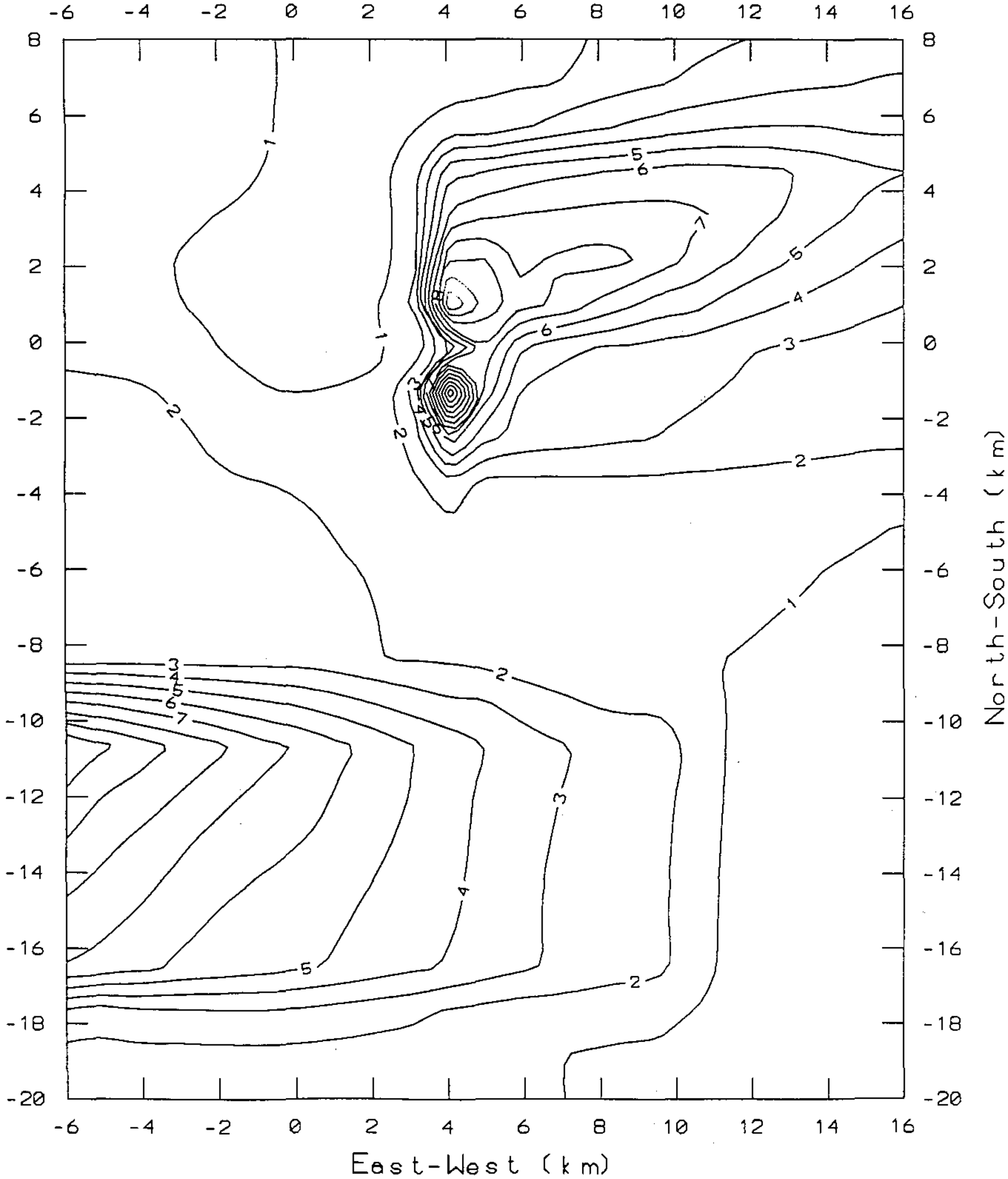


Figure V3/3.4(m)

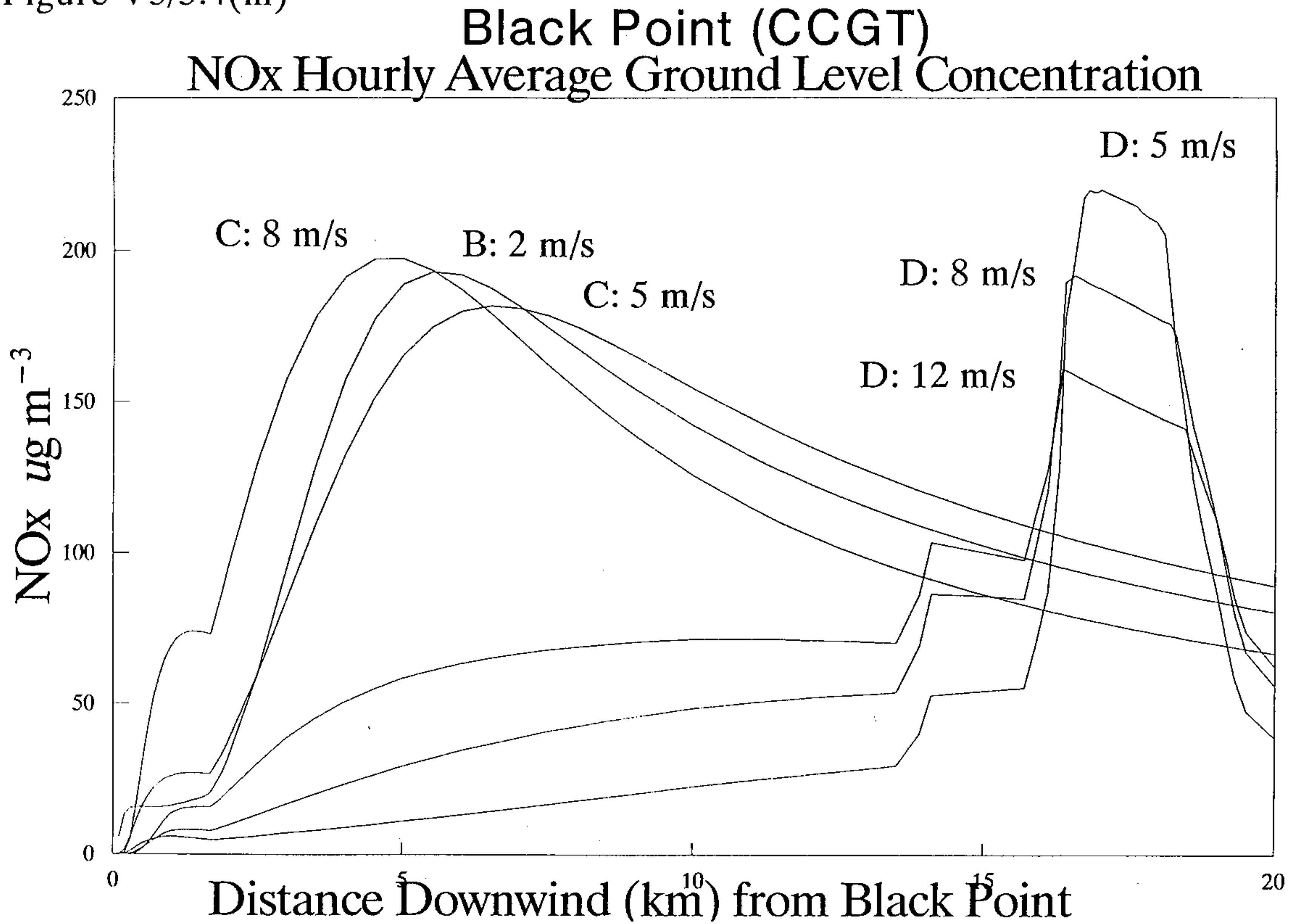
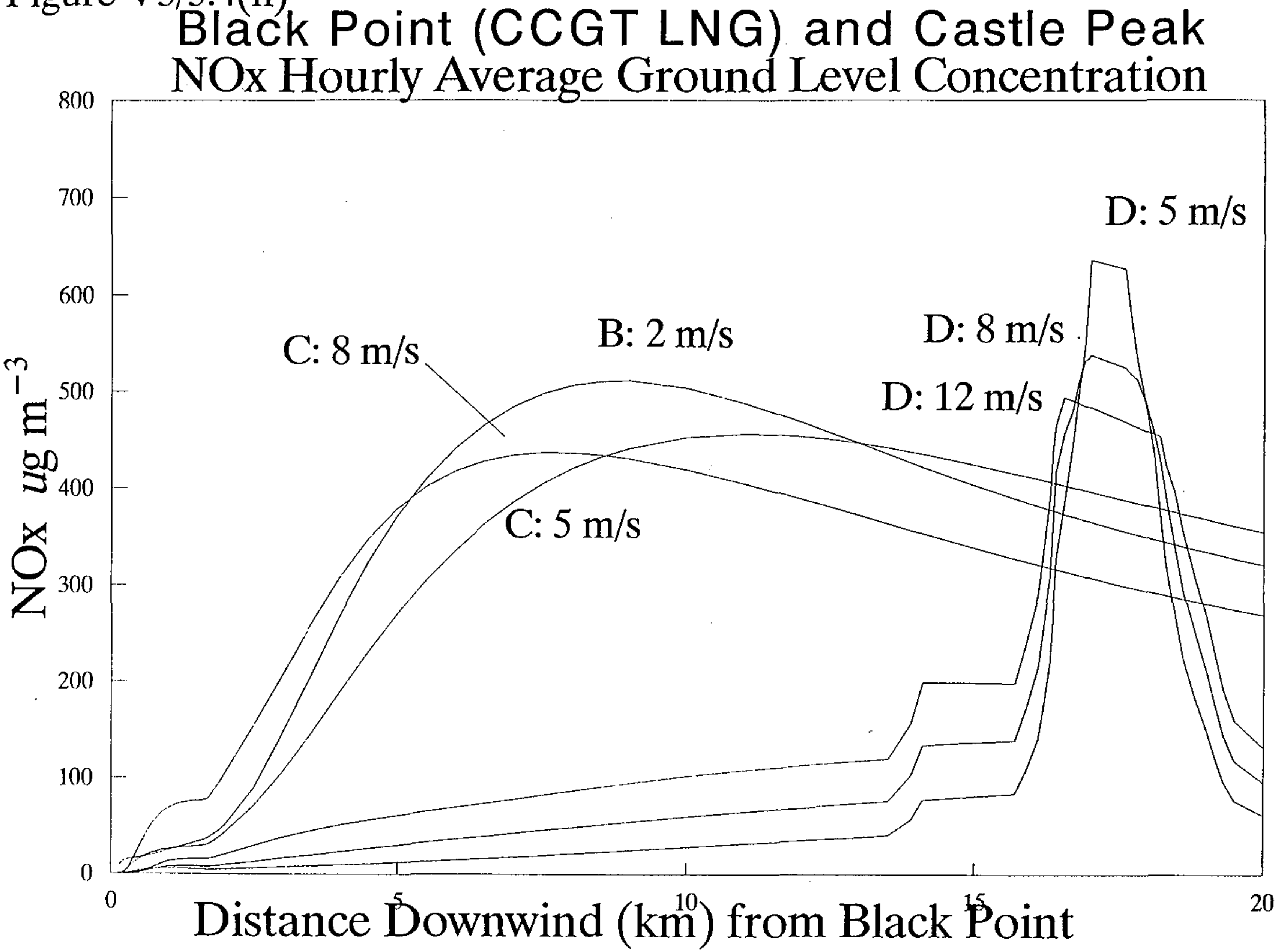


Figure V3/3.4(n)



Similar seasonal trends to those described for Scenario 1, and variations according to climatological data used (i.e. Chek Lap Kok) will apply to these results, but overall it is clear that the air quality impacts are insignificant.

3.4.3 Open Cycle Gas Turbine Units

The open cycle gas turbine units were modelled separately from the main stacks because the worst-case operating scenarios are unlikely to coincide. The predictions were made for NO_x since this had already been identified as the critical pollutant (although the KIA will address all relevant pollutants). The preliminary results shown in Table V3/3.4(b) indicate that plume rise will be sufficient to ensure the plume does not unacceptably affect any ground-level or elevated receptors. However, the effects of terrain may be quite significant and this scenario will be examined in detail in the wind tunnel.

Table V3/3.4(b). Predicted 1-hour average concentrations ($\mu g/m^3$) of NO_2 due to Open Cycle Gas Turbine Emissions (10 x 100MW units at full load)

Distance Downwind (km)	Elevation (m)		
	0	50	100
1	4	13	49
2	7	9	16
3	9	11	14
4	13	13	15

3.5 Background Concentrations

3.5.1 Existing Background Concentrations

A full description of background air quality is presented in Section V3/3.3 and Annex B of Volume 1 of the IAR. The main relevant aspects are summarised below:

- Due to its coastal location, short-term (1-hour and 24-hour average) concentrations of pollutants are heavily dependent on the wind direction. This determines whether the air mass has arrived at Hong Kong after crossing the ocean, in which case it is likely to be 'clean', or whether it has traversed the land and possibly industrial areas, resulting in rather poorer air quality. Thus, during the summer months, with a high frequency of winds from the southern and western quarters, background air quality tends to be good so that any high concentrations of pollutants are mostly due to emissions from the territory's urban areas and occur either within the urban areas or inland from them; the western and southern coastlines are likely to be very clean by comparison.

During the winter months, background air quality is likely to be poorer, but still emissions from within the territory's urban areas are the dominant source , resulting in the highest concentrations in the urban areas. In some cases this results in the AQOs being exceeded locally, particularly with respect to NO_2 (e.g. close to main road interchanges). Generally, in rural areas, however, concentrations remain well below the AQOs.

- Long-term (annual average) concentrations tend to smooth out these differences, but there is still a marked difference between 'urban' and 'rural' concentrations. Generally, the AQOs are not exceeded, even in urban areas (with one or two exceptions, e.g. NO_2 in Kwun Tong), and an overall increase in the territory's emissions load would be required to change this significantly.

These points are relevant to this assessment in the following ways:

- With westerly and largely southerly winds, the plumes from the new power station will be carrieo within a relatively clean airflow. This means that aside from urban areas where local emissions will be influential, the background level will be quite low.

- With northerly winds, which will cause the plumes to affect north Lantau, a generally higher background level might be expected. However, in this case a more significant factor needs to be considered, that is the growth in background concentrations resulting from PADS developments.

3.5.2 Future Background Concentrations

The north Lantau coastline will be subject to considerable development within the timeframe of the power station development. This will result in the creation not only of the new town of Tung Chung and other sensitive receptors, but also major sources of pollutant emissions:

- the new airport at Chek Lap Kok will be a source of NO_x and hydrocarbons;
- the new north Lantau Highway will be a significant source of NO_x;
- light industry and commercial premises will generate both SO_2 and NO_x.

These will combine to produce a significantly elevated background level along north Lantau compared with the current levels which are probably typically rural. This will be an important factor in determining the overall impact of the new power station's emissions on Lantau receptors, particularly when combined with the plumes from Castle Peak power station. Although preliminary air quality predictions were made as part of the PADS study it is necessary to investigate this issue more thoroughly now, since it may be critical in determining how control of emissions from the power station will fit in to the best regional strategy.

To this end ERL's work is being complemented by work being undertaken in two other studies:

- the north Lantau development study;
- the replacement airport design consultancy.

A meeting was recently hosted by the EPD at which all the relevant consultants attended to co-ordinate their work programmes. This will enable the KIA to take on board the results obtained from the other studies in order to allow a robust assessment to be made.

3.6 Assessment of Impacts

3.6.1 (i) Human Health and Nuisance - Scenario 1

(a) Sulphur Dioxide

The results of the numerical modelling exercise indicate that SO_2 will not cause any significant health impacts when compared with the 24-hour and annual average AQOs; even allowing for elevated background levels, this is not considered to be an issue of concern. The short-term modeling results also indicate that impacts would be acceptable, using the 1-hour average AQO as the criterion. However, because the effects of terrain can have significant implications for short-term dispersion, it is considered that this scenario must be studied further during the KIA, together with dispersion of emissions from the open cycle gas turbines, allowing for possible high-rise developments just to the south of the power station.

(b) Nitrogen Dioxide

As for SO_2, it can be concluded that the 24-hour and annual average impacts will be acceptable. However, the results indicate that there is a potential for unacceptable impacts over the short term, particularly considering the contribution of Castle Peak emissions and the likely future growth of background concentrations along the north Lantau coast. There is considerable uncertainty associated with the results, which are likely to be pessimistic, and the frequency with which a northwesterly wind will combine the Black Point and Castle Peak plumes at full load, in the summer months, is probably extremely low (<1%). Nevertheless, this is still an impact scenario of concern and will require more detailed analysis in the KIA, together with consideration of short-term impacts for other wind direction/receptor combinations.

(c) Particulates and Trace Metals

The modelling of stack emissions indicates quite clearly that resultant particulate concentrations at ground level will be very low and well within the AQOs. No further study of the issue is therefore considered necessary. By applying the trace metal emissions presented in Section V3/3.2 to the predicted annual average total particulate concentrations, the equivalent atmospheric concentrations of trace metals were obtained; these are shown in Table V3/3.6(a). There are no legally binding criteria in Hong Kong by which to assess the significance of these impacts. We have therefore assembled a range of indicators to assist in the assessment; these are shown in Table V3/3.6(b). By comparing the data in these two Tables the following conclusions can confidently be drawn:

- predicted concentrations are much less than typical urban concentrations, and also less than typical rural concentrations (except selenium and copper, for which no rural data are available);

- all predicted concentrations, with the exception of cadmium, are negligible compared with available guideline values; even the predicted cadmium level is at most only 10-15% of the guideline value;

Considering these predictions were made using the worst case assumptions to derive emission rates, it can be concluded that ambient trace metal concentrations will not increase sufficiently to cause any concern regarding human health impacts through inhalation. Considering also that the predicted levels are all safely below typical rural levels it can reasonably be concluded that deposition rates will not cause any significant uptake of the metals through the soil into agricultural produce. Consequently, no indirect health impacts are likely through this route.

(d) Hydrocarbons

As argued above, in Section V3/3.3.1, no significant impacts are likely as a result of emissions of unburnt hydrocarbons.

(e) Acidification of Drinking Water

From the assessment of acidification potential which is presented below in Section V3/3.6.2(i), it is concluded at this stage that impacts through this route will be insignificant as a result of 'dry' acid deposition (defined in the next section). This conclusion, however, requires confirmation once the possible effects of wet deposition have been investigated in the KIA.

Table V3/3.6(a)
Predicted Annual Average Atmospheric Concentrations of Trace Metals resulting from Operation of the Completed Coal-Fired Power Station (Scenario I)

Trace Metal	Ground Level Concentration (ng/m^3)
Arsenic	0.25
Cadmium	0.06
Chromium	0.36
Copper	0.32
Mercury	0.21
Nickel	0.72
Lead	0.43
Zinc	0.71
Selenium	1.73
Antimony	0.02

Table V3/3.6(b)
Annual Average **Guideline Values and Typical Ambient Concentrations of Trace Metals**

Contaminant	Guideline Value (ng/m^3)	Reported Rural Concentration (ng/m^3)	Reported Urban Concentration (ng/m^3)
Arsenic	-	1 - 10[1]	200 - 1000[1]
Cadmium	1 - 5 (rural)[2] 10 - 20 (urban)[2]	1 - 5[1]	5 - 50[1]
Chromium	-	0 - 3[1]	4 - 200[1]
Copper	2000[3]	-	17[1]
Mercury	-	2 - 3[4]	2 - 31[4]
Nickel	-	9 - 50[1]	60 - 300[1]
Lead	500 - 1000[2]	100 - 3003[1]	500 - 3000[1]
Zinc	5000[3]	18 - 104[4]	220[4]
Selenium	1000[3]	-	0.5 - 3.0[4]
Antimony	5000[3]	6.1[4]	0.6 - 4.0[4]

1 WHO Regional Publications, European Series No.23
2 World Health Organisation Guidelines
3 Calculated from UK Occupational Exposure Limits 1990, Guidance Note EH 40/90. The occupational exposure limits are divided by 100 to derive 'voluntary' exposure limits.
4 A survey of Atmospheric Trace Elements in the UK (1979), AERE Harwell Report R9886.

3.6.1 (ii) Human Health and Nuisance - Scenario 2

(a) Sulphur Dioxide

The results of the numerical modelling exercise indicate that SO_2 will not cause any significant health impacts when compared with the 1-hour, 24-hour and annual average AQOs. Even allowing for elevated background levels, this is not considered to be an issue of concern. It is therefore not considered necessary to investigate this any further in the KIA.

(b) Nitrogen Dioxide

As for SO_2, it can be concluded that the 24-hour and annual average impacts will be acceptable. However, the results indicate that there is a potential for unacceptable impacts over the short term. As for Scenario 1, there is considerable uncertainty associated with the results which are likely to be pessimistic. Nevertheless, this is clearly still the key potential human-health impact under this scenario and will need to be investigated thoroughly in the KIA.

(c) **Particulates and Trace Metals**

Resultant concentrations under Scenario 2 would be approximately 50% of those predicted under Scenario 1 because of the use of gas) and would not result in any significant impacts since the ground level concentrations would be negligible compared with the AQOs. No further study of this issue is therefore considered necessary.

As for Scenario 1, by applying the trace metal emissions presented in Section V3/3.2 to the predicted annual average total particulate concentrations, the equivalent concentrations of trace metals were obtained; these are shown in Table V3/3.6(c). By comparing the data in this Table with the proposed impact indicators in Table V3/3.6(b), it can be seen that ambient trace metal concentrations will not increase significantly at all and thus will not cause any human health impacts through inhalation. As for Scenario 1, therefore, no indirect health impacts through contamination of agricultural produce are considered likely.

Table V3/3.6(c)
Predicted Annual Average Atmospheric Concentrations of Trace Metals resulting from Operation of the Completed Power Station (Scenario II)

Trace Metal	Ground Level Concentration (ng/m^3)
Arsenic	0.13
Cadmium	0.03
Chromium	0.18
Copper	0.16
Mercury	0.11
Nickel	0.36
Lead	0.22
Zinc	0.36
Selenium	0.87
Antimony	0.01

(d) **Hydrocarbons**

As argued above, in Section V3/3.3.1, no significant impacts are likely as a result of emissions of unburnt hydrocarbons.

(e) **Acidification of Drinking Water**

From the assessment of acidification potential which is presented below in Section V3/3.6.2(i), it is concluded at this stage that impacts through this route will be insignificant as a result of 'dry' acid deposition (defined in the next section). This conclusion, however, requires confirmation once the possible effects of wet depostion have been investigated in the KIA.

3.6.2 (i) The Natural Environment - Scenario 1

(a) Effects of gaseous pollutants

Although direct vegetation damage resulting from exposure to elevated levels of gaseous pollution has been observed in the proximity of industrial installations, it has been notoriously difficult to simulate field conditions in the laboratory in order to obtain damage 'threshold' levels and dose-response relationships. Furthermore, the extent to which such threshold levels and relationships are applicable to vegetation in other parts of the world, is arguable. However, they do provide an indicator of the potential for damage and represent the best available means of assessing the likelihood of impacts in this case.

From a review of many studies and consultation of expert opinion, CDA and ERL (1988) arrived at the following general conclusions regarding effects on trees, crops and other vegetation:

- The range of threshold concentrations of SO_2 required to produce acute visible foliar injury to trees is extremely wide, but short-term minimum concentations approaching and in many cases far exceeding 1000μg/m3 are most likely applicabe. Short-term threshold levels for NO_2 are reported to be up to twice this level.

- Threshold levels for chronic injury to trees are much lower and long-term (annual average) concentrations in the range of 100-500μg/m3 are likely to cause damage (in more sensitive cases perhaps as low as 50μg/m3, and in less sensitive cases perhaps 600μg/m3).

- A similarly large range of threshold levels have been assigned to acute (i.e. taking place over a matter of hours) crop and other plant damage from SO_2. These range from about 800μg/m^3 to 11000μg/m^3 for different species. For NO_2 the range is about 2000-60000μg/m^3.

- Threshold levels for chronic injury to crops (i.e. taking place over months or years), however are considered to be much lower. In some cases annual average SO_2 concentrations as low as 20μg/m^3 were reported, but these probably take account of any synergistic effects with ambient NO_2. It was concluded that a conservative threshold level which could be applied as a general indicator for Europe would be 20-30μg/m^3 as an annual average, and that every 1μg/m^3 above this could result in a growth rate or crop yield reduction of about 0.2%.

- At low levels of SO_2 some species have responded with increased growth rates and/or crop yields.

Although the real damage function for vegetation in Hong Kong could differ from this by perhaps 50% or more, it indicates that the predicted annual average concentrations are most unlikely to result in any noticeable crop or plant damage. Acute damage from very high short-term concentrations is equally unlikely since the typical damage thresholds which are quoted are in the region of thousands μg/m^3 and higher. Although some studies have reported synergistic effects of exposure to both SO_2 and NO_2, such information could not be applied with any confidence to this situation, since the pre-conditions for the synergy are even less likely to prevail than the pre-conditions for the single-pollutant damage. Overall, therefore, it must be concluded that there is no evidence to suggest that direct vegetaion damage would result from the power station emissions.

(b) **Effects of acid deposition**

Acid deposition can take place either in dry form (i.e. dry deposition of SO_2 and NO_x) or in wet form (i.e. wet deposition of emitted SO_2 in the form of sulphate (SO_4^{2-}) and emitted NO_x in the form of nitrate (NO^-_3). Most deposition in the vicinity of the source usually takes place as dry deposition, the rate of deposition being proportional to the ambient concentration of the acidic gas. This is because it takes time for oxidation of SO_2 to sulphate to take place and for the sulphate to be deposited in rain (though in a 'closed cell' system, where air masses tend to recirculate over a region, this may mean that wet deposition takes place not far from the source). The proportional relationship is given as:

Dry Deposition (flux) = Vg [ ]

where Vg is the deposition velocity for a particular gas and [ ] is the gas concentration.

For this study deposition velocities of 0.4 cms^{-1} for NO_2 and 0.5 cms^{-1} for SO_2 were used.

From a modelling point of view dry deposition is much easier to handle, and predicted annual average dry deposition rates for Scenario I (including the effects of Castle Peak emissions) are presented as contours of equal deposition in Figures 3.6(a) and (b), for SO_2 and NO_x respectively. The deposition rates are presented in units of kilo-equivalents per square kilomètre per year ($keq/km^2.yr$), which indicates their equivalent 'acid' deposition rate (each molecule of SO_2 deposited has twice the acid potential of a molecule of NO_2). In this way the contribution to acid deposition from each pollutant can be estimated by simple addition of their acid equivalent deposition rate.

The results indicate that the maximum total dry deposition rate (sulphate plus nitrate), to the northeast of the site (using Lau Fau Shan climatological data) would be in the order of 20 $keq/km^2.yr$. Across most of the study area, however, the predicted deposition rate is much less than this. The significance of this for the natural environment is difficult to assess, for reasons outlined in Section 3.3.2. However, it can be put into context by comparing it with information on critical loads which have been proposed for the protection of the natural environment in Europe. The maximum predicted deposition rate is roughly equivalent to the most stringent critical load proposed for very sensitive regions where the soils have minimal buffering capacity, the bedrock has low weathering rates and high rainfall results in a high flux of water through the system. As discussed in Section 3.3.2, it is likely that the soils in Hong Kong are, in general, quite sensitive to acid deposition, although this will vary quite significantly from one area to the next. More importantly, the impacts resulting from any acidification which takes place would depend on the landuse as much as anything else. To the northeast it is considered unlikely that there would be sigificant impacts for this reason (see Section 3.3.2). Elsewhere, the predicted dry deposition rates are well below any critical load which might reasonably be proposed and it most unlikely that any of the impacts described in Section 3.3.2 would occur to any significant degree.

There is also the contribution of wet deposition to take account of, however. At the distances from the source which have been considered, wet deposition from the power station emissions would not normally be expected to be a significant contributor to total (dry plus wet) deposition. However, rainfall in Hong Kong is already quite acidic and it is not clear how much of this is due to emissions in the PRC being introduced into the convective rainfall cells which develop over southern China during the summer monsoon. In the same way it cannot be concluded with certainty at this stage that the power station emissions will not affect the acidity of rainfall over the territory. Neither is it clear to what extent the emissions might affect rainfall acidity at more distant receptors (i.e. in the PRC). At this point it is considered that the final emissions control measures decided upon to mitigate human health impacts are more than likely to satisfy requirements for controlling acid deposition. Nevertheless, this aspect of the assessment will require more detailed evaluation during the KIA, taking account both of the wind-tunnel dispersion modelling results and climatological data from the Royal Observatory.

Figure V3/3.6(a)
Annual Average Dry Deposition of SO_2 for Scenario I (keq km^{-2} yr^{-1})

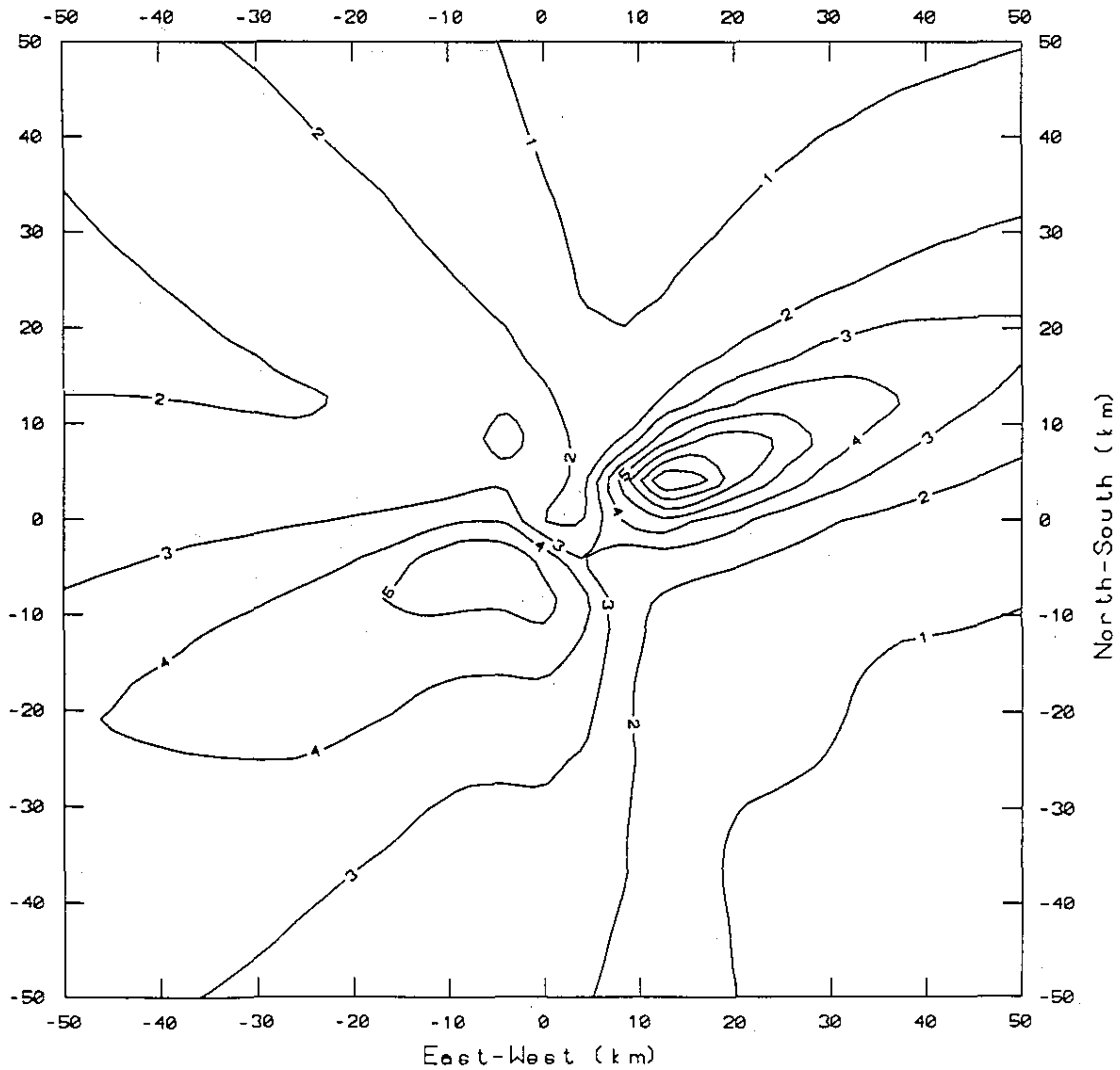
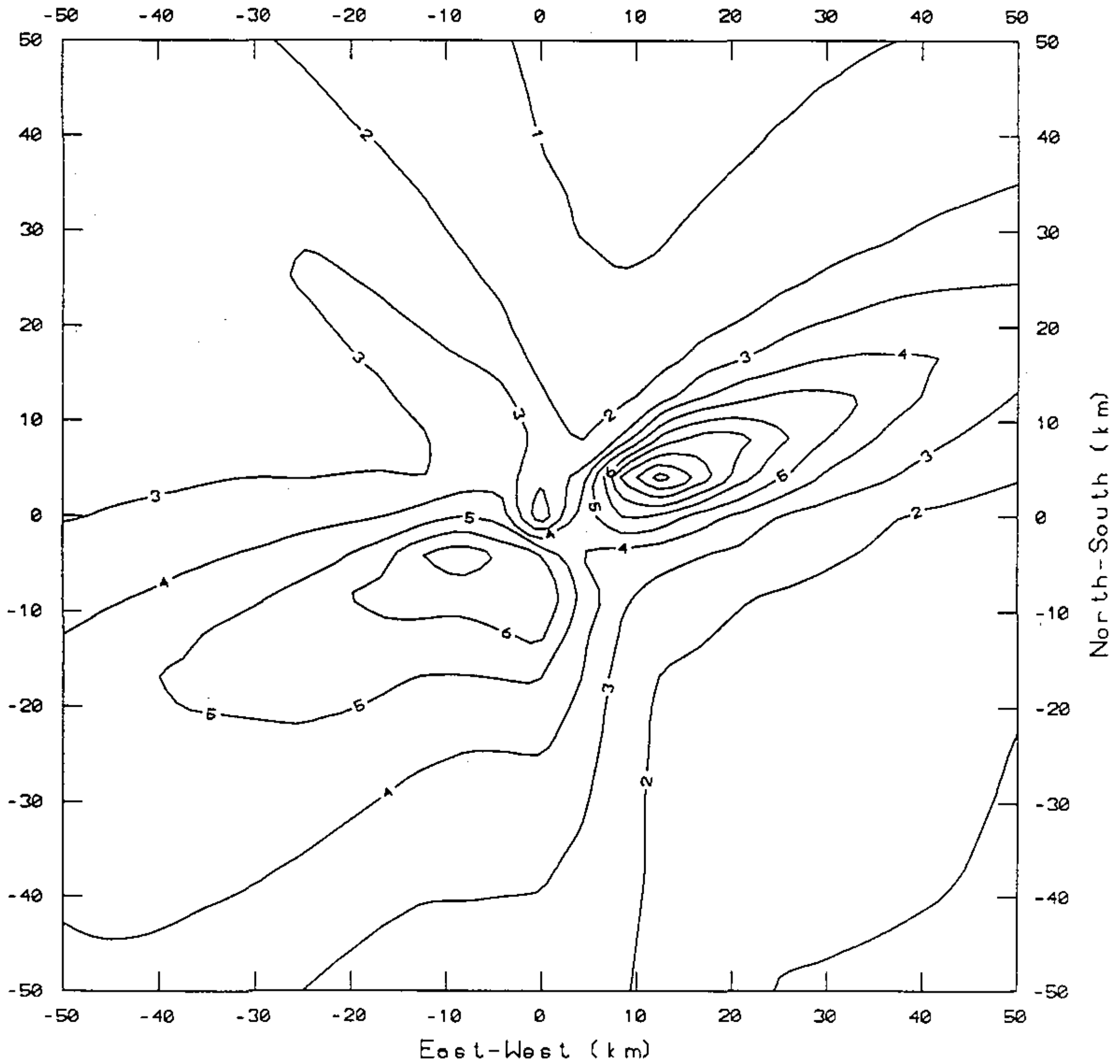


Figure V3/3.6(b)
Annual Average Dry Deposition of NO_x for Scenario I (keq km^{-2} yr^{-1})



3.6.2 (ii) The Natural Environment - Scenario 2

(a) Effects of gaseous pollutants

Considering the information presented in Section V3/3.6.2(i) and the lower air quality impacts predicted for this scenario, it is clear that no direct vegetation impacts are to be expected.

(b) Effects of acid deposition

Considering the assessment presented above for Scenario 1, in Section 3.6.2(i), it is concluded that acid deposition is even less likely to result in significant impacts under Scenario 2. Nevertheless, during the KIA this will be investigated in more detail before a final conclusion is made.

3.6.3 (i) Building Materials - Scenario 1

From the review work undertaken by CDA and ERL (1988) general damage functions were derived for the effect of SO_2 on building materials. Of most relevance to Hong Kong, the most conservative estimates of damage to galvanised and painted steel indicate that the expected lifetime of the material would decrease at a rate of 0.25–0.75% per $\mu g/m^3$ above zero concentration. Thus the predicted annual average concentrations would most likely result in less than a 0.5% decrease in such material lifetimes. This is not significant and no further investigation is considered necessary.

3.6.3 (ii) Building Materials - Scenario 1

As for Scenario 1, no significant impacts are at all likely and no further study of this issue is considered necessary.

3.7 Conclusions, Mitigation Measures and Further Study

The assessments undertaken for the IAR have covered all the potential air quality impacts associated with the operation of the new power station. Overall, on the assumption that the EPD's BPM of emissions control are implemented, it is considered that the potential for human health impacts is only possibly significant with respect to the short term, i.e. 1-hour average concentrations. The requirement for and type of mitigation measures can not be determined at this stage, however, because of the significant levels of uncertainty attached to the predictions made so far. This uncertainty should be reduced to manageable levels by undertaking wind tunnel tests during the next phase (Phase 2) of the KIA.

Preliminary output from simple wind tunnel tests will be available for review during April. At this stage a second series of much more complicated tests will be made providing detailed information of how the plumes from both Black Point and Castle Peak will disperse across the complex terrain of the New Territories, Lantau Island and, if necessary Shekou (this will depend on the implications of results obtained for Lantau). By August or September it is expected that a comprehensive set of tests will have been completed and the results presented in a Phase 2 Report. This report will provide detailed information on the potential benefits, technical feasibility and costs of a range of options for mitigating short-term impacts, if proven to be unacceptable under the base case presented at this stage.

The only other potential impacts that are recommended for further study in the KIA are those associated with acidification. In summary, it is considered that the power station emissions are unlikely to result in any significant impacts, based upon the predicted dry deposition rates and our understanding of the sensitivity of the territory's soils and water supplies to acidification. However, the contribution of wet deposition requires further investigation.

4. NOISE ENVIRONMENT

4.1 Introduction

The preliminary noise assessment performed for the proposed LTPS in the Final Site Search Report as completed on September 1990, has been reviewed. This assessment was based on the criterion of a L_{90} noise level of 55 dB(A) at 500m from the main boiler house, achievable by current technology. Noise emissions produce relatively localised and non-cumulative impacts to the surrounding environment and Noise Sensitive Receptors (NSRs), and were sensibly controlled in the first place when the potential sites for the LTPS were identified in the least populated rural areas of the territory. The present LTPS site, Black Point, ranked best and recommended environmentally in the overall assessment, is average amongst the eight assessed options on the noise aspects. The assessment indicated that operation of the LTPS is not expected to cause significant disturbance to residents at any of the receptors under consideration.

This section presents a more detailed assessment of the operational noise impacts against a predicted increase in the surrounding background noise levels to allow impact identification and the development of mitigation proposals.

Recommendations were given by the Consultants in the plant design process regarding the site location, boundary layout and plant arrangement. The latest plant layout is planned with the boundary cut slope formed to preserve the natural topography at the south of the Black Point headland. A continuous natural barrier is formed along the south and east side of the site that blocks off the plant noise propagation path from the potential NSRs.

The assessment of operational noise involved the following four stages, in order to predict the corrected noise level received by NSRs from the planned development.

- **Sources noise survey:** Relevant noise information at the existing CPPS was gathered from review of the existing noise surveys and on-site noise measurements. Where planned noise sources were incomparable with those at CPPS, noise data from plant manufacturers and publications was used.

- **Noise source modelling:** Major noise sources were identified, ranked and characterised, estimated sound power levels (SWL) were assigned for each major source.

- **Noise propagation calculation:** The model was suitably modified and used to perform noise propagation calculations at NSRs under different layouts and conditions.

- **Criteria comparison:** Noise levels calculated and corrected at the NSRs were compared with target levels, from which the change of noise environment brought about by the planned development was estimated.

4.2 Inventory of Noise Sources

Through review of noise surveys, noisy equipment and activities have been identified and classified as either continuous or transient sources. Estimations of source SWL have been performed for ranking, and minor sources have been screened to keep the assessment concise and manageable. In the course of data gathering, full fledged spectral noise records were often unavailable and difficult for transient noise measurement, and the assessment was performed with noise calculations based on the nominal dominant frequency band.

4.2.1 Source Sound Power Level (SWL)

SWL is a noise parameter specific to the source characteristic that is unaffected by ambient noise levels and the physical location of equipment. Hence SWL has been employed for source ranking and as the basis for noise propagation prediction.

SWL of noise sources can be determined explicitly according to standard procedures (e.g. ISO 3743-1976 and ISO 3744-1981) during equipment shop testing, and it is highly recommended that noise specification for procurement of major equipment should be written in both Sound Pressure Level at reference distance and SWL, as according to guidelines in ISO 3740-1980.

Explicit SWL determination methods were not feasible for the noise survey at CPPS, and SWL estimations were obtained by applying the on-site noise measurement results in three characteristic equations depending on the characteristics of the source type.

$$SWL = 10 \log_{10} (W/Wo)$$

where W is the acoustic power emitted
Wo is the reference power (10^{-12} watt)

i) Point Source

For sources with small physical dimensions in comparison with the noise measurement distance (r), the SWL for the source is compiled by:

$$SWL = SPL + 10 \log 4\pi r^2 - DI \text{ dB} \qquad \text{(eq. 4.1)}$$

where DI is directivity index = 0 dB when source in free field
= 3 dB when source on ground
= 6 dB when source bounded by two surfaces

ii) when a line source is considered:

$$SWL = SPL + 10 \log \frac{4\pi al}{\alpha} - DI \qquad \text{(eq. 4.2)}$$

where: a = perpendicular distance between source and receptor.
l = length of source.
α = included view angle at receptor (in radians).

iii) **When the source is enclosed in a building or enclosure:**

$$SWL\ enclosure = SPL_{rev.} + 10 \log A - 6 - TL\ enclosure \quad \text{(eq. 4.3)}$$

where $SPL_{rev.}$ is the interior reverberant SPL
A is the area of emitting surfaces
TL is the transmission loss of the material

Compilation of the sources SWL from noise survey measurement is always subject to error due to noise contributions from other noise sources, reflection from other than the ground, near field effects and source directivity effects, and these errors were minimised by sensible selection of measurement locations.

4.2.2 Principal Noise Souices

i) **Boiler Hall (BH)**

At the CPPS a semi-enclosed boiler hall design was adopted, and the same layout is assumed for the planned LTPS. A large number of noise sources, including the burners, coal mills and feeders, primary air and forced draught fans, and large steam pipes and gas ducts, will create a closely spaced and intermixed noise pattern. The interaction of individual noise sources interaction will be further superimposed with the reflection contributions from surfaces on the boiler and the ESP structures. The resultant diffuse and semi-reverberant noise field was characterised with a log-average Leq of about 88 dB(A)[1].

The noise emission from each Phase of the boiler halls was studied as four plane noise sources, at the three openings. Imaginary facades with zero transmission loss are assumed. The resultant blend of the low frequency flame and flow noise, and high frequency rotating machinery noise leads to designation of 500 Hz as the dominant frequency band for calculation. The southern, side and northern facades for each Phase of boiler hall are modelled as plane sources with SWL of 104, 120 and 127 dB(A) respectively.

ii) **Turbine Hall (TH)**

Steam turbines, electrical generators and associated auxiliaries emit high pitched mechanical and electrical noise and are generally housed in purpose-built acoustic enclosures. At the LTPS the four turbine-generator sets will be further enclosed in a common turbine hall. The noise survey results[1] as measured for the existing Castle Peak 'B' Power Station, with the same designed power capacity, have been used as the basis for assessment.

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1 CLP report no. SSB/ES/R-79/86, "Assessment of Noise Levels in Castle Peak 'B' Power Station". Oct. 86.

Turbine hall facades will be considered as noise emission surfaces with SWL calculated by eq. 4.2 taking the interior noise level as 90 dB(A) and transmission loss due to cladding as 20 dB. The SWL for the southern, side and top facades for each Phase of turbine hall are hence calculated to be about 105, 97 and 107 dB(A) respectively. High and medium frequency components of the interior noise are preferentially attenuated by the hall panels, and hence the dominant frequency of the external noise is taken at 250 Hz.

iii) Induced Draught Fans (ID fans)

ID fans are one of the major outdoor noise sources that give out predominantly low frequency flow noise from the fan and ducts. The measured noise level is 83 dB(A) at 5 metres from the ID fans and motors[1], and an estimated SWL on the basis of a single point source is 105 dB(A) at nominal frequency of 125 Hz. For simplicity, the eight ID fan sets for each generating phase are aggregated as a single point source at the notional centre with SWL of 114 dB(A).

iv) Flue Gas Desulphurisation Plant (FGD)

FGD is a new facility in the planned LTPS not present at CPPS, made up of unitised scrubbing sections and the common limestone and gypsum handling sections. The recommended off-site noise level as suggested in CEGB standard 182[2] at 400m from the unit scrubbing and common section is 40 dB(A) and 35 dB(A) respectively.

Taking into consideration the additional natural barrier attenuation, less stringent FGD noise requirements should be appropriate without worsening the overall noise emission. Hence the overall SWL for each phase at the scrubbing section and common section were taken as 115 dB(A) at 500 Hz, and 115 dB(A) at 250 Hz respectively.

v) Generator Transformer

Low frequency noise, dominant at about 125 Hz, will be produced from the winding vibration and core magnetostriction effect. The noise level measured at a distance of 6 m from one of the generator transformer bay front opening was 82 dB(A), and the estimated SWL for each bay and one phase (4 bays) is calculated to be 110 and 116 dB(A) respectively.

vi) Coal Handling Plant

Coal handling plant consists of a number of outdoor machines operating at a dominant frequency of about 1,000 Hz. Some equipment such as the bulldozers, stacker/reclaimers and unloaders are mobile, and hence the overall plant SWL in full phase of Scenario I will be aggregated at the notional centre of the coal stockyard and jetty based on the manufacturer's noise data provided in Table V3/4.2(a) below:

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[2] "Noise Limits for New Power Station" CEGB standard 182, June 1988

Table V3/4.2(a)
Noise Emission Data for Coal Handling Plant

Equipment	Unit SWL dB(A)	Reclaiming	Stacking
At Stockyard:			
Conveyors	82/m	118	118
Transfer Towers	105-111	121	121
Portal Scraper	123	126	-
Stacker/Reclaimer	111	114	-
Bulldozer	119	122	-
Crushing Station	128	131	-
Total :		**132 dB(A)**	**123 dB(A)**
At Jetty:			
Conveyors	82/m	-	115
Ship Unloaders	117	-	120
Total :		-	**121 dB(A)**

Higher noise emissions will be produced by the Coal handling plant during the reclaiming operation than that during the unloading/stacking process. Whilst the coal reclaiming operations do not take place 24 hours a day, they are continuous and daily operations, and will be modelled as such. The overall coal plant reclaiming noise during both phases of Scenario I, and phase 2 of Scenario II will be taken as 129 dB(A) SWL.

vii) **Combined Cycle Gas Turbines (CCGT)**

Four combined cycle gas turbine and heat recovery steam generation (HRSG) units will be installed in Phase I of the Scenario II development. The typical noise level from a CCGT is around 66 dB(A) at a distance of 60m, equivalent to a point source SWL of 110 and 116 dB(A) for each CCGT unit and the overall Phase I complement of four CCGT units respectively.

viii) **Other Prevailing Noise Sources**

In addition to the above plant, identified as the major sources contributing to the off-site noise emission, there exist a number of smaller noisy items of plant in the CPPS that are worth mentioning. The cooling water pumps, air compressors for various services, and the station transformers etc, all produce a high level localised noise environment, but are generally enclosed in concrete or steel cladded housings. These sources will not be major noise components propagating off-site to NSR, and hearing protection for plant operators should be provided if necessary.

4.2.3 Intermittent Noise Sources

i) Gas Turbines (GT)

The ten 100 MW gas turbine units, that are emergency power units, will produce mainly high frequency noise at harmonics of a range of blade frequencies corresponding to different rotor stages. Standard noise treatments, such as suction and discharge silencers, and machines housing, are considered necessary and a standard feature, to maintain an acceptable in-plant noise level during operation, and an overall SWL of about 120 dB(A) should be achievable. Six gas turbines will run up in the event of tripping of a 680 MW boiler unit, with the consequence of an additional noise emission (SWL) of about 128 dB(A) at high frequency on very rare occasions but will not pose a nuisance to NSRs.

ii) Start-up and safety valves vent noise

High frequency jet noise is produced by turbulence and shock waves as high pressure steam is vented to the atmosphere from blow down or drain valves during daily plant start up operations and also from the occasional lifting operation of the steam safety valves. Noise-induced trauma or hearing loss to operators may result from the possible high intensity sound, hence CEGB [2] has the following vent noise limit:

Safety valve (vent in plant)	105 dB(A) at 1m
Safety valve (vent to atmo.)	105 dB(A) at 15m
blow down/drain valve	105 dB(A) at 15m

To meet the above noise limit, silencers will be required. The intermittent vent noise will be further attenuated by the natural topographical barrier and will not cause nuisance to the NSRs.

4.3 <u>Sensitive Receivers</u>

The proposed LTPS site is located at the north of Black Point and on the present beach at Yung Long which is isolated from any immediate residential areas by the natural topographic envelope. The forming of the site boundary cut slope at Black Point and the natural bowl edge feature surrounding the Yung Long beach, are major features of the LTPS which will minimize the deterioration of surrounding noise quality and noise impact to sensitive receivers.

The existence and conditions of possible affected sensitive receivers were investigated by site visit and by reference to the population figure as at 1990 in the Planning Guide Plan No: D/TM1/11.

NSR1 (Lung Kwu Sheung Tan) - is the nearest NSR south east of the site, with a recorded population of 68 living in rural wooden huts. The area remains classified for residential use in the PADS strategy plan.

NSR2 (Tsang Tsui Village) - is the area north east of the site with scattered residential dwellings and the BBC Relay Station with a recorded population of 9.

NSR3 (Lung Kwu Tan) - is the area 2-5 km to the south east of Black Point with scattered residential use in the villages of Pak Long, Sha Po Kong, Nam Long and Lung Tsai. Total recorded population is about 800. Lung Kwu Tan will be retained for residential use in the latest PADS strategic plan.

24-hour noise records at representative locations close to NSR1, NSR2 and NSR3 were taken and the noise monitoring results have been presented in V1/3.6.

The prevailing background level in the day, evening, and night-time periods at the three NSR locations, presented in Table V3/4.3(a), were taken as the arithmetic mean of the L_{90} measurement in the corresponding time periods.

Table V3/4.3(a)
Background Noise Levels at NSR Locations

Location		**L_{90} dB(A)**	**L_{90} + 10 dB(A)**
NSR1 (Lung Kwu Sheung Tan)	Day Evening Night	44 46 40	54 56 50
NSR2 (Tsang Tsui)	Day Evening Night	42 39 40	52 49 50
NSR3 (Lung Kwu Tan)	Day Evening Night	49 44 40	59 49 50

4.4 Statutory Criteria/Requirements

4.4.1 Off-site operation noise

Noise emission from permanent sources in Hong Kong is controlled by the Noise Control Ordinance, and the details of assessment and criteria are stipulated in the "Technical Memorandum for the Assessment of Noise from Places other than Domestic Premises, Public Places or Construction Sites" (TM). For major new developments, the Environmental Chapter of the Hong Kong Planning Standards and Guidelines (HKPSG) is also relevant.

i) **Statutory Criteria from the Technical Memorandum**

In the TM, the following procedures are required for assessment:

- Determine the appropriate Area Sensitive Rating (ASR) and Acceptable Noise Level (ANL) for the Noise Sensitive Receiver (NSR) in question.

- Conduct measurements to obtain the Corrected Noise Level (CNL) of the noise under investigation.

- Compare the CNL with the ANL to determine if a Noise Abatement Notice may be issued.

The TM is used primarily to determine whether a Noise Abatement Notice may be issued, or, if one is already in force, to determine whether it is being complied with. The general requirement of EPD for planning new development is that the CNL from the new installation must not exceed the appropriate ANL minus 5 dB(A).

Commissioning for phase one of the planned LTPS is scheduled for completion in 2001, and that for phase two in 2008.

A review of the situation of the three existing NSRs indicates that the dwellings are typical of a rural residential area, unaffected by Influencing Factors (IFs), and hence an ASR of 'A' should be assigned, and should remain so for the phase 1 operation of the LTPS.

The assessment of the future noise environment will assume that PADS will proceed as planned and the coastal areas between Lung Kwu Sheung Tan and Lung Kwu Tan will be reclamined for deep waterfront industry and cargo working area between 2001 to 2006. Hence it is likely that during that phase II operation, the Lung Kwu Tan area will be directly affected by that development and be classified as ASR 'C',but as a conservative estimate an ASR of 'B' has been assigned.

ii) **Noise Guidelines from the Hong Kong Planning Standards and Guidelines**

In the planning of the proposed LTPS, as a new development in the rural areas, HKPSG recommend that noise emissions should be limited to avoid consistent excess of 10 dB(A) above the prevailing background. On review of the base line survey, the (L_{90} + 10) dB(A) criteria for the three NSR at different periods range from 49 to 56 dB(A), and should form criteria during Phase I Operation. These baseline surveys will experience an uptrend following the PADS development and will not be relevant for NSRs at LKST and LKT during the Phase II operation.

iii) **Target Noise Level (TNL) for the assessment**

Further to the above discussion, the ANL-5 and background (L_{90} + 10) criteria will be compared and the lower limit will form the TNLs for the assessment of noise impact (see Table V3/4.4(a) below):

Table V3/4.4(a)
Comparison of Assessment Criteria

		Noise Criteria dB(A)			
		ANL	ANL-5	L_{90} + 10	TNL
Phase I Operation					
NSR1	Day and evening	60	55	55	55
	Night time	50	45	50	45
NSR2	Day and evening	60	55	51	51
	Night time	50	45	50	45
NSR3	Day and evening	60	55	57	55
	Night time	50	45	50	45
Phase II Operation					
NSR1	Day and evening	65	60	>55	>55
	Night time	55	50	>50	50
NSR2	Day and evening	60	55	51	51
	Night time	50	45	50	45
NSR3	Day and evening	65	60	>57	>57
	Night time	55	50	>50	50

4.5 Modelling of Noise Propagation

4.5.1 Modelling Algorithms

CONCAWE reports[1] are one of the most comprehensive literature surveys and experimental studies of governing algorithms and empirical data for off-site propagation of noise emission from complex plant structures. They form the basis of the noise propagation model in the report. The brief of the propagation equations and their specific application in the report is prepared in Annex V3/B for reference.

[1] CONCAWE, 1981 the propagation of noise from petroleum and petrochemical complexes to neighbouring communities.

4.5.2 Modelling methods

An inventory of SWLs and dominant frequencies for the major prevailing noise sources are derived in Annex V3/B, these sources are located as in the various planned LTPS layout options (the plant layout for the two Scenarios, as at Feb 91, with indication of the noise source models are shown in Annex V3/B). The plant layouts were superimposed on the large scale survey map to read and measure the corresponding information including source-receiver distances and barrier height and distance. The calculations of the noise level attributed from individual noise sources were performed with a programmed spreadsheets.

It should be noted that the noise propagation calculations were performed for a number of possible layouts in the design process. There have been some revisions in some plant arrangement details but no major difference in the noise emission pattern will result, except from the main plant alignment which has been rotated 180°. The effect on noise emission will mainly be that the assumed boilerhall front openings, a main noise emitter originally facing north will be facing the south, and the effects have been noted and corrected in the noise calculations.

4.6 Prediction of Future Noise Environment

4.6.1 Noise Prediction

Six sets of the noise propagation computation spreadsheets, that give the predicted noise level contributable to the two scenarios of the planned LTPS emission under the two Phases of operation, are enclosed in Annex V3/B for reference. Detailed accounts of the partial noise level of each major source are listed, and it is possible to keep track of the change in the overall noise emissions by the application of improved noise control to the critical sources, or relaxation of noise specification for less critical noise components.

The noise emission from a power station will comprise tonal components, hence a tonal correction of 3 dB(A) has been added to give the Corrected Noise Level (CNL). The noise assessment was prepared from data under full load conditions which is the assumed condition for the day and evening period. During most of the time in fact and particularly during night-time operation, the plant will be operating at part load condition. Although this was not studied, it is clear that the overall noise emission will be reduced.

4.6.2 Significance of Impacts

The existing noise level, target noise level and predicted noise emissions from the LTPS under both Scenarios and their operation phases, are summarized in Table V3/4.6(a) for ease of comparison.

The table illustrates that noise emissions from the planned LTPS will not exceed the existing prevailing background noise. Plant noise will be faintly audible by the small number of NSRs at Lung Kwu Tan, but the extent of the noise will be minimal and unlikely to be a noise nuisance. Noise effects on the other locations will be still less, and will not be audible by NSRs at Lung Kwu Sheung Tan and Tsang Tsui.

Table V3/4.6(a)
Noise Environment Change and Criteria Comparison

Phase I (1993 - 2003)	Time period	Existing Background L_{90}	Target Noise Level	Scenario I Predicted CNL	Scenario II Predicted CNL
NSR1 (Lung Kwu Sheung Tan)	Day & Evening Night-time	45 40	55 45	41 <41	24 <24
NSR2 (Tsang Tsui)	Day & Evening Night-time	41 40	51 45	30 <30	20 <20
NSR3 (Lung Kwu Tan)	Day & Evening Night-time	47 40	55 45	32 <32	11 <11
Phase II (2003 - 2009)					
NSR1 (Lung Kwu Sheung Tan)	Day & Evening Night-time	>45 >40	>55 50	45 <45	41 <41
NSR2 (Tsang Tsui)	Day & Evening Night-time	41 40	51 45	33 <33	30 <30
NSR3 (Lung Kwu Tan)	Day & Evening Night-time	>47 >40	>57 50	37 <37	32 <32

[1] CNL at Lung Kwu Sheung Tau and Lung Kwu Tan respectively.

4.6.3 Comparison With Noise Criteria

By comparing the predicted CNL at all existing NSRs with the TNL (as presented in Table V3/4.6(a)), which is the lower limit of either the (ANL-5) on the (L_{90} + 10) criteria, it is concluded that in all the cases the target noise level criterion can be satisfied; safety margins of more than 10 dB(A) are likely during the day and evening period, and due to part-load operation there will also be a large safety margin during the night-time operation.

Based on the assessment study, it can be concluded that during the operational phase of the planned LTPS development, statutory noise requirement will be complied with and no significant noise impacts will arise.

5. WATER QUALITY

5.1 Introduction

This section of the IAR firstly identifies the sources of effluents produced by the LTPS and the location of sensitive receptors in relation to the site. Next the Statutory Criteria and requirements are presented.

It then looks at the marine effects of the physical presence of the necessary reclamation and the way in which its design has been developed to mitigate potentially adverse impacts (see also V2/2.4).

Section V3/5.6 quantifies the effluent management arrangements on site and presents estimates of the combined treated effluent characteristics and how they compare to local ambient seawater. Section V3/5.7 reviews the main factors that will affect the quality of ambient seawater over the next 10 to 20 years.

Section V3/5.8 accesses the likely significance of effluent discharges focussing on temperature rise and metal loadings and indicates tasks for the Key Issues Study on Water Quality.

Section V3/5.9 indicates IAR-stage mitigation and V3/5.10 gives the framework for the Oil Spill Contingency Plan. Section V3/5.11 gives the Key Issues and Conclusions.

5.2 Inventory of Effluent Sources and Their Treatment

The effluents produced by the LTPS will be very similar to that of the CPPS with one exception. For the LTPS it is necessary to include consideration of effluents produced by systems to clean the coal-fired boiler stack gases.

Data for this section come from the operational statistics of the CPPS and from designers/operators of flue gas desulphurisation systems.

5.2.1 Cooling Water

This is the dominant 'effluent' from the LTPS. Essentially it is a straight-through seawater cooling system with screens on the intake to remove suspended solids which would otherwise block or damage the cooling circuit within the station. Various other effluents are discharged with the cooling water (see V3/5.6).

The flow is dosed with free chlorine to inhibit the growth of organisms within the cooling circuit but analyses at CPPS indicate that residual chlorine concentration in the outfall is low. The seawater is discharged back to sea at approximately 10°C–12°C[1] higher than it went in. This temperature difference is vital to the operation of any thermal power station and it is a prime objective of the engineering design to ensure that no 'recirculation' occurs i.e. warmed water from the discharge affecting the temperature of the intake water. Avoiding any recirculation with the outfall from CPPS is a'so essential.

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1 10°C cited in the Site Search Report but the final discharge temperature may be between 10°C and 12°C above the intake temperature.

The flow rate is massive and is about 50% greater for Scenario I than for Scenario II as coal-fired units require more cooling. The flows are:

Scenario I (all coal)	- 21 m^3/s per 680 MW unit x 8 units	= 6.0 x 10^5 m^3/hr or 3.7 x 10^9 $m^3/year$[1]
Scenario II (gas and coal)	- 21 m^3/s per 680 MW unit x 4 units	= 3.0 x 10^5 m^3/hr
	+ 7 m^3/s per 600 MW unit x 4 units	= 1.0 x 10^5 m^3/hr or 2.5 x 10^9 $m^3/year$[1]

The composition of the discharge will be broadly similar to that from CPPS (except for the presence of FGD effluent - see V3/5.6) as the intention is to place the cooling water (CW) intake on the North Western Waters WCZ side of Black Point rather than in Deep Bay. Table V3/5.2(a) summarises the CLP data on the composition of the discharge from CPPS. The combined 'A' and 'B' station CW discharge at CPPS is about 1.1 x 10^7 m^3/day i.e. the same order of magnitude as the 2 LTPS Scenarios.

Table V3/5.2(a) Cooling Water Discharge from Castle Peak Power Station

October 90 - January 91	residual chlorine	-	not generally detected*
April 90 - September 90	residual chlorine	-	not generally detected*
September 89 - March 90	residual chlorine	-	not generally detected*
	oil - majority nil but all values		< 3 mg/l
	total suspended solids	- generally	< 100 mg/l
		majority	< 60 mg/l
	pH - approx 8 - 8.3		

no other parameters determined — Source : CLP

* could be up to 0.5 mg/L

5.2.2 Water Treatment Plant

The ion-exchange demineralisation plant produces regeneration effluent containing the ions removed from the raw water supply. The total dissolved solids (TDS) of the water from WSD supplied at CPPS is approximately 400 mg/l. This will be concentrated approximately 10 fold in the regeneration effluent which will therefore have a TDS of about 4000 mg/l. Most of this consists of Na^+, K^+, Ca^{2+}, Mg^{2+}, NH_4^+, Cl^-, SO_4^{2-}, CO_3^{2-}. It will not contain significant quantities of trace toxic metals. After the anion and cation regeneration effluents have been mixed the resultant pH will be neutral.

The quantity of such effluent at CPPS is 4 x $10^5 m^3/yr$. For LTPS Scenario I, it is will be about 6 x $10^5 m^3/yr$. For Scenario II it will be about two thirds of Scenario I, but this is not significant. It will be mixed with the Cooling Water flow prior to discharge. The quality is the same for Scenarios I and II.

1 Based on the high merit order - an equivalent operating year of 6,132 hours at 100% unit loading.

5.2.3 Ash Pit

CLP advise that the 'B' Station system on CPPS is the most appropriate "model" on which to base estimates for the LTPS. From water balance data for the site the effluent flow rate at the 'B' Station is known to be about 1 x 10^6m^3/yr. At the LTPS it can be assumed to be double i.e. 2 x 10^6m^3/yr for Scenario I. Scenario II will be half that, 1 x 10^6m^3/yr. These are conservative estimates of annual average figures.

The effluent composition will be similar to the 'B' station performance. These data and those for the 'A' Station are presented in Tables V3/5.2(b) & (c).

Table V3/5.2 (b)
Composition of ASH PIT effluent Castle Peak 'A' Station–all values in mg/l except pH

	1990									1991
	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
Sus. Solids	38.0	32.0	42.0	70.5	64.0	68.5	69.0	55.0	51.5	64.0
Iron	<0.1	<0.1	<0.1	0.17	<0.1	0.1	0.25	0.15	<0.1	0.18
Cadmium	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chromium	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Copper	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Lead	<0.1	<0.1	<0.1	0.23	0.27	0.28	0.38	0.34	0.17	0.251
Arsenic	<0.1	<0.1	<0.1	<0.1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
pH	9.2	9.1	9.5	9.3	9.7	9.2	9.2	9.1	9.15	8

Metals were not included in the analyses prior to April 1990 Source : CLP

Table V3/5.2 (c)
Composition of ASH PIT effluent Castle Peak 'B' Station–all values in mg/l except pH

	1990							
	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sus. Solids	36.0	37.0	58.0	81.0	76.0	75.0	85.0	79.0
Iron	-	-	-	-	0.27	0.48	0.35	0.55
Cadmium	<0.1	<0.1	<0.1	-	<0.1	<0.1	<0.1	<0.1
Chromium	<0.1	<0.1	<0.1	-	0.12	0.23	0.15	0.14
Copper	<0.1	<0.1	<0.1	-	<0.1	<0.1	<0.1	<0.1
Lead	<0.1	<0.1	<0.1	-	0.82	0.5	0.61	0.69
Arsenic	<0.1	<0.1	<0.1	-	<0.01	<0.01	<0.01	<0.01
pH	10.1	11.1	10.5	10.9	8.4	8.4	8.4	8.0

Metals were not included in the analyses prior to April 1990 Source : CLP

5.2.4 Domestic Sewage Effluent

On-site biological treatment will be provided for the LTPS workforce as it currently is at CPPS. The maximum daytime working population on site will be about 1,000. The license quantity for CPPS is 2,160 m^3/day for 1,400 personnel. The equivalent flow rate for the LTPS is therefore expected to be about 1,550 m^3/day, or 566,000 m^3/year. The quantity will be the same for both Scenario I and II. The treated effluent composition will be similar to CPPS as shown in Table V3/5.2(d).

Table V3/5.2(d) Treated Domestic Sewage Characteristics - CPPS		
Parameter	**Mean**	**Range**
BOD	100mg/l	63-180 mg/l
pH	7.23	6.25 - 9
Chlorine	0.3 mg/l	0.05 - 1 mg/l
Data April 90 - Jan 91		Source : CLP

5.2.5 Run-off from Coal Stockyard

The coal used to fire the LTPS at Black Point will be stored in a stockyard immediately to the north of the generating units. The stockyard is adjacent to the sea for materials handling reasons and will be on reclaimed land.

The run-off will be collected and treated prior to discharged. The quality of the effluent will be controlled in order to protect the marine environment. For the CCPS to the south of Black Point, the coal stockyard run-off is passed to a settling lagoon, to reduce the level of contaminants. Similar treatment will be provided at the LTPS.

The composition of this treated effluent at CPPS has been regularly monitored since Station start up and Table V3/5.2 (e) summarises the data collected by CLP. The data set for the 'A' station goes back to Sept 1989 and for the 'B' Station to May 1990. This licensed discharge limits for CPPS are included in the Table.

The quantity of run-off which is treated and discharged is given as approximately 500,000 m^3 per year. Storm surge flows, which are very lightly contaminated due to much lower contact time with the coal, are overflowed at CPPS to the sea. The normal treated flow is discharged through a dedicated short outfall in the case of the 'A' station and blended with the Cooling Water outfall for the 'B' station.

At the LTPS the normal treated flow will be blended with the cooling water and the storm surge flow will be pumped to the Tsang Tsui Ash Lagoons. The quantity of coal stockyard run-off is a function of the stockyard's plan area (as well as of course rainfall). At CPPS the stockyard area is about 25 ha or 250,000 m^2. At the LTPS it will be about

600,000 m^2 for Scenario I
300,000 m^2 for Scenario II

Table V3/5.2 (c)

Composition of Coal Stockyard Run-off from Castle Peak Power Station – all values in mg/l

		Castle Peak 'A' Power Station																	Castle Peak 'B' Station									
		1989				1990												1991	1990								1991	
		Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	
No of days in month when discharge occured		17	0	0	1	0	2	3	15	12	12	21	18	8	0	2	0	0	11	12	21	18	8	0	2	0	0	
Parameter	Licenced Limit																											
Suspended Solids	100	m 40 [1] r 4–98			12		18	37	m 25 r 2–72	m 16 r 35–30	m 38 r 17–61	m 51[2] r 17–168	m 40 r 20–61	m 33 r 13–82		11			m 39 r 24–68	m 65 r 12–97	m 62 r 19–90	m 85 r 62–99	m 72 r 32–95		89			43
Oil and grease	20	nil			nil		nil	nil	nil	nil	nil	nil	nil	nil		nil			nil	nil	nil	nil	nil		nil			0
Iron	10	<0.1			<0.1		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1			0.16	0.21	0.28	0.25	0.27		0.47			0.27
Mercury	0.1	<0.1			<0.1		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.01		<0.01			<0.1	<0.1	<0.1	<0.01	<0.01		<0.01			0.01
Cadmium	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	<0.1		<0.1			0.1
Chromium	2.0	<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		<0.1			0.1
Copper	2.0	<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		0.14			0.1
Lead	2.0	<0.1			<0.1		<0.1	<0.1	<0.1	<0.1	<0.1	0.2	0.22	0.35		<0.1			0.57	0.44	0.35	0.79	1		0.67			0.64
Nickel	2.0	<0.1			<0.1		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.31		<0.1			0.13	0.18	0.17	0.33	0.31		0.27			0.23
Zinc	2.0	<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		<0.1			0.1
Arsenic	2.0	<0.1			<0.1		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.01		<0.1			<0.1	<0.1	<0.1	<0.01	<0.01		<0.01			0.01
Manganese	2.0	<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		<0.1			0.1
(Selenium)	–	n.d.			n.d.		n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d. lamp on order –	--	n.d. --	--	>	n.d.	n.d.	n.d.	n.d.	n.d.		n.d.			n.d.

The total annual flow receiving treatment from the 'A' and 'B' together is approximately 500,000m³ — The peak discharge rate permitted under the license is 324m³/min

Notes

[1] A value of 324 mg/l was recorded on 7 Sept 89 during heavy rain when the influent was about 13 – 14,000 mg/l. This value is not included in the reported mean.

[2] The 168 value occured during heavy rain fall on 4 Jul 1990. All other measured values were within a maximum of 87 mg/l.

- n.d. – not determined
- a blank means that as no discharge occured there was no effluent to analyse.

Therefore the likely quantities for the two Scenarios based on 2m/year rainfall are :

1,200,000 m^3 per year for Scenario I
600,000 m^3 per year for Scenario II

The composition of this run-off after treatment will be similar to that from CPPS as the range of coals used will be similar.

5.2.6 Effluent for FGD Plant

There are various possibilities for FGD systems and the eventual choice will depend on stack gas clean-up performance, effluent and solid by-product generation and power generation economics. For the purposes of this section of the IAR the following cases are considered.

Case 1 Limestone/Gypsum FGD with Prescrubber and Purge producing commercial grade gypsum by-product.

The FGD plant effluent is of course dependent on the scenario, with all flows and loads in Scenario I being twice those in Scenario II.

The effluent flow rate estimates for Case 1 are taken from the Tables in Annex 3D. They are:

Scenario I - 2240 m^3/hr or 1.4 x 10^7 m^3/year
Scenario II - 1120 m^3/hr or 7 x 10^6 m^3/year

Case 2 a Seawater and Lime FGD system based on data for the 'Flakt' process. This uses the once-through cooling water for the station as its process water.

Only small quantities (relative to the Limestone (gypsum process) of process water are needed to dissolve the lime reagent. This system could be fitted with a prescrubber of necessary[1]:

Scenario I - 10^7 m^3/hr or 6.5 x 10^5 m^3/yr
Scenario II - 53 m^3/hr or 3.3 x 10^5 m^3/yr

5.2.7 PFA Decantrate

When necessary, the PFA will be slurried as at CPPS and pumped to the Tsang Tsui Ash Lagoons. The energy requirement per unit volume will be much less than for the CPPS as the LTPS is next to the Lagoons.

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1 This appears to produce the worst-case trace toxic metal contaminant profile of the commercial grade options (see Annex V3/D). Note, however the use of either or both a prescrubber or purge are process and mitigation options that cannot be confirmed at this time.

An extensive EIA was carried out for the Tsang Tsui Ash Lagoons project by the consultants[1] in 1985. Since operation began CLP have carried out monitoring of oysters in the vicinity of the lagoons seawall to determine if there is any effect from possible leakage from the Lagoon containment system. Decantrate return from the lagoons will most likely be pumped back to Castle Peak for discharge with the Cooling Water. As reported in the Site Search Study[2] work carried out at the Tsang Tsui Lagoons[3] on water inside the impoundment has shown very low levels of metal contamination and measurements in oysters reared close by outside the seawall has shown that no significant accumulation of metals from this source is taking place.

Water balance data from CPPS indicate that the pumped flow back from the Ash Lagoons is negligible. The EIA considered a range of flows depending on PFA production rate and ash to water ratio. These were :

High	12,000 m^3/day or 4.4 x $10^6 m^3$/yr
Average	5,400 m^3/day or 2.0 x $10^6 m^3$/yr
Low	500 m^3/day or 1.8 x $10^5 m^3$/yr

(the maximum pump design capacity is 7 x $10^6 m^3$/yr)

For the first 2 units of Phase 1 of the LTPS the PFA production and slurry water flow is estimated as follows :

PFA production rate	– 280,000 tonnes per year
PFA to water ratio in slurry	– 35:65
Slurry water flow rate	– 520,000 tonnes per year
Water retention in settled PFA	– 100% of PFA weight
Balance of slurry water for discharge	– 240,000 tonnes per year (2.4 x $10^5 m^3$/yr)

Theoretically, the flows could be at these levels, but in practice CPPS experience suggests these will be negligible.

5.2.8 Boiler Water Blowdown

In order to keep mineral concentrations at the required limit in the boiler water, a bleed-off known as 'blowdown' is needed.

The quantity is quite small – 2 x $10^5 m^3$/yr at CPPS and about 3 x $10^5 m^3$/yr at LTPS. This will be the same for both Scenario I and II.

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1 Lagoon at Tsang Tsui and Associated Works Environmental Impact Key Issues Report 14 January 1985 – L.G. Mouchel and Partners (Asia) James Williamson and Partners, ERL (Asia) Ltd. and Brian Clouston and Ptns and Addendum No. 2 Marine Impacts March 1985.

2 ERL (1990) 6000MW Thermal Power Station Final Site Search Report.

3 CLP Scientific and Technical Services Department, "Trace metals monitoring of seawater inside the Tsang Tsui Ash Lagoons, 1989.

The quality is high and poses no pollution problem. It will be mixed with the Cooling Water prior to discharge.

5.2.9 Oil Separator Water

The quantity of treated water is 2 x $10^7 m^3/yr$ at CPPS (A and B) and will be about 6 x $10^7 m^3/yr$ at the LTPS (irrespective of Scenario) as some drainage from the oil pipe-trenches will also be directed to the oil separator at LTPS. The treated effluent composition will be similar to that at CPPS i.e. generally < 5 mg/l oil. It has no other significant contaminants.

5.2.10 Other Contaminated Drainage

All contaminated drainage run-off at the LTPS will pass through separators to remove suspended solids and oil. Other sources include precipitator/FGD drainage areas (approx 200,000 m^3/yr or 100,000 m^3/yr rainfall onto 10 ha in Scenario I and 5 ha in Scenario II) respectively and plant washdown.

5.2.11 Marine Oil Spills during Fuel Delivery

The potential for an oil spill during delivery is clearly related to the size of shipment, the frequency and magnitude of deliveries and the types of oil delivered. These factors are different for the two Scenarios I and II.

a) Scenario I (all coal)

The LTPS site will have 2 off 10,000 tonne fuel oil tanks, the strategic store probably being held at CPPS. Having filled these initially from an ocean-going vessel probably about 20,000 dwt, replenishment will be by much smaller vessels, most likely 1000 tonne barges.

b) Scenario II (gas and coal)

The LTPS site will have 4 off 60,000 tonne distillate oil tanks. As for Scenario I after initial filling by ocean-going ships (probably 80,000 dwt) replenishment will be by coastal vessels.

Statistics on cargo spillage from ships was presented to Government by the consultants for the Area 38 Development Study. Based on data collected by the International Tanker Owners Pollution Federation Ltd. the likelihood of a large oil spill (in excess of 5000 barrels, approximately 1000 m^3) is about 2 x 10^{-3} per tanker per year or once in 500 years for each tanker. This is based on 64 recorded and documented incidents in a tanker population of about 30,000 in the period 1977-1986. It specifically covered vessels in the 3,000-45,000 grt (gross registered tonnage) range.

From IMO data (International Maritime Organisation, formally Intergovernmental Maritime Consultative Organisation) the likelihood of such an incident escalating to the point where the vessel becomes a serious casuality[1] is about one tenth of the accident rates in the above paragraph.

As regular deliveries of oil from large vessels will not be a feature of the LTPS under either scenario the frequency of a large release of oil from one of them is less than 2×10^{-3} per year.

Smaller releases from barges could occur but statistics on this are not available. Clearly the scope for a release is limited to the small tonnage carried and the necessary jetty equipment would be capable of containing the majority of lost oil much of which would evaporate quite rapidly. The configuration of the preferred layout would make the job of containment and recovery of spilled oil less difficult as it is a berth and in more sheltered water than a long jetty.

Overall it is considered that :

a) the scope for releases is very limited due to the small scale of regular deliveries.

b) the physical arrangement of the reclamation and berth aids oil containment and recovery.

c) as the location is fairly well distanced from mariculture zones, gazetted beaches and Sites of Special Scientific Interest, the consequences of a release would not cause serious damage.

The oil spill contingency plan is discussed in Section 5.9.

5.2.12 Maintenance Dredging

It is anticipated that regular maintenance dredging of the access channel and the turning basin will be required. The likely quantity of material that will require disposal, the frequency of the dredging activity and the suitability of the material for conventional marine disposal at one of the territory's gazetted marine dump sites are indicated below.

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[1] The definition of a "serious casualty" is :

a) a fire, explosion, collision, grounding, contact, heavy weather damage, ice damage, hull cracking or suspected hull defect resulting in :

(i) structural damage rendering ship unseaworthy;
(ii) loss of life;
(iii) pollution.

b) a breakdown necessitating towage or shore assistance
c) a total loss

The size of the proposed access channel and turning basin is approximately 100 ha. It has been estimated that a likely deposition rate for the area of Outer Deep Bay is 1.8m every two years. If a uniform deposition rate over the area is assumed, the quantity of sediment deposited every two years is 1.8 Mm^3. It is likely that dredging of the material would occur every four years in order to minimise potential disruption to operations. Consequently, approximately 3.6 Mm^3 of sediment would be removed every four years in an operation that is likely to take approximately four months. In order to maintain the necessary 20m draught, the area would be "overdredged" in order to allow clearance to be maintained towards the end of each four year period.

Sampling and analysis of sediments undertaken to date in the area indicate that significant contamination of material is very unlikely. Samples taken both by EPD and CLP, to the north and south of Black Point are presented in Table V1/3.4(b). The results indicate that levels of toxic metals are in most cases at least an order of magnitude lower than levels stipulated in the Deep Bay Guidelines on Dredging, Reclamation and Drainage Works[1]. Consequently, it can be presumed that sediment removed from this area would be deemed suitable for disposal, by EPD, at one of the territory's gazetted marine dumping sites. Clearly, such a presumption may have to be reconsidered in the future, if the area were to be need for the dumping of toxic muds.

The exact position of the access channel and the basin are as yet not fixed. Once this has been established the sediments within the area will be sampled and analysed in order to confirm their suitability for marine disposal. Dredging works would be carried out in conformity with the Deep Bay Guidelines.

5.3 Sensitive Receptors

Uses of marine and coastal waters which are sensitive to water pollution include:

- bathing and other recreational beaches;
- mariculture zones;
- marine fisheries areas and water pollution sensitive ecosystems, including coastal ecosystems and proposed marine SSSIs.

The identified water sensitive receptors that may potentially be affected by the thermal plume and the other water effluent discharges from the operating LTPS at Black Point are described in the following sections.

5.3.1 Beaches

Bathing beaches that are popular and managed by government are gazetted to legally protect and maintain their legitimate uses. There are also other major beaches across the territory that are less popular than those gazetted but are still regularly visited. The latter are not given gazetted status not because they have low aesthetic and recreational values but because they are remote and less accessible to the public. In this regard, gazetted beaches warrant priority protection whilst other major beaches should be conserved as far as possible.

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[1] ERL (Asia) Limited (1990) Deep Bay Guidelines on Dredging, Reclamation and Drainage Works for EPD of HK Government.

o **Gazetted Beaches**

The gazetted beaches closest to Black Point occur in a cluster located inside a shallow bay south of Tuen Mun New Town. Of these, the nearest is Butterfly Beach, which is nevertheless more than 12 km away from Black Point, measured on the main tidal stream.

According to EPD's quality ranking for all gazetted beaches in Hong Kong, the cluster of beaches at Tuen Mun New Town south all lie between barely unacceptable and unacceptable. The water quality of the beaches is subject to heavy faecal and other pollution due to the discharges from the Tuen Mun nullah and the Pillar Point outfall. It is likely that water quality at the beaches, which are protected by Tap Shek Kok and Pillar Point headlands, will be influenced primarily by local Tuen Mun discharges and that the LTPS will not have any measurable effect.

o **Major Beaches**

According to the HKPSG and the subregional Landuse Plan, beaches in NT west with recreational value are Yung Long, Lung Kwu Sheung Tan and Lung Kwu Tan. Information and data on the utilisation rate for the non-gazetted beaches are unavailable. However, of the three, Yung Long is considered to have the highest scenic and recreational value because of its unobstructed view, elongated shape and clean sand. On the beach is a small water sports centre indicating the waters may be used for sailboarding and canoeing during the summer. This beach would be lost as it lies wholly within the LTPS site. This is, however, in conformity with Government planning as it is part of the Tuen Mun Port Development area for Deep Waterfront Industry.

Lung Kwu Sheung Tan is considered to have the lowest recreational value due to the dark sand and the construction activities presently occuring at the back of the beach. Both Lung Kwu Tan and Sheung Tan are unlikely to be used extensively for bathing, but occasional fishing activities can be expected. Both these beaches will be lost in the Tuen Mun Port Development, as indeed would the Yung Long beach.

5.3.2 Mariculture Zone and Marine Fisheries

o **Mariculture**

Mariculture is permitted under licence only in 27 designated Fish Culture Zones, although there are no statutory provisions in Hong Kong to directly protect oyster beds. However, under the Foreshore and Seabed (Reclamations) Ordinance, Cap. 127, the operator can claim compensation if a reclamation affects his oyster bed area.

All the listed Fish Culture Zones are far away from Black Point with the nearest one at Tung Chung. It is more than 15 km away and is protected by Chek Lap Kok from the influence of main tidal stream. The coastal area from Nim Wan to Tsim Bei Tsui is known to have oyster beds of about 1,500 ha and this is an official Mariculture Sub Zone of Deep Bay Water Control Zone. It is 3km away from the LTPS at its nearest point.

The economic significance of the oyster fishery has declined greatly since the late 1950's. It is now only significant in local terms. There has been, a major decrease in oyster production, from over 1,000 tonnes per year in 1958 to about 200 tonnes in 1987 according to the AFD.

o **Marine Fisheries**

Most fishing done by HK fishermen is in international waters, especially the East China Sea, although some fishing is carried out off the coast of China. A few small vessels operate in Hong Kong waters. There are no definite fishing zones in Hong Kong and no administrative limit on where fishing boats can operate. Except in Victoria Harbour and Tolo Harbour, small scale fishing activities can be found everywhere, but more concentrated activities are observed in northern and western Lantau waters. Trawling and gill netting are carried out off Lung Kwu Tan and Sheung Tan and in Deep Bay but are less frequent off Yung Long beach. In 1984, Hong Kong fisheries production from Deep Bay was estimated at 168 tonnes, representing 0.06% of the total catch from Hong Kong waters.

5.3.3 Sensitive Ecosystems

o **Terrestrial SSSIs**

The nearest terrestrial SSSIs to the LTPS site are Pak Nai, the Lung Kwu Chau group and Mai Po together with Inner Deep Bay. Pak Nai (6 km to the NE) and Lung Kwu Chau group (4 km to the SW) were accorded this status because of their ornithological interests. The Mai Po marshes in Inner Deep Bay (16 km to the NE) contains the largest and most important dwarf mangrove communities in Hong Kong and is an ornithological site of international importance.

o **Marine SSSIs**

To date, there is only one area which is undergoing designation as a marine SSSI; Hoi Ha Wan in northern Sai Kung to the far east of the territory. A list of possible marine reserves has also been proposed to Government but all of them are on the eastern coast of NT and southern coast of Lantau and none is close to Black Point.

5.3.4 Summary

Overall the Black Point site is well distanced from sensitive boilogical marine and terrestrical receptors. The loss of the Yung Long beach is considered to be the only significant impact but this is planned to be lost under the PADS development.

5.4 Statutory Criteria/Requirements

The legislative background for water pollution control in Hong Kong is presented in V1 Sec. 2.3. There are two related aspects which apply to the operation of the LTPS :

- the Water Quantity Objectives (WQO) of the receiving waters
- the Standards for effluent discharged into receiving waters.

5.4.2 Water Quality Objectives (WQO)

Black Point itself is at the boundary of two Water Control Zones (WCZ); Deep Bay and North Western Waters. For Deep Bay the WQO was gazetted on 23 November 1990[1]. WQO have not yet been gazetted for North Western Waters but they are expected to be in August 1991.

In the Site Search Study[2] it was reported that WQO had not been gazetted for Deep Bay and North Western Waters but cited the Deep Bay Integrated Environmental Management Study[3] which recommended the guideline for temperature in Outer Deep Bay as being the range of natural fluctuation not to exceed 1°C (that for Inner Deep Bay being 2°C).

When the Deep Bay WCZ WQO was gazetted the 2°C rise was adopted for the complete Zone i.e. the WQO for temperature rise in Outer Deep Bay is the same as for the Inner Bay and is 2°C. The other parameters in the WQO accord with the Deep Bay Management Plan guidelines.

Although no WQO are yet available for North Western Waters it is unlikely that the temperature rise limit will be greater than 2°C.

5.4.3 Effluent Standards

In November 1990 the Interim Effluent Guidelines were succeeded by the statutory Technical Memorandum[1] issued by the Secretary for Planning, Environment and Lands under section 21(1) of the Water Pollution Control (Amendment) Ordinance 1990 and brought into operation in accordance with section 21(9) of this Ordinance. A difference between the Guidelines and the TM is that the former did not address the magnitude (or flow rate) of the effluent whereas the latter does. In the case of discharge to Coastal Waters standards are set for 12 flow rate ranges from $< 10m^3$/day upto $> 5000 < 6000$ m^3/day. The LTPS cooling water flow for the ultimate station being approximately :

1.5×10^7 m^3/day for Scenario I (all coal)
1×10^7 m^3/day for Scenario II (gas and coal)

The TM (section 2.6) states

"The Authority will set standards for effluents outside the listed flow ranges case by case. Standards for effluents above the highest flow band will be more stringent than those in the tables".

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1 Water Pollution Control Ordinance (Cap 358) Statement of Water Quantity Objectives (Deep Bay Water Control Zone).

2 6000MW Thermal Power Station, Site Search Report, Supporting Information Volume 1 : The LTPS Sites 1990. ERL (Asia) Ltd.

3 by ERL (Asia) Ltd. for EPD December 1988.

1 Technical Memorandum "Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters". Hong Kong Government. 30 November 1990.

The tables relevant to the area in which the LTPS site lies are reproduced here as Tables V3/5.4(a), (b) and (c).

From these Tables it can be seen that the TM designates two types of coastal water – 'inshore' and "marine". These are defined in Section 3.2 of the TM :

"Inshore waters means all coastal waters where the water depth is less than 6m at mean low tide or that are within 200m of the mean low water mark, whichever position is further from the shore.

Marine waters means all coastal waters except inshore waters".

For Deep Bay the whole Zone is covered by the "inshore waters" definition.

Consultation with the Water Policy Group of EPD has indicated that consideration of appropriate standards will have to be based on mathematical modelling of the Cooling Water outfall (or outfalls) effect on the temperature of the surrounding receiving water as stated in the Site Search Report (Sept. 1990).

In section 4.4.4 of the TM it is stated that different areas may have different standards and that within coastal waters special areas need specific restrictions. Such special areas include bathing beaches, Sites of Special Scientific Interest, marinas and mariculture sites. The specific restrictions are given in Table V3/5.4(d). The LTPS site comfortably satisfies all the above prohibitions.

Secondly section 9.3 states:

"The Authority will not allow dilution as a means of meeting effluent standards. This would cause excessive loading on the receiving waters and their biological systems. For this purpose the license may specify an instantaneous peak flow. This does not necessarily prohibit mixing different effluent streams within the premises."

Finally on defining its application and scope the TM statesin section 2.3 that:

"Where a user takes water from a natural water course or water body and then returns it after use, different standards may apply. The authority will not impose standards requiring the effluent to be cleaner than the water that the user takes."

The final point is of particular relevance to the LTPS Cooling Water outfall. Table 5.4(f) shows for Deep Bay; the effluent standard for the highest flow rate in the TM, the gazetted WQO for the corresponding parameters (or determinands as they are dubbed in the TM) plus the monitored values from the EPD's most recent Marine Water Quality Report and from CLP's LTPS – EIA Monitoring programme. It shows the same data for North Western Waters (marine, not inshore) except for the gazetted WQO's.

The TM specifies two further aspects of coastal discharges. Firstly certain substances are prohibited in the effluent. These are shown in Table V3/5.4(e).

The data indicate :

- The LTPS Cooling Water (CW) will be discharged at about 10°C higher (max) than it went in. The maximum sea water temperature is 30°C in Outer Deep Bay and 28°C in Urmston Road, so the maximum discharge temperature would be 40°C for Deep Bay and 38°C for Urmston Road. Neither would exceed therefore the 45°C limit for effluent flows >5000 and < 6000 m^3/day. The CW flow is however about one thousand times greater than this.

- The suspended solids standard is 25mg/l for Deep Bay and 30 mg/l for Urmston Road. The reported maximum for Urmston Road is 17 mg/l but for Deep Bay it is 91mg/l. These are depth averaged values and CW intake will be close to the bottom so could be expected to be in the range of 100-150 mg/L. Therefore if CW were taken from Deep Bay and returned after use to either Deep Bay or Urmston Road Section 23 of the TM would need to be applied. However this is not the design intention.

- The EPD and EIA monitoring results show that Outer Deep Bay is currently in conformity with its WQO for the following parameters/determinands pH; E. Coli; dissolved oxygen. Parameters which currently exceed the WQO are ammonia and probably inorganic nitrogen.

- The Effluent Standards in the TM have a limit for boron which is 0.2mg/l for Deep Bay and 0.3mg/l for Urmston Road (at flow rate of >5000 and < 6000 m^3/day). In the Tsang Tsui PFA Lagoon EIA[1] it was reported that typical seawater is quoted as having about 4.5 mg/l boron and monitoring results in 1980 in Hong Kong showed 4 mg/l. This would appear to be another case where section 2.3 would need to be invoked independent of the locations of CW intake and outfall.

- Wastes liable to form scum, deposits or discolouration are prohibited; this issue in relation to the cooling water discharge will be considered at the Key Issue Assessment Stage, when further infromation regarding the control measures to be adopted are available.

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[1] Key Issue Report on Tsang Tsui PFA Lagoon Addendum No. 2 Marine Impacts prepared for China Light and Power by Environmental Resources Ltd. March 1985 (section 1.7 p.8)

Table V3/5.4(a) Standards for effluents discharged into the <u>coastal waters of Deep Bay Water Control Zone</u>
(All units in mg/L unless otherwise stated; all figures are upper limits unless otherwise indicated)

Flow rate (m^3/day) / Determinand	≤10	>10 and ≤200	>200 and ≤400	>400 and ≤600	>600 and ≤800	800 and ≤1000	>1000 and ≤1500	>1500 and ≤2000	>2000 and ≤3000	>3000 and ≤4000	>4000 and ≤5000	>5000 and ≤6000
pH (Ph units)	6–9	6–9	6–9	6–9	6–9	6–9	6–9	6–9	6–9	6–9	6–9	6–9
Temperature (°C)	45	45	45	45	45	45	45	45	45	45	45	45
Colour (lovibond units) (25mm cell length)	1	1	1	1	1	1	1	1	1	1	1	1
Suspended solids	50	50	50	50	50	50	25	25	25	25	25	25
BOD	20	20	20	20	20	20	10	10	10	10	10	10
COD	80	80	80	80	80	80	50	50	50	50	50	50
Oil & Grease	20	20	20	20	20	20	10	10	10	10	10	10
Iron	10	10	10	7	5	4	3	2	1	1	1	1
Boron	5	4	3	2.5	2	1.6	1.1	0.8	0.5	0.4	0.3	0.2
Barium	5	4	3	2.5	2	1.6	1.1	0.8	0.5	0.4	0.3	0.2
Mercury	0.1	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Cadmium	0.1	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Other toxic metals individually	1	0.5	0.5	0.5	0.4	0.4	0.25	0.25	0.15	0.1	0.1	0.1
Total toxic metals	2	1	1	1	0.8	0.8	0.5	0.5	0.3	0.2	0.14	0.1
Cyanide	0.1	0.1	0.1	0.1	0.1	0.08	0.06	0.06	0.03	0.02	0.01	0.01
Phenols	0.5	0.5	0.4	0.3	0.25	0.2	0.1	0.1	0.1	0.1	0.1	0.1
Sulphide	5	5	5	5	5	5	2.5	2.5	1.5	1	1	0.5
Total residual chlorine	1	1	1	1	1	1	1	1	1	1	1	1
Total nitrogen	100	100	100	100	100	100	80	80	50	50	50	50
Total phosphorus	10	10	10	10	10	10	8	8	5	5	5	5
Surfactants (total)	15	15	15	15	15	15	10	10	10	10	10	7
E. coli (count/100ml)	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000

Source : Technical memorandum – standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters. Water Pollution Control (Amendment) Ordinance 1990.

Table V3/5.4(b) Standards for effluents discharged into the inshore waters of Southern, Mirs Bay, Junk Bay, North Western, Eastern Buffer and Western Buffer Water Control Zones
(All units in mg/L unless otherwise stated; all figures are upper limits unless otherwise indicated)

Flow rate (m^3/day) Determinand	≤10	>10 and ≤200	>200 and ≤400	>400 and ≤600	>600 and ≤800	800 and ≤1000	>1000 and ≤1500	>1500 and ≤2000	>2000 and ≤3000	>3000 and ≤4000	>4000 and ≤5000	>5000 and ≤6000
pH (pH units)	6-9	6-9	6-9	6-9	6-9	6-9	6-9	6-9	6-9	6-9	6-9	6-9
Temperature (°C)	40	40	40	40	40	40	40	40	40	40	40	40
Colour (lovibond units) (25mm cell length)	1	1	1	1	1	1	1	1	1	1	1	1
Suspended solids	50	30	30	30	30	30	30	30	30	30	30	30
BOD	50	20	20	20	20	20	20	20	20	20	20	20
COD	100	80	80	80	80	80	80	80	80	80	80	80
Oil & Grease	30	20	20	20	20	20	20	20	20	20	20	10
Iron	15	10	10	7	5	4	3	2	1	1	0.8	0.6
Boron	5	4	3	2	2	1.5	1.1	0.8	0.5	0.4	0.3	0.2
Barium	5	4	3	2	2	1.5	1.1	0.8	0.5	0.4	0.3	0.2
Mercury	0.1	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Cadmium	0.1	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Other toxic metals individually	1	1	0.8	0.7	0.5	0.4	0.3	0.2	0.15	0.1	0.1	0.1
Total toxic metals	2	2	1.6	1.4	1	0.8	0.6	0.4	0.3	0.2	0.1	0.1
Cyanide	0.2	0.1	0.1	0.1	0.1	0.1	0.05	0.05	0.03	0.02	0.02	0.01
Phenols	0.5	0.5	0.5	0.3	0.25	0.2	0.1	0.1	0.1	0.1	0.1	0.1
Sulphide	5	5	5	5	5	5	2.5	2.5	1.5	1	1	0.5
Total residual chlorine	1	1	1	1	1	1	1	1	1	1	1	1
Total nitrogen	100	100	80	80	80	80	50	50	50	50	50	30
Total phosphorus	10	10	8	8	8	8	5	5	5	5	5	5
Surfactants (total)	20	15	15	15	15	15	10	10	10	10	10	10
E. coli (count/100ml)	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000

Source : Technical memorandum - standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters. Water Pollution Control (Amendment) Ordinance 1990.

Table V3/5.4(c) Standards for effluents discharged into the marine waters of Southern, Mirs Bay, Junk Bay, North Western, Eastern Buffer and Western Buffer Water Control Zones (All units in mg/L unless otherwise stated; all figures are upper limits unless otherwise indicated)

Flow rate (m^3/day) Determinand	≤10	>10 and ≤200	>200 and ≤400	>400 and ≤600	>600 and ≤800	800 and ≤1000	>1000 and ≤1500	>1500 and ≤2000	>2000 and ≤3000	>3000 and ≤4000	>4000 and ≤5000	>5000 and ≤6000
pH (pH units)	6–9	6–9	6–9	6–9	6–9	6–9	6–9	6–9	6–9	6–9	6–9	6–9
Temperature (°C)	45	45	45	45	45	45	45	45	45	45	45	45
Colour (lovibond units) (25mm cell length)	4	1	1	1	1	1	1	1	1	1	1	1
Suspended solids	500	500	500	300	200	200	100	100	50	50	40	30
BOD	500	500	500	300	200	200	100	100	50	50	40	30
COD	1000	1000	1000	700	500	400	300	200	150	100	80	80
Oil & Grease	50	50	50	30	25	20	20	20	20	20	20	20
Iron	20	15	13	10	7	6	4	3	2	1.5	1.2	1
Boron	6	5	4	3.5	2.5	2	1.5	1	0.7	0.5	0.4	0.3
Barium	6	5	4	3.5	2.5	2	1.5	1	0.7	0.5	0.4	0.3
Mercury	0.1	0.1	0.1	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Cadmium	0.1	0.1	0.1	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Other toxic metals individually	2	1.5	1.2	0.8	0.6	0.5	0.32	0.24	0.16	0.12	0.1	0.1
Total toxic metals	4	3	2.4	1.6	1.2	1	0.64	0.48	0.32	0.24	0.2	0.14
Cyanide	1	0.5	0.5	0.5	0.4	0.3	0.2	0.15	0.1	0.08	0.06	0.04
Phenols	0.5	0.5	0.5	0.3	0.25	0.2	0.13	0.1	0.1	0.1	0.1	0.1
Sulphide	5	5	5	5	5	5	2.5	2.5	1.5	1	1	0.5
Total residual chlorine	1	1	1	1	1	1	1	1	1	1	1	1
Total nitrogen	100	100	80	80	80	80	50	50	50	50	50	50
Total phosphorus	10	10	8	8	8	8	5	5	5	5	5	5
Surfactants (total)	30	20	20	20	15	15	15	15	15	15	15	15
E. coli (count/100ml)	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000

Source : Technical memorandum - standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters. Water Pollution Control (Amendment) Ordinance 1990.

Table V3/5.4(d) Prohibited Effluents - COASTAL WATERS

No new effluent will be allowed :

- within 100m of the boundaries of a gazetted beach in any direction, including rivers, streams and storm water drains;
- within 200m of the seaward boundaries of a marine fish culture zone or a site of special scientific interest, and within 100m of the landward boundaries;
- in any typhoon shelter;
- in any marina;
- within 100m of a seawater intake point.

Table V3/5.4(e) Prohibited substances - COASTAL WATERS

polychlorinated biphenyls (PCB)
polyaromatic hydrocarbon (PAH)
fumigant, pesticide or toxicant
radioactive substances
chlorinated hydrocarbons
flammable or toxic solvents
petroleum oil or tar
calcium carbide
wastes liable to form scum, deposits or discoloration
sludge, floatable substances or solids larger than 10mm

Table V3/5.4 (f)
Marine Water Quality off the LTPS Site at Black Point

to be read in conjunction with Notes for Table V3/5.4(f)

Parameter/ Determinand in mg/l unless otherwise specified	Outer Deep Bay						North Western Waters					
	WCZ Effluent Standard[10]	Water Quality Objectives	EPD's 1990 Monitoring Results	EIA Monitoring Results[2]			WCZ Effluent Standards[10]	Water Quality Objectives	EPD's 1990 Monitoring Results[3]	EIA Monitoring Results[4]		
				Oct 1990	Nov 1990	Dec 1990				Oct 1990	Nov 1990	Dec 1990
pH (pH units)	6-9	6.5 - 8.5[5]	m 8.3 r 7.9 - 8.6	7.8	8.1	8.2	6 - 10	!	m 8.3 r 8.2 - 8.4	7.8	8.1	8
Temperature °C	45	max rise 2°C	m 23.4(S) 24.3 (B) r (15-30) (15-30)	23	21.3	19	45	n	m 23 (S) 22.4 (B) r (17 - 28) (16 - 18)	23	22.5	20
Colour (Lovibond Units)[5]	1	n.o.	5.22 (NTU)	3.4 (NTU)	0.6 (NTU)	0.7 (NTU)	1	o		3.7 NTU (S) 1.3 NTU (M/B)	2 (NTU)	0.5 - 8.3 (NTU)
Suspended Solids	25	max change 30%	m 20 r 2.5 - 91	7.7	2	2	30	n	m 12 r 4.5 - 17	2	2	1 - 2
BOD	10	n.o.	m 1.2 r 0.2 - 5.4	1	<1	1	30	c	m 0.5 r 0.3 - 0.6	1	1	1
COD	50	n.o.	n.r.	n.d.	n.d.	n.d.	80		n.r.	n.d.	n.d.	n.d.
Oil & Grease	10	n.o.	n.r.	0.2	0.07	1	20	g	n.r.	0.05	0.1	0.03
Iron	1	n.o.	n.r.	0.43	0.091	0.068	1		n.r.	0.22	0.137	0.1
Boron	0.2	n.o.	n.r.	n.d.	n.d.	n.d.	0.3	z	n.r.	n.d.	n.d.	n.d.
Barium	0.2	n.o.	n.r.	n.d.	n.d.	n.d.	0.3	z	n.r.	n.d.	n.d.	n.d.
Mercury	0.001	n.o.	n.r.	n.d.	n.d.	n.d.	0.001	c	n.r.	n.d.	n.d.	n.d.
Cadmium	0.001	n.o.	n.r.	<0.00005	<0.00005	0.00013[11]	0.001	t	n.r.	0.00054	<0.00005	<0.00005
Other toxic metals individually	0.1	n.o.	n.r.	see below	see below	see below	0.1	t	n.r.	see below	see below	see below
Total toxic metals	0.1	n.o.	n.r.	see below	see below	see below	0.14	c	n.r.	see below	see below	see below
Cyanide	0.01	n.o.	n.r.	n.d.	n.d.	n.d.	0.04	d	n.r.	n.d.	n.d.	n.d.
Phenols	0.1	0.05[6]	n.r.	n.d.	n.d.	n.d.	0.1		n.r.	n.d.	n.d.	n.d.
Sulphide	0.5	n.o.	n.r.	<0.01	<0.01	n.d.	0.5	-		<0.01	<0.01	n.d.
Total residual clorine	1	n.o.	n.r.	<0.1	<0.1	n.d.	1	e		<0.1	<0.1	<0.1
Total nitrogen	50	inorganic only 0.5 max	m 1.1 r 0.6 - 2.3	0.23	0.77	n.d.	50	x	m 0.7 r 0.4 - 1.1	0.2	0.15	n.d.
Total phosphorus	5	n.o.	m 0.13 r 0.03 - 0.4	0.21	0.25	n.d.	5	p	m 0.05 r 0.03 - 0.06	0.13	0.1	n.d.
Surfactants (total)	7	n.o.	n.r.	0.01	<0.05	n.d.	15	c	n.r.	<0.05	<0.05	n.d.
E.Coli (count/100ml)	1000	max 610[7]	m 25 r 0 - 470	300	200	300	4000	c	m 467 r 160 - 1360	320 - 2700	230 - 1000	280 - 3400
Calcuim	n.s.	n.o.	n.r.	334	371	380	n.s.	t	n.r.	310	n.d.	390
Sulphate	n.s.	n.o.	n.r.	2200	2300	2310	n.s.	c	n.r.	2275	2500	2500
Dissolved Oxygen	n.s.	min 5(4)[8]	m 7.2 r 6.3 - 8.7	7.7	7.8	8.3	n.s.	d	m87(S) 81(B) r75-98 71-88	7.2	8	8 - 8.7
Salinity (g/kg)	n.s.	max change	m 19	29	27	28	n.s.			29.5	30	28 - 31
Ammonia (as N)	n.s.	0.021	n.r.	0.02	0.46	n.d.	n.s.	j	n.r.	0.02	0.06	n.d.
Chromium	see above	n.o.	n.r.	0.00009	0.0015	0.0014	see above	a	n.r.	0.0008	0.0014	0.0016
Copper	see above	n.o.	n.r.	<0.005	<0.005	<0.005[11]	see above		n.r.	<0.005	<0.005	<0.005
Lead	see above	n.o.	n.r.	0.0007	0.00038	0.00066[11]	see above	1	n.r.	0.0009	0.00033	0.0006
Nickel	see above	n.o.	n.r.	<0.005	<0.005	<0.005	see above	9	n.r.	<0.005	<0.005	<0.005
Zinc	see above	n.o.	n.r.	0.0083	0.0054	0.0049[11]	see above	9	n.r.	0.013	0.0058	0.01
Arsenic	see above	n.o.	n.r.	<0.001	<0.001	<0.001	see above	1	n.r.	<0.001	<0.001	<0.001
Manganese	see above	n.o.	n.r.	0.029	0.038	0.020	see above	!	n.r.	0.02	0.012	0.012
Selenium	see above	n.o.	n.r.	<0.001	<0.001	<0.001	see above	!	n.r.	<0.001	<0.001	<0.001

Notes for Table V3/5.4(f)

1. The EPD results for Outer Deep Bay are from the 1990 Marine Water Quality in Hong Kong Report and the 1990 data for monitoring station DM4 contained in computer printout.

2. The EIA Monitoring Results are for Site B5 just north east for the Nim Wan end of the Tsang Tsui Ash Lagoons.

3. The EPD results for North Western Waters are from the 1990 Marine Water Quality in Hong Kong Report and the 1990 data for monitoring station NM5 contained in computer printout.

4. The EIA Monitoring Results are for sites F3, F4, F5 in Urmston Road (and to a lesser extent F1 and F2 around Black Point).

5. This is for marine waters excepting Yung Long Bathing Beach Subzone and natural range is not to be extended by more than 0.5 pH units. For the Subzone the corresponding values are 6.0 – 9.0 and 0.5 pH units.

6. There is a WQO for the Yung Long Bathing Beach Subzone only; this subzone is within the LTPS site.

7. This WQO is for the mariculture subzone, the nearest point of which is about 3km from the nearest part of the LTPS site boundary. The E. Coli WQO for the Yung Long Bathing Beach Subzone is 180 per 100mL but this is within the site.

8. The figure in brackets refers to the minimum concentration for the mariculture subzone. The 5mg/l is the minimum for the marine waters of Outer Deep Bay.

9. Colour and turbidity. These are put together as the Technical Memorandum has a colour standard and the WQO has a turbidity objective. It is appreciated that they are not directly comparable.

10. The WCZ Effluent Standards are for the highest flow rate range in the Technical Memorandum i.e. >5000 and < 6000 m^3/day.

11. These results are supported by CLP results of seawater metal concentration analyses outside the Tsang Tsui Ash Lagoon wall in 1989.

Abreviations	n.o.	–	no objective
	n.r.	–	not reported
	n.d.	–	not determined
	m	–	mean
	r	–	range
	s	–	surface
	b	–	bottom

5.5 Physical Effects of the Reclamation

At the site search stage it was recognised that the physical presence of the reclamation would alter the natural flow pattern of the sea around Black Point. The extent to which this would happen and the significance of changes are a function of the reclamation's size, shape and orientation to the natural coastline.

It has been a major objective of the site layout definition process (carried out by CLP in conjunction with their consultants and in consultation with Government) to produce a reclamation profile which has the least effect on the existing flow regime.

The preferred layout, shown in Figure V3/2.4(α), has the following specific advantages regarding water quality and other water flow aspects.

o by choosing a location that reclaims the bay between Black Point and the southern end of the Tsang Tsui Ash Lagoons :

  - a smooth profile can be obtained that avoids awkward corners and angles and creation of still areas between the natural bay and reclamation walls that might be prone to stagnation and siltation.

  - potential water quality problems resulting from dovetailing the LTPS reclamation into the possible PADs reclamation to the south of Black Point are avoided.

  - if the PADs reclamation goes ahead the overall effect would be to produce a continuous rounded coastal profile from Tsang Tsui Ash Lagoons to Pillar Point (Area 38).

  - there are no potential problems if this PADs reclamation does **not go** ahead i.e. from a straight sea wall at right angles to Lung Kwu Sheung Tan beach against which the PADs reclamation would abutt.

  - potential conflict with placing structures close to and on top of the NWNT sewage outfall is completely avoided.

o the preferred layout, with a seawall berth close in to the existing shoreline has minimum effect on the navigation channel and reduces the likelihood of pollution from marine spills as berthing is easier, the risk of collision with other shipping is less and allows for consideration of the possibility of leaving vessels alongside during typhoons.

o the smooth profile will have the least effect on the natural tidal flow into and out of Deep Bay to/from Urmston Road.

o although Yung Long beach will be lost (it is within the LTPS site) those at Lung Kwu Sheung Tan and Lung Kwu Tan are to be retained and are not likely to experience any change in erosion or deposition characteristics as a result of the presence of the LTPS reclamation.

As part of the Engineering Design, work being carried out by CLP, hydraulic modelling will be undertaken to refine the reclamation profile and predict flow and sedimentation characteristics. This work will be integrated with the Key Issue Study on Water Quality being carried out by ERL (Asia) Ltd.

However the significant contribution to minimisation of environmental impact from the precise siting and layout has been made at this Initial Assessment Stage.

It is not practical at this stage to clearly define the difference between Scenarios I and II except to note that the introduction of combined cycle units, in place of coal ones, reduces the site size and extent of the reclamation. This is not regarded as a significant issue however with respect to ensuring that Water Quality Objectives are met.

5.6 Effluent Management

The inventory of effluents is presented in V3/5.2. It is the design intention that effluents will be mixed on the premises with the cooling water flow. This is indicated in Table V3/5.6(a) which also summarises which effluent flows are dependent on Scenario.

Table V3/5.6(a)
Summary of Effluent Flows/Cooling Water

Contributor	Flow Rate m^3/yr	
	Scenario I	Scenario II
Water Treatment Plant	6 x 10^5	4 x 10^5
Ash Pit	2 x 10^6	1 x 10^6
Treated Domestic Sewage	6 x 10^5	6 x 10^5
Coal Stockyard Run-off	1.2 x 10^6	6 x 10^5
FGD Plant[1]	104 x 10^7/6 x 10^5	7 x 10^6/3 x 10^5
Boiler Water Blowdown	3 x 10^5	3 x 10^5
Oil Separator Water	6 x 10^7	6 x 10^7
Precip/FGD Run-off	2 x 10^5	1 x 10^5
Sub Total[1]	7.9 x 10^7/6.6 x 10^7	7.0 x 10^7/6.3 x 10^7
Cooling Water	3.7 x 10^9	2.5 x 10^9
Combined Outfall (all above contributors)[1]	**3.78 x 10^9/3.77 x 10^9**	**2.57 x 10^9/2.56 x 10^9**

Note 1 - Figures for FGD Cases 1 and 2 respectively

5.6.1 Ash Pits

The metal load from the Ash Pits can be estimated from the data in Table V3/5.2(c) and is shown in Table V3/5.6(b).

Table V3/5.6(b) Estimated metal loads from Ash Pits

Parameter	estimated concentration mg/L (g/m³)	estimated flow rate m³/yr		Load kg/yr	
		Scenario I	Scenario II	Scenario I	Scenario II
Fe	0.41	2 x10⁶	1 x 10⁶	820	410
Cd	0.10[1]	↓	↓	220	100
Cr	0.16	↓	↓	320	160
Cu	0.10[1]	↓	↓	200	100
Pb	0.65	↓	↓	1300	650
As	0.01[1]	↓	↓	20	10

1 Worst case taking 'less than' values as the actual

$\frac{g}{m^3} \times \frac{m^3}{yr} \times \frac{1}{1000} = \frac{kg}{yr}$

5.6.2 Coal Stockyard Run-off

The coal stockyard will be constructed in such a way that the first 450mm of any rainfall event will be retained and subsequently discharged only after settlement of suspended solids.

From the flow rate and composition information in V3/5.2.5 the metal load can be estimated and this is shown in Table V3/5.6(c).

Table V3/5.6(c) Estimated metal loads from Coal Stockyard Run-off

Parameter	estimated concentration mg/L (g/m³)	estimated annual flow rate m³/yr		Load kg/yr	
		Scenario I	Scenario II	Scenario I	Scenario II
Fe	0.27	1.2 x10⁶	6 x 10⁵	324	162
Hg	0.01	↓	↓	12	6
Cd	0.1[1]	↓	↓	120	60
Cr	0.1[1]	↓	↓	120	60
Cu	0.1[1]	↓	↓	120	60
Pb	0.64	↓	↓	768	384
Ni	0.23	↓	↓	276	138
Zn	0.1[1]	↓	↓	120	60
As	0.01[1]	↓	↓	12	6

1 worst case, taking 'less than' values as the actual

$\frac{g}{m^3} \times \frac{m^3}{yr} \times \frac{1}{1000} = \frac{kg}{yr}$

5.6.3 FGD Effluent

Cleaning the stack gas from the coal-fired units transfers sulphur and trace metal contaminants from the atmospheric emissions to a) liquid effluent discharges and b) 'solid' byproducts which, if it cannot be utilized, becomes a waste. There are various ways of achieving the necessary degree of gas-cleaning and the precise method (and variations on that method) are not decided at this stage (see Sections V3/3 and 6). These will be further explored and evaluated in the Key Issues Reports on Air Quality, Water Quality and Solid By-Products (if the latter study is confirmed as necessary). For the purposes of this Initial Assessment, cases are considered to provide an indication of the effluent implications of possible outcomes.

These cases are :

Case 1 - a Limestone/Gypsum FGD system with a prescrubber and a chloride purge (routed to a wastewater treatment plant) resulting in a gypsum product of commercial grade, a sludge containing metal hydroxides and a treated effluent discharge containing trace toxic metals[1]. (see Annex V3/D Option 1(a), Table V3/D6(a) and (b)).

The estimated 'worst-case' metal loads in the effluent discharge are given in Table V3/5.6(d) for Scenarios I and II for both treated and untreated effluent (as appropriate) equivalent. This is based on an operating year of 6132 hours at full load (high merit order).

Removal efficiencies for the treated effluent are based upon those measured at the FGD wastewater treatment plant at Steinkohle TPS in (what was) West Germany and are not necessarily the maximum reduction levels achievable in such treatment plants (this will depend on design factors).

Table V3/5.6(d)
Case 1 (commerical grade gypsum product) Metal Loads kg/yr

Parameter	Scenario I		Scenario II	
	Untreated Effluent	Treated Effluent	Untreated Effluent	Treated Effluent
As	839	83.9	419	41.9
Cd	755	75.5	377	37.7
Cr	2246	673.7	1122	336.8
Cu	1388	138.8	693	69.3
Hg	141	56.3	70	28.1
Ni	3956	1186.8	1978	593.4
Pb	7169	716.8	3584	358.4
Zn	8497	849.6	4248	424.8
Flow Rate m^3/yr	1.4×10^7		7×10^6	

Data from Annex V3/D (high merit order)

Case 2 - a sea water FGD system based on data for the 'Flakt' process. This uses virtually all the once-through cooling water flow and quantities of lime and process water. This system could be fitted with a prescrubber if necessary (see footnote 1 on this page).

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1 This system is chosen as it appears to produce the worst-case toxic metal profile in the effluent discharge, the use of either or both a prescrubber and purge are process/mitigation options that cannot be confirmed at this stage.

The estimated 'worst-case' trace metal loads are given in Table V3/5.6(e) for Scenarios I and II for both treated and untreated effluent for a system fitted with a prescrubber (see Annex V3/D for details).

Table V3/5.6(e)
Case 2 Flakt Seawater and Lime Process Metal Loads kg/yr

Parameter	Scenario I		Scenario II	
	Untreated Effluent	Treated Effluent	Untreated Effluent	Treated Effluent
As	1115	593	557	296
Cd	1539	1414	769	707
Cr	4009	3432	2004	1716
Cu	2078	1413	1039	706
Hg	198	141	99	70
Ni	6803	5662	3401	2831
Pb	14946	14058	7473	7029
Zn	16548	15017	8274	7508
Flow Rate m^3/yr	6.5×10^5		3.3×10^5	

Data from Annex V3/D (high merit order)

5.6.4 Estimated Cooling Water Composition

From the input data given above in V3/5.6.1, 2 and 3 and the measured sea water composition around Black Point, the "before and after" picture of the Cooling Water flows can be estimated.

Data collected from the CPPS indicate that passage through the Cooling Water circuits of the power station does not affect pH, suspended solids, residual chlorine, ammonia or oil and grease concentrations. These parameters are therefore not expected to significantly alter between inlet and outlet. Other parameters; colour, COD, boron, barium, cyanide, phenols, sulphide phosphorus and surfactants would not be changed significantly, as there are no major sources of these substances within the circuits or in the effluents added to the Cooling Water outfall (quantities of boron and barium may arise from the FGD process (dependent of the type selected) and if sulphide dosing is used in wastewater treatment concentrations of sulphides may rise slightly). It is expected that the E. coli concentration would drop slightly as the treated domestic sewage is chlorinated and records show a residual concentration ranging from 0.1 - 1.0 mg/l in the domestic effluent discharge. This may result in some slight reduction in the E. coli present in the ambient seawater, coming from Urmston Road. The BOD would not rise measurably due to the large dilution (5 orders of magnitude).

Of the other effluents added to the Cooling Water prior to discharge the ones considered to have some effect on the resultant outfall composition are the FGD effluent, the coal stockyard run-off and the ash pit effluent. The metal loads from these sources are totaled in Tables V3/5.6(f) & (g). It is important to add to this the metals present in the inlet CW flow. These are included in the table.

The presence of some "less than" concentration data, hampers numerical estimating for some metals (Cu, Ni, Cd, Zn and As) and for Hg there are no analyses. However for Cr and Pb actual concentrations are available and it can be seen that for a Case 1 FGD system the LTPS contribution is relatively light in percentage terms, the majority, being present in the inlet seawater. However, with the Seawater FGD option the LTPS contribution can be as much as 50% of the total load. These figures represent the worst case and are based on the most pessimistic specifications for coal, lime and process water. Loads of many trace metals could be reduced by a half or more simply by fitting a very high efficiency electrostatic precipitator (>99.9%) that would prevent almost all the flyash (and the metals thereon) from entering the FGD system. Contributions from the lime/limestone would remain however. The data gaps will be filled later if possible. In Table V3/5.6(h) these loads are converted to concentrations.

Table V3/5.6(f) Sum of Metal Loads in CW Outfall kg/yr

SCENARIO I

	Ash Pits Effluent	Coal Stockyard Run off	FGD Effluent		Inlet Sea Cooling Water from NWW	Total Metal Loads		% Contribution from LTPS
			Case 1	Case 2		With Case 1 FGD	With Case 2 FGD	
Flow Rate m^3/yr --->	2 x 10^6	1.2x10^6	104x10^7	*	3.7x10^9	3.78[1]x10^9	3.77[1]x10^9	n/a
Fe	820	324	n.d.	n.d.	5.5x10^5	5.5x10^5	5.5x10^5	i.d.
Hg	n.d.	12	56	141	n.d.	68	153	i.d.
Cd	200	120	75	1410	1850	2250	3580	i.d.
Cr	320	120	674	3430	3700	4810	7570	23.1/51.0
Cu	200	120	139	1410	18500	19000	20200	i.d.
Pb	1300	768	717	14200	22200	25000	38400	1102/42.1
Ni	n.d.	276	1190	5660	18500	20000	24400	i.d.
Zn	n.d.	120	850	15000	37000	38000	52100	i.d.
As	20	12	84	593	3700	3820	4330	i.d.

* uses the inlet sea cooling water in addition
1 inclusive of all inputs shown in Table V3/5.6(a)
n.d. no data
n/a not applicable
i.d. insufficient data ("less than" figures for seawater cannot give a reliable estimate of % contribution)

Table V3/5.6(g) Sum of Metal Loads in CW Outfall kg/yr

SCENARIO II

	Ash Pits Effluent	Coal Stockyard Run off	FGD Effluent		Inlet Sea Cooling Water from NWW	Total Metal Loads		% Contribution from LTPS
			Case 1	Case 2		With Case 1 FGD	With Case 2 FGD	
Flow Rate m^3/yr --->	1 x 10^6	6x10^5	7x10^7	*	2.5x10^9	2.57[1]x10^9	2.56[1]x10^9	n/a
Fe	410	162	n.d.	n.d.	3.7x10^5	3.7x10^5	3.7x10^5	i.d.
Hg	n.d.	6	28	70	n.d.	34	76	i.d.
Cd	100	60	38	107	1250	1450	2120	i.d.
Cr	160	60	337	1720	2500	3060	4440	18.3/43.7
Cu	100	60	69	706	12500	12700	13400	i.d.
Pb	650	384	358	7030	15000	16400	23100	8.5/35.0
Ni	n.d.	138	593	2830	12500	13200	15500	i.d.
Zn	n.d.	60	425	7500	25000	25500	32600	i.d.
As	10	6	42	296	1250	1310	1560	i.d.

* uses the inlet sea cooling water in addition
1 inclusive of all inputs show in Table V3/5.6(a)
n.d. no data
n/a not applicable
i.d. insufficient data ("less than" figures for seawater cannot give a reliable estimate of % contribution)

Table V3/5.6 (h) Estimated Cooling Water Inlet and Outfall Composition

Parameter/Determinand	INLET	OUTFALL	
		SCENARIO I	SCENARIO II
	from NWW - Urmston Road	from NWW - Urmston Road	from NWW - Urmston Road
pH (pH units)	8.3	8.3	8.3
Temperature (°C)	16-28	26-38	26-38
Colour (Lovidbond units)	-	-	-
Suspended Solids	12	12	12
BOD	0.5	0.5	0.5
COD	n.d.	n.d.	n.c.
Oil & grease	0.06	0.06	0.06
Iron	0.15	i.d.	i.d.
Boron	n.d.	n.c.	n.c.
Barium	n.d.	n.c.	n.c.
Mercury	n.d.	i.d.	i.d.
Cadmium[1]	0.0005	0.00056/0.00095	0.00056/0.00083
Total toxic metals	0.01	see below	see below
Cyanide	n.d.	n.c.	n.c.
Phenols	n.d.	n.c.	n.c.
Sulphide	<0.01	<0.01	<0.01
Total residual chlorine	<0.1	nil	nil
Total nitrogen	0.17	0.17	0.17
Total phosphorus	0.11	0.11	0.11
Surfactants (total)	<0.05	0.05	<0.05
E. coli (count/100ml)	1000	<1000	<1000
Ammonia	0.04	0.08	0.08
Chromium[1]	0.001	0.0013/0.0020	0.0012/0.0017
Copper	<0.005	i.d.	i.d.
Lead	0.006	0.0066/0.0102	0.0064/0.0090
Nickel	<0.005	i.d.	i.d.
Zinc	0.01	0.01	0.01
Arsenic	<0.001	i.d.	i.d.

all values in mg/L except where specified

[1] Two figures are shown, the first for Case 1 FGD and the latter for Case 2 FGD

$$\frac{kg}{yr} \times \frac{yr}{m^3} \times 1000 = \frac{mg}{L}$$

5.6.5 Dissolving Gypsum in Cooling Water

A major problem with the Limestone/Gypsum FGD process in Hong Kong is the lack of an apparent market for commercial grade gypsum in the region. This means that the gypsum becomes a 'waste' requiring disposal. Options are very limited. One possibility is to dissolve it in the Cooling Water prior to discharge. It is doubtful whether this is sensible from a chemical process point of view, it being logical to opt for the seawater process in this situation. However simply from an initial estimating standpoint the loads would be approximately as shown in Table V3/5.6(i). Table V3/5.6(ii) show the figures adjacented from those for a commercial grade gypsum produced at the Steinkohle Power Station in Germany. This station uses a very high efficiency ESP (>99.9%) and incorporates a prescrubber and purge routed via a wastewater treatment plant. The data shows the levels to which it is possible to reduce trace metal loads for either the seawater or dissolved gypsum options.

Table V3/5.6(i)
Trace Metal Loads arising from dissolution of FGD gypsum

Contaminant	Scenario I		Scenario II	
	Untreated Effluent kg/yr	**Treated Effluent kg/yr**	**Untreated Effluent kg/yr**	**Treated Effluent kg/yr**
As Arsenic	1178	656	589	328
Cd Cadmium	1561	1437	780	718
Cr Chromium	4107	3531	2053	1765
Cu Copper	2236	1572	1118	785
Hg Mercury	201	145	100	72
Ni Nickel	7001	5861	3500	2930
Pb Lead	15263	14376	7631	7187
Zn Zinc	17394	15864	8697	7931

Notes:

1. Data from Annex V3/D based upon a system fitted with a prescrubber from which the effluent is either discharged directly or routed via wastewater treatment.

2. High merit order.

3. Worst case metal concentrations in coal, limestone and process water.

Table V3/5.6(j) Trace Metal Load in Gypsum

Contaminant	Concentration in Gypsum mg/kg	LTPS Load kg/yr	
		Scenario I 9.6×10^5 t/yr	Scenario II 4.8×10^5 t/yr
As	0.5	480	240
Cd	0.06	60	30
Cr	0.7	670	335
Cu	0.8	770	385
Hg	0.09	86	43
Ni	0.4	380	190
Pb	5.7	5470	2735
Zn	13.3	12770	6385
Se	0.18	170	85
Ca	approx 29.4%	2.82×10^5	1.41×10^5
SO_4	approx 70.6%	6.78×10^5	3.34×10^5

The numbers in Table V3/5.6(i) and (j) indicate that if dissolving gypsum in the cooling water outlet is to be persued, close attention must be given to removal of trace metals from the system. The addition of the calcium and sulphate ions themselves will not significantly alter the local ambient concentrations of these species in the sea.

5.7 Effects of Changes in Ambient Marine Water Quality

5.7.1 Introduction

Physical developments (other than the LTPS) in the vicinity of the site and territory-wide regulatory developments will affect some change in the water quality off Black Point.

5.7.2 Sources of Change

These can be listed as follows :

1. Physical Developments in the Vicinity

1.1 Shekou Industrial Port Development
1.2 Nantou-Ma Wan (PRC) Sewer Outfall
1.3 Dredging off Shekou
1.4 WENT Landfill
1.5 NWNT Sewerage Scheme
1.6 Tuen Mun Port Development (inc. Area 38)

The Project Profile Sheets for 1.1 to 1.3 taken from the Deep Bay Integrated Environmental Management Report Volume 2 : The Impacts of Development Dec. 1988 are shown overleaf 201, 202 and 203)

Associated with building development projects in both Hong Kong and the PRC is the winning of marine sands (and possibly the placement of contaminated muds from reclamation projects in Hong Kong) on the seabed off Black Point.

2. Regulatory Development

2.1 The Technical Memorandum of the WPCO controlling effluent discharges
2.2 The Livestock Waste Control Scheme
2.3 The anticipated declaration of Water Quality Objectives for the North Western Waters WCZ.
2.4 Implementation of the Deep Bay Guidelines and related Works control.

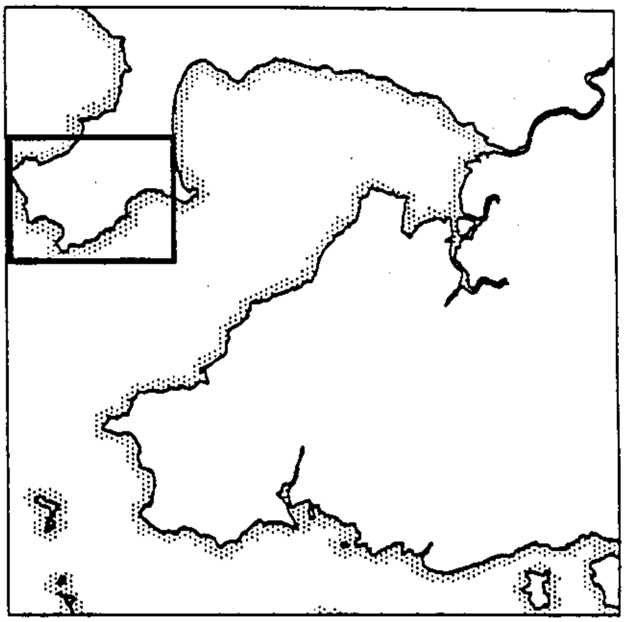
3. Two further aspects will influence change :

3.1 The upgrading of treatment to domestic sewage at the Pillar Point sewage treatment works
3.2 The implementation of the Tsuen Wan, Kwai Chung, Tsing Yi Sewerage Master Plan which may reduce pollution drawn in from the east on the flood tide.

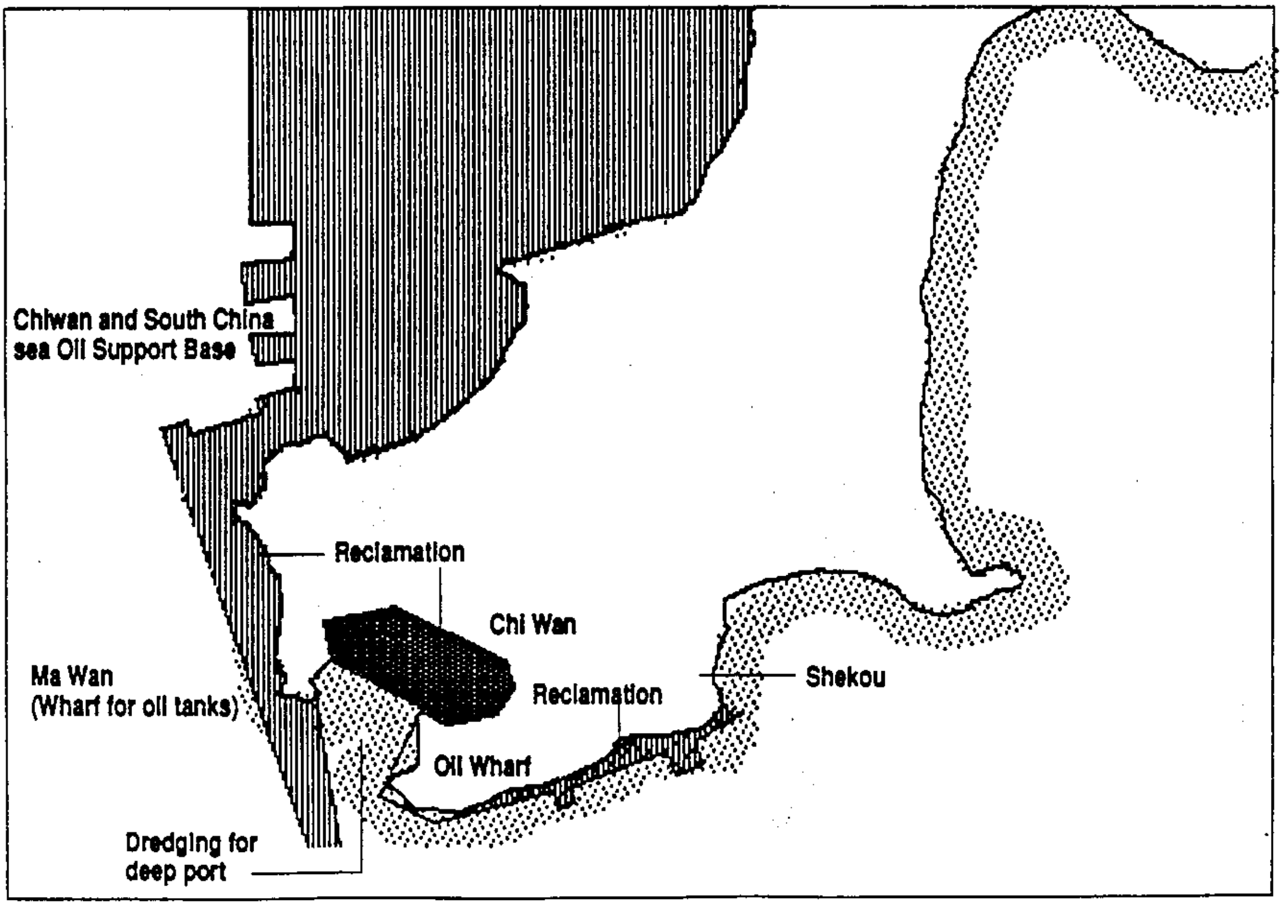
The Regulatory Developments will all serve to improve coastal water quality and minimise the adverse impacts of Hong Kong projects. Items 2.1 to 2.4 above will reduce pollutant loads to coastal waters from residential areas, manufacturing industry, construction activities and agriculture. The effluents which flow in from the new NWNT sewer and the Pillar Point SWT will carry less BOD and toxic metal loads as a result of implementing these measures. The new industries setting up on industrial land in the Tuen Mun Port Development Area will have strict effluent standards applied to them (cf. Area 38) and thus will be very different from the current grossly-polluting type in Kwai Chung and Tsuen Wan.

Shekou Industrial Port Develpment

Shekou has been designated as an industrial development zone within the Shenzhen Special Economic Zone. As part of the industrial development its port area is undergoing expansion along with the neighbouring area of Chi Wan. There is little detailed information available at present with regard to this project; however it is expected to involve massive coastal reclamation to provide land areas for port development and large scale dredging for navigation channels, ship manoeuvreing areas and berths.



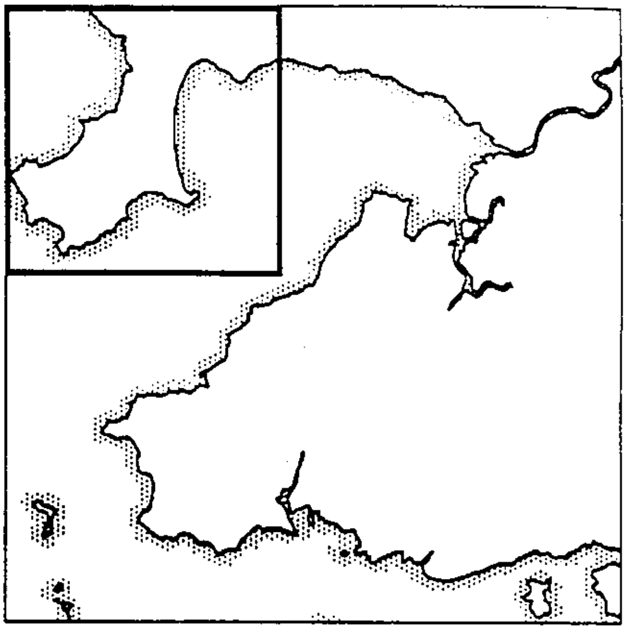
Key elements of the development are:
• Reclamation of Ma Wan to form a wharf for oil tanks.
• Development of an oil support base at Chi Wan with associated dredging to provide deep water access.
• Reclamation along the coast between Chi Wan and Shekou for the development of an oil wharf and other industrial activities.
Following completion of the port development, there will be a continual requirement for maintenance dredging and associated spoil disposal operations.

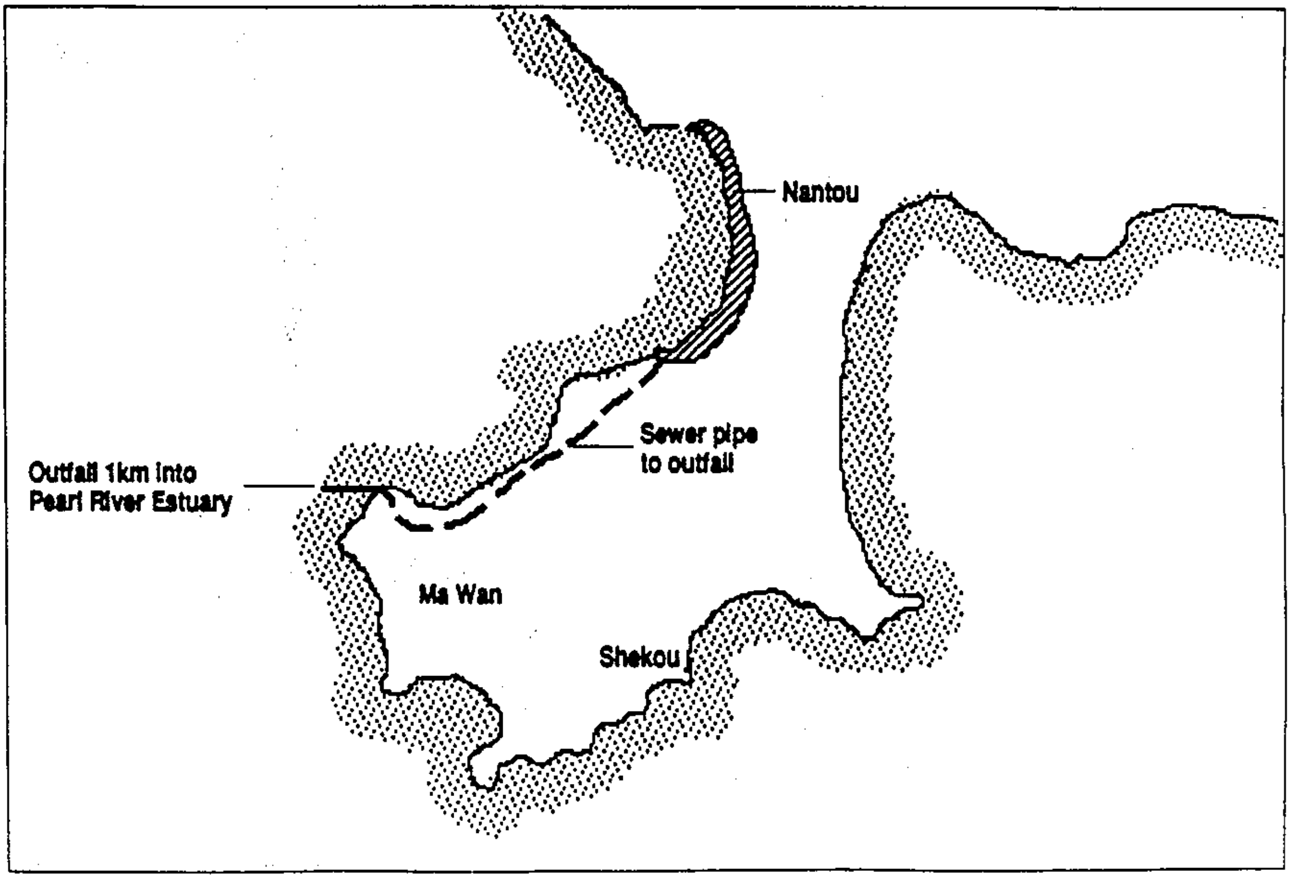


Nantou–Ma Wan Sewer outfall

The Shenzhen planning authorities are proposing to build a sewage system to collect effluents from the Special Economic Zone and discharge them into the Pearl River Estuary. The first phase of this proposed scheme is an outfall to serve the Nantou–Ma Wan industrial area with an estimated flow of c.200,000m^3/day. This is currently under construction.

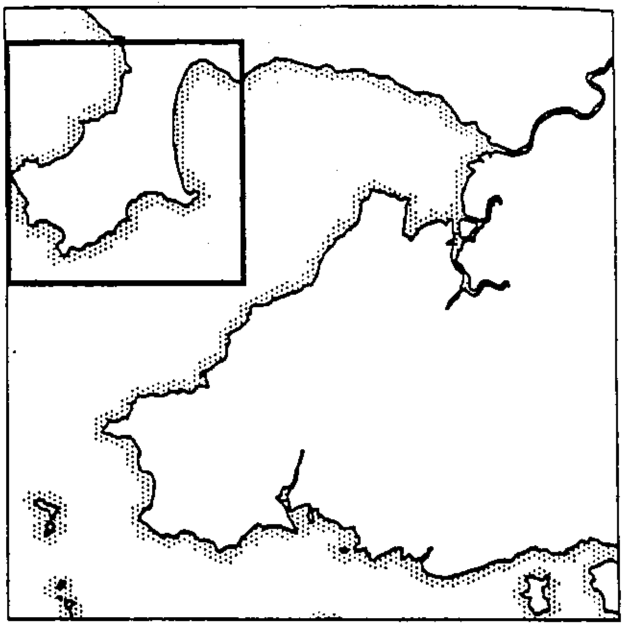
Later phases will link up other areas of the SSEZ to the outfall (e.g. Futian area and settlements/resort developments around the estuary).

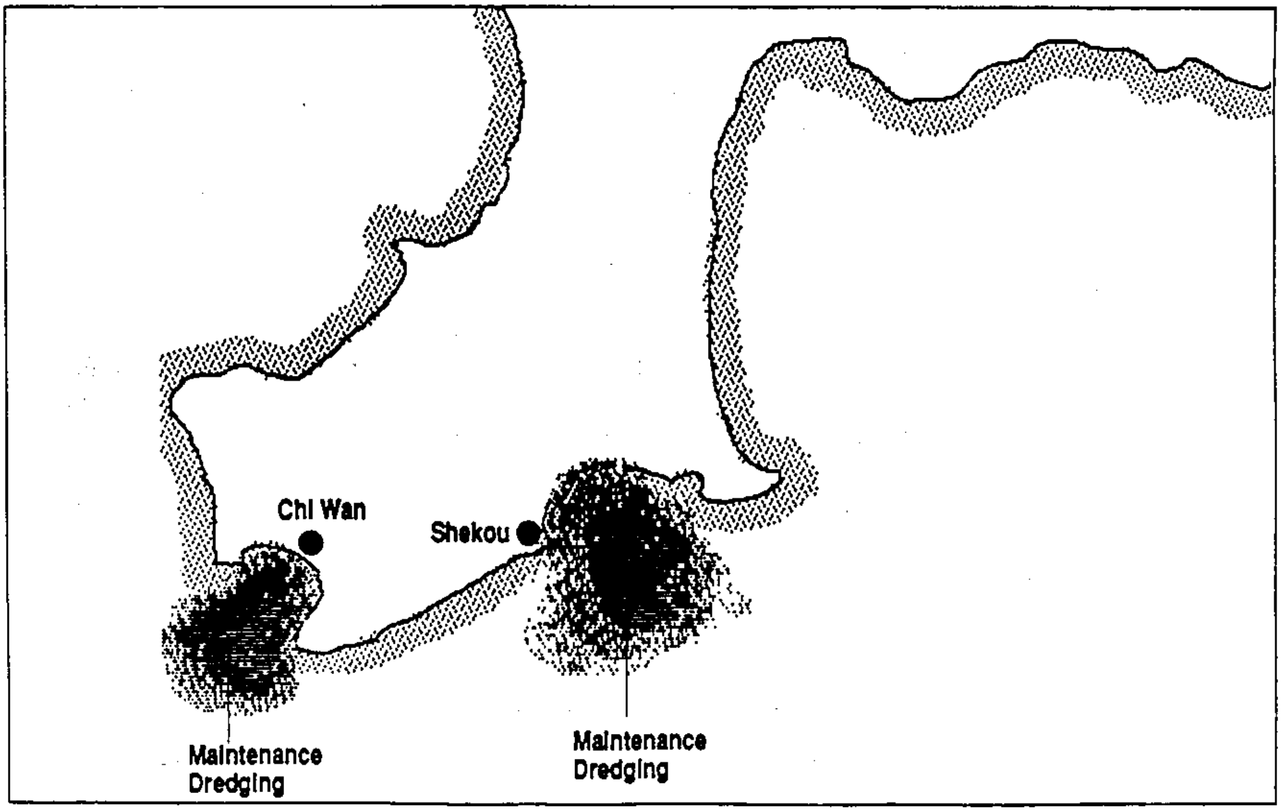




Dredging Off Shekou

Maintenance dredging operations are carried out at present in order to maintain navigable water depths in the approaches to port facilities at Shekou. Information is not available on the location of disposal grounds for dredged spoil nor on the annual volume of material that is dredged.





The NWNT sewer will introduce a new and large load of polluting matter into the water body. However, an EIA has been carried out for Government indicating that the impacts will be acceptable. In toxic metal terms the LTPS will be a very minor contributor compared with the toxic metal load assumptions made for the sewage in that Study (see V3/5.8.2). The discharge from the sewer however will become less polluting as time passes due to the regulatory controls upstream.

The only factor acting to possibly reduce marine water quality is the PRC developments, in and around Shekou. The consultants would urge Government to seek the implementation of the environmental management recommendations concerning joint PRC–Hong Kong action contained in the Deep Bay Integrated Environmental Management Report Dec. 1988.

The marine water quality off Black Point is currently good with high dissolved oxygen levels, low toxic metal concentrations and although the suspended solids levels are high these are due to natural causes. These is however a detectable E. coli 'cloud' from Pillar Point extending to Black Point and probably into Outer Deep Bay on the flood tide.

The changes described above are expected to make marine water quality better in the long term with the reservation that PRC–inputs need to be controlled also.

5.8 Significance of Impacts

5.8.1 Cooling Water Discharge

At the Site Search Report stage the results of initial modelling were reported. These were based on a technique given by Miller and Brighouse[1]. Two main system assumptions were made and stated at that time :

- o the CW is discharged at a depth of at least 4m. If discharged into shallower water the thermal plume will be elongated due to the influence of the seabed.
- o the CW is discharged perpendicular to the shore (and the seawall at that time) and the current direction. If discharged at less than 90° to these attachment to the shoreline could occur elongating the plume.

Both these assumptions are valid for the LTPS proposal. Various orientations of intake and outfall are being evaluated in the engineering studies and the Water Quality Key Issues Study but the two assumptions above apply to all of them.

The temperature decay is dependent on; the entry temperature, CW flow rate, receiving water temperature, tidal current velocities and water depth. The predicted temperature effect of the thermal plume in the case of the ultimate LTPS for Scenario I for an outfall temperature of either 10°C or 12°C above ambient is shown in Table V3/5.8(a).

For the Deep Bay Water Control Zone (WCZ) the gazetted WQO is that the natural range must not be exceeded by more than 2°C. The WQO for North Western Waters have yet to be gazetted but it is expected that for temperature the Objective will not be greater than 2°C.

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1 Miller D.S. and Brighouse B.A. (1984) Thermal Discharges. British Hydromechanics Research Association.

Table V3/5.8(a)
Plume Centreline Temperature Decay

CW temp. 10°C above ambient		**CW temp. 12°C above ambient**	
Distance along plume centreline (m)	**Temp. above ambient (°C)**		**Temp above ambient (°C)**
-	-	11	77
-	-	10	91
-	-	9	111
8	99	8	137
7	126	7	174
6	166	6	231
5	232	5	321
4	348	4	482
3	586	3	812
2	1222	2	1694
1	4302	1	5962

The results of the above predictions indicate that the plume would not raise the surrounding temperature of the sea by more than 2°C once it had travelled about 1km for a 10°C above ambient release temperature, or 1.7km for a 12°C above ambient release temperature. It is anticipated that the thermal effect would be more readily dispersed in North Western Waters than in Outer Deep Bay where the relatively confined waterbody may result in a more widespread effect. However this may not be significant given that the nearest oyster beds in Deep Bay are about 3km to the north east. (the nearest part of the Mariculture Sub Zone to the nearest part of the LTPS site).

Scenario I clearly represents the worst case as far as thermal load in the cooling water is concerned. For Scenario II the maximum flow rate is 1 x $10^7 m^3$/day compared to 1.5 x $10^7 m^3$/day for Scenario I both with the same initial excess temperature of 10°C.

The temperature data show (see Table V3/5.4(f)) that there appears to be little potential for taking relatively cool water from Urmston Road and discharging it in Outer Deep Bay as the ambient temperature there is not much higher. However this will be explored as part of the engineering studies. As the LTPS will be developed in stages, the possibility exists to have separate outfalls in different locations. This may also be examined.

During the Water Quality Key Issues Study more sophisticated modelling predictions will be made regarding the relationship between intake and outfall locations and the temperature effect. The key points for the study to address are :

- temperature rise in Deep Bay with respect to the WQO and oysters

- potentially adverse interaction between the CW system and the NWNT sewer outfall

- recirculation between the LTPS intake and outfall and the LTPS intake and CPPS outfall (this is the issue of prime importance to power station design and operation).

5.8.2 Trace Metals

Estimates indicate that trace metal concentrations in outgoing cooling water would not be measurably increased by the addition of site effluents other than that from FGD, containing trace metals i.e. ash pits, coal stockyard run-off. If a commercial grade gypsum FGD system is incorporated trace metal concentrations would not be significantly affected. However, there is potential for significant trace metal release if gypsum is dissolved in the CW outfall but this depends on practical controls over the gypsum trace metal content. This will be examined further in the Key Issues Study on Water Quality where the estimated CW flows will however still be modelled for dispersion of a conservative pollutant.

The significance of trace metal discharges from the LTPS should be seen in the context of such releases from sewage outfalls in the vicinity. From data presented in V1/2.15.3 the total toxic metal (TTM) load from sources will be about 110,000 kg/yr. Summing the metals from Table V3/5.6(f) and recalling that several numbers are 'less thans' which will overstate the metal quantity, the TTM loads for Scenario I 7,500 kg/yr (Case 1 FGD) and 45,000 kg/yr (Case FGD) (the latter is roughly equivalent to that currently estimated to be discharged from Pillar Point sewage discharge).

In the EIA for the North West New Territories Sewerage Scheme (Final Report 1990) the TTM for a flow of 303,524 m^3/day is given as **3,910 kg/day**. This is nearly all originating from "industrial processes" generating a flow rate of 202,654 m^3/day containing a metal load of **3,240 kg/day**. These represent 1,427,150 kg/yr and 1,182,600 kg/yr respectively.

The Consultants consider these to be unrepresentative of future industry as they are equivalent to a TTM concentration of about 30 mg/L. This is based on Tsuen Wan and Kwai Chung survey data, the most notorious metals effluent black-spots in the territory. The new Technical Memorandum on effluents requires that TTM discharges to foul sewers be below 1 to 2 mg/L for flows >600 m^3/day and for marine discharges in the 0.5 to 0.1 mg/L range.

However, notwithstanding these assumed metal inputs of 1 million plus kg/yr of TTM from the NWNT sewer pipe, no adverse impact was identified. The worst LTPS contribution to TTM is about 30 times less than this and is thus not expected to cause any adverse impact on the marine environment. However, these tentative conclusions will require further investigation in the Water Quality Key Issue Report.

5.9 Mitigation Measures

The design of the reclamation profile is in part a mitigation measure for water quality impacts for the reasons given in Section V3/5.5.

In the Key Issue Study on Water Quality the optimum location for the CW intake(s) and outfall(s) will be determined and the question of trace toxic metal release and mitigation measures (wastewater treatment) will be further examined.

5.10 Oil Spills

There will be no regular calls at the LTPS by large carriers. The regular consignments of fuel oil and/or distillate will be made by coastal barges. Spills from such vessels will be small (of the order of hundreds of m^3) and relatively easy to contain. Further there are no sensitive marine features close by to be affected. In view of the above the environmental significance is judged to be low and not a Key Issue.

5.11 Oil Spill Contingency Plan

The potential for large spills is very low at the LTPS site and the Plan should reflect this. CLP will follow the Oil Pollution Contingency Plan provisions laid down by the Hong Kong Marine Department as it applies to the type and magnitude of oil deliveries envisaged. This document contains guidelines for the use of oil skimmers, dispersants and systems of containment. The Plan will be co-ordinated with that for the CPPS already in existence.

5.12 Key Issues and Conclusion

The Operational Water Quality section has identified the following Key Issues :

- The effect on sea flow patterns of the physical presence of the reclamation. The present view is that the design concept does everything feasible to minimise the effect but mathematical modelling should be carried out to confirm this and provide detailed information for judging acceptability.

- The extent of the thermal plume from the Cooling Water (CW) discharge. Mathematical modelling will be carried out to test the effects of outfall location and depth. Of particular importance are :

  - prevention of recirculation between intake and outfall both within the LTPS and between it and CPPS

  - avoiding any adverse interaction between the CW intake outfall and the outfall of the NWNT sewer

  - preventing unacceptable temperature rise in Deep Bay.

  In conjunction, confirmatory modelling of the dispersal effects of conservative pollutants from the cooling water discharge will be carried out.

- Initial estimates of toxic metal discharges from LTPS effluents in this IAR indicate that discharges will not cause a significant adverse impact. Further work is needed to refine estimates particularly with respect to the overall FGD arrangements.

In the Consultants' opinion these are the only Key Issues to arise in the Operational Water Quality area.

The work of the Initial Assessment has reinforced the consultants' view that the site is acceptable in marine water quality terms and the results of the mathematical modelling are expected to confirm this.

6. WASTE DISPOSAL

6.1 Introduction

This section examines the nature of the solid wastes and by-products likely to arise from the operations of the proposed LTPS at Black Point, the marketing and disposal options available for each of these materials, and the environmental impacts associated with each option.

The principal solid product would be ash. Combustion of pulverised coal results in the production of two types of ash:

- **furnace bottom ash** (FBA), comprising about 10% of the total, a dense clinker which is collected in hoppers at the base of the furnace;

- **pulverised fly ash** (PFA), comprising about 90% of the total, a fine, grey particulate material.

Other large volume wastes could arise from the flue gas desulphurisation (FGD) plant required to reduce levels of sulphur dioxide (SO_2) emitted with the flue gases from coal-fired units to acceptable levels. Two different FGD systems are under active consideration, both are so-called wet scrubbing processes:

- the Limestone/Gypsum process;

- the Seawater process (two plant types);

Solid products arising from these processes could include large quantities of gypsum (Limestone/Gypsum process) and possibly sludges which could result from the treatment of FGD waste water (both systems) if detailed design shows a requirement for such treatment. Further details of the FGD plant are contained in Sections V3/3 and V3/5 (Air and Water Quality respectively).

Other wastes that would arise from the LTPS (although in much smaller quantities) include spent transformer oils, tank bottom sludges, shipping wastes covered by the marine convention MARPOL, general refuse, scrap metal, drum screen rejects and demineralisation effluent treatment plant resins. The nature and timing of the provision of MARPOL reception facilities will be agreed with Marine Department at the appropriate time.

Section V3/6.2 gives a detailed inventory of the likely solid wastes and Section V3/6.3 discusses waste management proposals and develops preliminary solid by-product disposal strategies for Scenarios I and II at the LTPS.

6.2 Inventory of Waste Sources

6.2.1 (i) Ash - Scenario I

Under the high merit order senario the proposed LTPS, with an annual coal burn of 1,560,000 tonnes/yr/unit and an average ash content for the coal of 14%, would produce 218,000 tonnes/yr of ash per 680 MW unit. Most of this (about 90%) would be in the form of PFA, with the remainder (10%) as FBA. Table V3/6.2(a) shows the annual arisings of PFA and FBA over the proposed construction period and beyond. Ultimately with eight 680 MW units in place over 1.5 million tonnes of PFA and 175,000 tonnes of FBA could be produced.

Table V3/6.2(a)
Annual Ash Arisings at Proposed LTPS - Scenario I

Year	No. of Coal fired Units (680 MW)	FBA Arisings 10^3tonnes/yr	PFA Arisings 10^3 tonnes/yr
1996	1	22	196
1997	2	44	393
1998	2	44	393
1999	2	44	393
2000	3	65	590
2001	4	87	785
2002	4	87	785
2003	5	109	982
2004	6	131	1180
2005	6	131	1180
2006	6	131	1180
2007	7	153	1375
2008	8	175	1570
2009	8	175	1570
2010	8	175	1570

Notes:
1. Estimates based on proposed long term average coal specification of 14% a.r.b. ash.
2. Annual coal usage 1,560,000 tonnes/yr/unit.
3. 90% PFA, 10% FBA.

6.2.1 (ii) Ash - Scenario II

Table V3/6.2(b) details the annual arisings of ash from the coal-fired units over the proposed construction period and beyond. At full capacity, a total of only four coal fired units, are envisaged with an annual production of PFA of over 750,000 tonnes/yr and 87,000 tonnes/yr of FBA.

Table V3/6.2(b) Annual Ash Arising at Proposed LTPS - Scenario II			
Year	**No. of Coal Fired Units (680 MW)**	**FBA Arisings 10^3te/yr**	**PFA Arisings 10^3te/yr**
1996	0	0	0
1997	0	0	0
1998	0	0	0
1999	0	0	0
2000	0	0	0
2001	0	0	0
2002	0	0	0
2003	1	22	196
2004	2	44	393
2005	2	44	393
2006	2	44	393
2007	3	65	590
2008	4	87	785
2009	4	87	785
2010	4	87	785

Notes
1. Estimates based on proposed long term average coal specification of 14% a.r.b. ash.
2. Annual coal usage 1,599,000 tonnes/yr/unit.
3. 90% PFA, 10% FBA.

6.2.2 (i) Flue Gas Desulphurisation By-Products - Scenario I

The proposed LTPS coal-fired units will each produce over 30,000 tonnes/yr of sulphur dioxide (SO_2) when burning a coal having a sulphur content of 1% which, in the absence of pollution abatement plant, would mostly be emitted to the atmosphere with the flue gases. Atmospheric SO_2 is associated with acidification of the environment (acid rain) and has adverse human health affects if present in significant concentrations. The Governments' Best Practical Means (BPM) program specifies SO_2 reduction for large combustion plant and, in addition, air quality studies have indicated a requirement for SO_2 abatement if the Government's Air Quality Objectives (AQOs) are to be met.

Commercially available FGD systems have been reviewed in relation to the proposed LTPS at Black Point, two are under active consideration by CLP:

- **The Wet Limestone/Gypsum Process**: This FGD system uses a limestone slurry to absorb flue gas SO_2 in a wet scrubber. The system can be configured to produce various grades of gypsum (calcium sulphate dihydrate) or, alternatively, the gypsum could be dissolved in the cooling water and discharged from the seawater outfall provided no adverse impacts result (see Section V3/6.3.2).

- **The Seawater Process**: This also uses a wet scrubber to absorb SO_2, but the absorbent is the alkaline seawater used for cooling supplemented by quantities of lime. Sulphur dioxide is removed from the system as gypsum (calcium sulphate) in solution with the cooling water return. Both calcium and sulphate ions are major natural constituents of seawater. Two processses are being considered.

Likely arisings of FGD solid waste products are detailed in Table V3/6.2(c) for the limestone/gypsum options detailed below, the dissolution and seawater options do not produce any appreciable solid wastes in their basic configurations:

- **Option 1** – **The Wet Limestone/Gypsum Process:**
  - (a) – Commercial grade gypsum product;
  - (b) – Gypsum dissolved in seawater cooling.
- **Option 2** – **The Seawater Process.**

Limestone/gypsum FGD systems producing a commercial grade product normally incorporate a chloride purge stream (a bleed of absorber suspension) and/or a prescrubber to prevent the build up of chlorides and other contaminants in the closed circuit recycle loops and thus ensure quality specifications for the gypsum product. The effluent from these process options will contain trace levels of heavy metals.

Solid Wastes from Possible Mitigation Measures

Waste effluent arising from purge streams or prescrubbers can be treated to reduce levels of heavy metals prior to discharge to a fresh watercourse. This produces quantities of waste sludges that require disposal or utilization. It has not yet been determined whether the environmetal implications of marine discharge necessitate the use of wastewater treatment. (The issue will be addressed further in the Water Quality Key Issue Study). Note that a prescrubber could also be incorporated into the design of the seawater option.

A prescrubber may be incorporated either to reduce the levels of contaminants entering the FGD plant (with entrained ash particles or in gaseous form in the flue gases) and/or to reduce the levels of trace metals entering the marine environment. Calculations show however that for many heavy metals of concern a potential major source would be the FGD reagent (that enters the system downstream of the prescrubber) and not the species caught by the prescrubber (see Annex V3/D).

Table V3/6.2(d) details the typical concentrations of heavy metals in a sludge from FGD wastewater treatment from a system operating with a prescrubber and Table V3/6.2(e) shows the likely arisings of wastewater treatment sludges from a prescrubber over the LTPS lifetime. Arisings from a chloride purge will be less, typically about half that from a prescrubber depending on process conditions.

Table V3/6.2(c)
Annual FGD Solid By-Products Arisings at the Proposed LTPS -Scenario I

Year	No. of Coal-fired Units (680MW)	Limestone/Gypsum FGD - Option 1(a)	
		Commercial Grade Gypsum 1000 te/yr	Disposal Grade Gypsum 1000 te/yr
1996	1	78.3	8.5
1997	2	156.6	17.0
1998	2	156.6	17.0
1999	2	156.6	17.0
2000	3	234.9	25.5
2001	3	234.9	25.5
2002	4	313.2	34.0
2003	4	313.2	34.0
2004	5	391.5	42.5
2005	6	469.8	51.0
2006	6	469.8	51.0
2007	7	548.1	59.5
2008	8	626.4	68.0
2009	8	626.4	68.0
2010	8	626.4	68.0

Notes:
1. Quantities based on a 1% sulphur coal at the LTPS at high merit order (supplied by Stone & Webster Engineering (UK) Ltd.).
2. Commercial grade gypsum at 10% moisture.
3. Options 1(b) and 2 do not produce any solid wastes in their basic configuration.

Table V3/6.2(d)
Composition of Sludge from Typical FGD Effluent Treatment (FGD System operating with a prescrubber)

Contaminant	Concentration (mg/kg)
Arsenic	432
Cadmium	94
Chromium	872
Copper	1148
Lead	1349
Mercury	94
Nickel	203
Zinc	1811
Aluminium	51007
Antimony	69
Boron	0
Fluoride	51522
Iron	23692
Manganese	1835
Molybdenum	642
Selenium	280
Tin	39
Vanadium	294

Source: "Evaluation and Treatment of Liquid Discharges from Flue Gas Desulphurisation Processes - Volume I" for Central Electricity Generating Board by Consultants in Environmental Sciences Ltd in association with Ewbank Preece Ltd, London 1987

Table V3/6.2(e)
Annual FGD Solids Arisings from possible Waste Treatment Plant - Scenario I

Year	No. of Coal-fired Units (680MW)	FGD Wastewater Treatment Plant Prescrubber Sludge 1000 te/yr
1996	1	8
1997	2	16
1998	2	16
1999	2	16
2000	3	24
2001	3	24
2002	4	32
2003	4	32
2004	5	40
2005	6	48
2006	6	48
2007	7	56
2008	8	64
2009	8	64
2010	8	64

Notes:

1. Quantities based on a 1% sulphur coal at the proposed LTPS at high merit order and adjusted from 4000MW UK TPS.

6.2.2 (ii) Flue Gas Desulphurisation By-Products - Scenario II

The different FGD processes discussed in Section V3/6.2.2(i) above would be considered under Scenario II. Table 6.2(f) lists the likely arisings of FGD waste products and wastes that could potentially arise from waste water treatment over the proposed construction period and beyond.

6.2.3 Miscellaneous Wastes

Various other wastes will be produced by the LTPS in small quanties which nevertheless require proper disposal. These are considered below.

a) **Spent Transformer Oils**

The use of PCB - dosed transformer oils has already been phased out in the electricity generating industry in the developed world so this serious aspect of chemical waste management is not an issue for the LTPS. No PCB-dosed transformer oils are used at the CPPS and will not be at the LTPS. It is likely that transformers will still need to be disposed of during the operating life of the LTPS and that their fluid will need to be drained and adequately handled. From operating experience within CLP the estimated quantity of such wastes from the LTPS at its ultimate development is about 150 drums per year. This will be the same in both Scenarios I and II.

b) **Others**

Table V3/6.2(g) lists solid wastes, oils and sludges which were produced at the CPPS during 1990. Although the quantities concerned are not in each case directly related to power output, estimates for the LTPS are made in the Table on a prorata basis with station capacity. These will be the same in both Scenarios I and II.

6.2.4 Tank Bottom Sludges

The LTPS will require the storage on site of substantial quantities of liquid fuel. The quantities, type and purposes are given below.

Scenario I - all coal

day tanks only (strategic store at CPPS) 2 off 10,000 tonne tank containing maximum 1% by wt sulphur fuel oil for 8 coal-fired units. This is operational contingency fuel for the normally coal-fired boilers.

Scenario II - gas and coal

a) day tank only (strategic store at CPPS)

1 off 10,000 tonne tank containing maximum 1% by weight sulphur fuel oil for 4 coal-fired units. This is operational contingency fuel for the normally coal-fired boilers.

b) 4 off 60,000 tonne tanks containing distillate oil for 4 combined-cycle units. This is operational contingency fuel for the normally-natural gas fired boilers. A larger quantity is needed as there is no strategic store of this fuel at CPPS.

Table V3/6.2(f)
Annual Solid By-Product Arisings and possible Sludge Arisings at the Proposed LTPS - Scenario II

Year	No. of Coal-fired Units (680MW)	Limestone/Gypsum FGD		FGD Wastewater Treatment Plant Prescrubber Sludge 1000 te/yr
		Commerical Grade Gypsum 1000 te/yr	Disposal Grade Gypsum 1000 te/yr	
1996	0	0	0	0
1997	0	0	0	0
1998	0	0	0	0
1999	0	0	0	0
2000	0	0	0	0
2001	0	0	0	0
2002	0	0	0	0
2003	0	0	0	0
2004	1	78.3	8.5	8
2005	2	156.6	17.0	16
2006	2	156.6	17.0	16
2007	3	234.9	25.5	24
2008	4	313.2	34.0	32
2009	4	313.2	34.0	32
2010	4	313.2	34.0	32

Notes:
1. Quantities based on a 1% sulphur Coal at the LTPS at high merit order (figures supplied by Stone & Webster Engineering (UK) Ltd).
2. Commercial grade gypsum at 10% moisture.
3. Options 1(b) and 2 do not produce any solid wastes in their basic configuration.
4. Prescrubber arisings adjusted from 4000MW UKTPS.

Table V3/6.2(g)
Solid Waste, Oil and Sludge Arisings CPPS and LTPS

Waste Type	Method of Disposal	Annual Quantity	
		CPPS	LTPS
1. Refuse	Taken by contractor to Government landfill site	16,000m^3	24,000m^3
2. Drum Screen rejects	Taken by contractor to Government landfill site	500m^3	750m^3
3. Scrap copper	Sold to scrap contractor for recycling	8 tonnes	12 tonnes
4. Mixed metal scrap		380 tonnes	570 tonnes
5. Oil drums	Sold to scrap contractor for recycling	330 drums	500 drums
6. Scrap oil drums	Sold for reuse	112 drums	170 drums
7. Chemical containers	Sold to scrap contractor for recycling	3000 containers	4500 containers
8. Boiler Feed Water Demineralisation Plant spent ion exchange resins	Returned to suppliers for reuse	25 tonnes	38 tonnes
9. Contaminated lube oil	Taken by contractor to Government landfill site	263 drums	400 drums
10. Fire Resistant Fluid		21 drums	30 drums
11. Cleaning Solvents	Sold by tender for recycling. Other surplus oil recycled internally	6 drums	10 drums
12. Sewage Sludge and kitchen grease		300m^3	450 m^3
	Currently stored awaiting suitable disposal[1]	n.d.	n.d.
	Currently stored awaiting suitable disposal[1]	n.d.	n.d.
	Removed by approved contractor to sewage treatment plant		

1 – these could be handled by the CWTC (Chemical Waste Treatment Centre) when it comes on-line.
n.d. – no data
Source : CLP 1991

These fuel storage tanks do not experience much turnover of fuel and accumulation of bottom sludges requiring removal is very small. From operating experience at CPPS desludging of tanks is only required about once every 10 years. The quantity at CPPS was approximately 17 tonnes, comprising 7 te from 100,000 te of long term storage, and 10 te from 5,000 tonnes of day tank storage.

This would be equivalent to :

Scenario I 40 tonnes per 10 years
Scenario II 36 tonnes per 10 years

By comparison the major liquid hydrocarbon terminals in Hong Kong each produce about 150-200 tonnes per year.

6.2.5 MARPOL Wastes for Shipping

The LTPS will be served by ocean-going vessels supplying coal, and limestone (or a chemical equivalent). In the case of Scenario II the distillate oil will be delivered at the start of operation to fill the storage tanks. Replenishment after that will be very infrequent. For both Scenarios I and II the day-tanks for oil would be replenished by local barge vessels. In this latter case any waste produced by the local vessels would not represent a significant increase to such waste generated in the territory so is not considered in the inventory. The inventory concerns ocean-going vessels arriving in Hong Kong specifically for the LTPS.

Assuming that these vessels are equipped with slow speed marine diesel engines the sources of MARPOL Annex I wastes (oil/water mixtures) are:

- sludge from on-board processing of fuel and lubricating oils;
- oily water from machinery bilges.

a) Oily sludge

A rule of thumb used to estimate the sludge quantity is:

a 10,000 shaft horse power ship at sea generates 0.25 tonnes per day.

The accumulation rate is pro-rata for increase in horse power. The maximum size holding tank provided on vessels for this sludge is normally 10 tonnes.

Although the LTPS facilities will be designed to berth vessels of up to 200,000 tonne dwt the average over a year will be 90,000 tonne dwt.

The shaft horse power of the 90,000 tonne coal ships is about 20,000 HP, and the average journey time is about 15 days. For Scenario I the number of coal-ship arrivals for the ultimate station is approximately 140 per year. For Scenario II the number is about half that i.e. 70 per year.

Therefore the quantities per year from coal ships for the Scenarios I and II are 1050 tonnes per year and 525 tonnes per year respectively.

For limestone ships the corresponding numbers are:

ship tonnage - average delivery size	- 15,000 dwt
shaft horse power	- 6,000 HP
average voyage length	- 6 days
no. of ship arrivals for ultimate station (8 units)	
- Scenario I (8 coal units)	- 40 per year
- Scenario II (4 coal units)	- 20 per year

Sludge production	
- Scenario I	- 40 tonnes per year
- Scenario II	- 20 tonnes per year

b) Oily bilge water

The IMO (International Maritime Organisation - a United Nations Agency) indicates[1] that for ocean-going vessels the oily bilge water accumulation is about 1-15 tonnes per day - a very wide range. For large, well-maintained vessels the accumulation rate is about 5.

It should be noted that this guidance publication is now 14 years old and in that time practises have changed. Since waste disposal has become an issue many ships have been equipped with oil/water separators (on board) and the oil-portion retained is not more than 10% of their total bilge quantity.

For estimation purposes the following are assumed.

Scenario I

Coal ships

accumulation rate	- 5 tonnes/day
voyage length	- 15 days
bilge quantity per ship arrival	- 75 tonnes
no. of ship arrivals for ultimate station (8 coal units)	- 140 per year
bilge water arising	- 10,500 tonnes per year
oily portion (approx)	- 1,000 tonnes per year

Limestone ships

accumulation rate	- 5 tonnes/day
voyage length	- 6 days
bilge quantity per ship arrival	- 30 tonnes
no. of ship arrivals for ultimate station (8 coal units)	- 20 per year
bilge water arising	- 600 tonnes per year
oily portion	- 60 tonnes per year

1 Guidelines on the Provision of Adequate Reception Facilities in Ports Part 1 (Oily Wastes) December 1976

Scenario II waste generation rates will be about half those of Scenario I as the number of ship arrivals will be approximately half.

No MARPOL Annex II wastes (Residues and Mixtures Containing Noxious Liquid Substances) will be produced from ships serving the LTPS.

The estimated MARPOL Annex I inventory is summarised in Table V3/6.2(h).

Table V3/6.2(h)
Estimated MARPOL Annex I Wastes Inventory for the Ultimate LTPS

	from coal ships	from limestone ships
Scenario I'(all coal)		
- oily sludge (tonnes per year)	1,050	30
- bilge water oily portion (tonnes per year)	1,000	60
Scenario II (gas and coal)		
- oily sludge (tonnes per year)	525	15
- oily bilge water (tonnes per year)	1,525	30

The numbers in Table V3/6.2(i) refer to the ultimate station. Following the notional development programme the build-up of wastes would be as follows :

Table V3/6.2(i) Phased Build up of MARPOL Annex I Wastes

Year	1999	2002	2006	2010
Scenario I	540	1075	1600	2150
Scenario II	270	540	1800	1100
numbers in tonnes per year (rounded up)				

6.3 Waste Management Proposals

6.3.1 (i) Ash - Scenario I

Furnace Bottom Ash (FBA)

Furnace bottom ash is a valuable resource and is utilised by the building and civil engineering markets worldwide.

The China Light and Power Company Ltd currently produce about 100,000 tonnes/yr of FBA which is all sold for use in the manufacture of concrete blocks. Production of FBA will rise by a further 175,000 tonnes/yr when the LTPS at Black Point is fully operational. It has been determined that this entire production can be commercially utilised by the Hong Kong building and civil engineering markets. Aside from the manufacture of lightweight concrete blocks, FBA has been used as a drainage layer and for sub-base construction in road works.

In the event that utilisation in this manner were not possible and export or other markets could not be found, the likely disposal route would be with the PFA at the existing lagoons at Tsang Tsui.

Pulverised Fuel Ash (PFA)

Pulverised fuel ash (PFA) produced territory wide accounts for about 15% of the total wastes produced in Hong Kong and in recent years there has been pressure for increasing utilization by commercial concerns. In Hong Kong its utilization is currently limited to certain Government sponsored operations, but various recent investigations indicate that there is considerable potential for further utilisation, pending a review by Government. However, the situation in most developed nations and that likely to pertain in Hong Kong, is that whilst efforts are made to utilize PFA from coal-fired power stations, a proportion still requires disposal.

The overall strategy practised by CLP is to establish secure disposal facilities for each power station on a continuous basis. However commercial outlets or beneficial uses are sought wherever and whenever possible to reduce the load requiring disposal. This policy reduces operating costs (those associated with disposal) and hence has the potential to influence the cost of electricity to the consumer.

Studies conducted by CLP and others on the utilization and disposal of PFA have been reviewed. Whilst it was not possible to formulate a detailed picture of the quantities of PFA that could be disposed of by particular routes it was concluded that environmentally acceptable end uses are available. These are :

o **PFA as a Reclamation Fill**

Three large projects conducted in Hong Kong have successfully used PFA as a reclamation fill; the Eastern Harbour Crossing, the Marsh Reclamation at Ha Tsuen and the Fish Ponds at Hung Shui Kiu. At present use of PFA in reclamations is restricted to above sea level sections.

A large number of reclamation projects are currently under consideration within Hong Kong; the co-ordination, review and collation of information on sources of fill for these prospective major public works is being carried out by Government's Fill Management Committee within GCO (CESD). Discussion with the FMC indicates that use of PFA in these projects will prove attractive given that the cost is competitive with alternative fill materials. The terms of reference of the Fill Management Committee include the coordination of the supply and demand of PFA with the aim of maximising its use as fill.

Figure V3/6.3(a) indicates the required total volume of fill for planned reclamations running beyond 1996 for projects, together with the likely volume required on an annual basis after 1996. This information is presented with the estimated production of PFA territory wide. It clearly indicates that commercial utilization is possible for the entire production of PFA until at least 2003.

Sources of marine fill have been identified for these reclamations, the largest being Tsing Yi - Green Island, Stanley South and the Brothers/N. Lantau. The estimated unit rates of utilizing these sources of fill range from 25-40 HK$/m^3. Calculations indicate that PFA could be utilised as a fill material costing on average 30 HK$/m^3. This demonstrates the competitive economic nature of PFA as a fill material.

Some concerns have been raised regarding radon emissions from PFA reclamations to inhabitants of buildings constructed thereon. However these levels, appear to be similar to those associated with local rock formations. Further building techniques in Hong Kong are generally of a type not associated with concerns over radon, i.e. structures are most often tall concrete buildings without ground level underfloor cavities where radon has been found to accumulate.

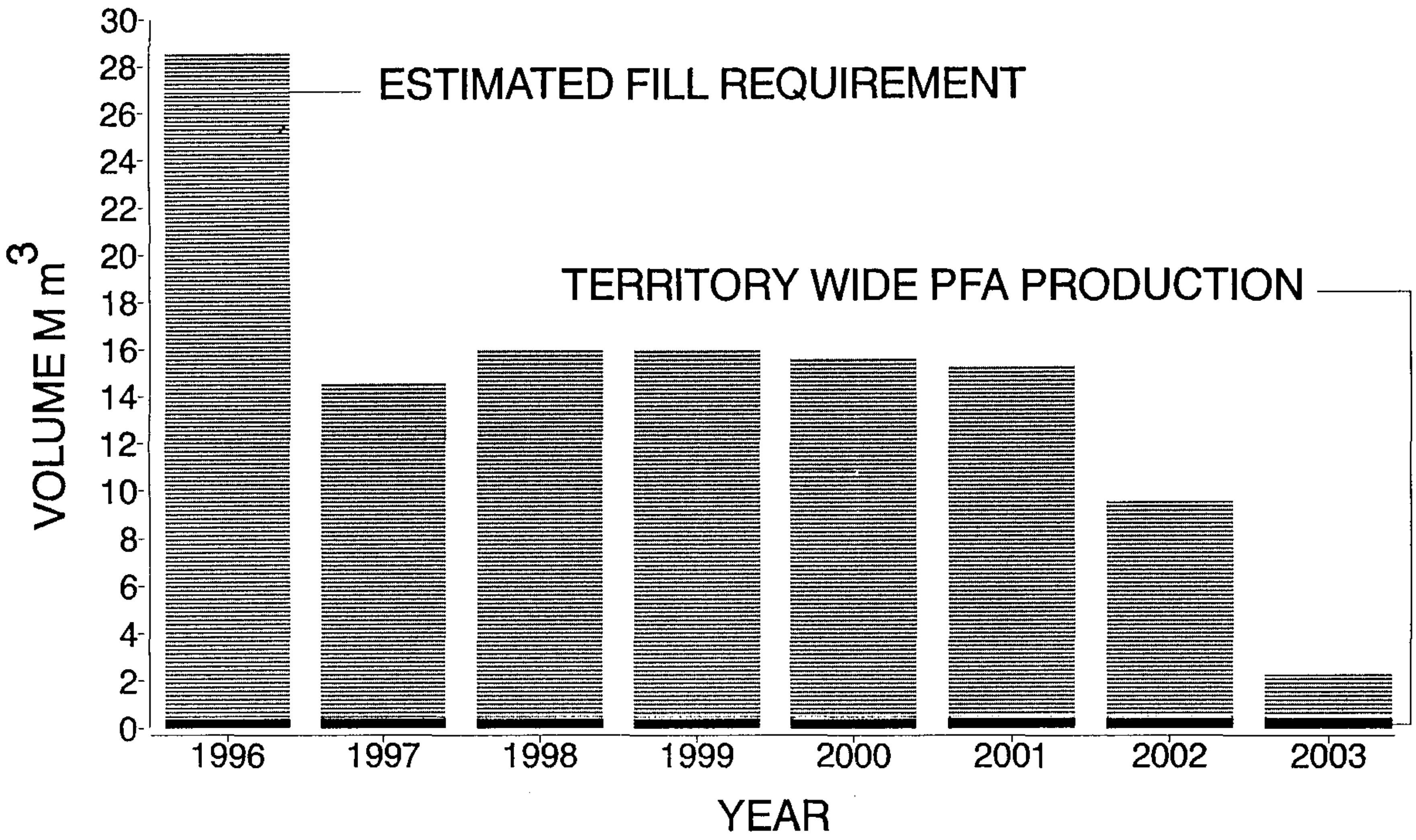
o **PFA as a Reclamation Fill for the Proposed LTPS**

Two possibilities are currently under consideration; utilization of existing reserves held in CLP's lagoons at Tsang Tsui and the utilization of production arising from the phased start-up of the LTPS units to progressively reclaim the site. The coal stockyard area is well suited for this purpose, with approximately 50% of the total stockyard area required when the first unit is commissioned in 1996, leaving some 50% of reclamation to be provided by its own PFA. CPPS currently disposes of approximately 1,000 tonnes of PFA per day at the Tsang Tsui Lagoons. It is estimated that by early 1992 when reclamation of the LTPS site is proposed to commence some 2 million tonnes of PFA will be held in the lagoons.

It is feasible to consider utilising the recoverable portion of this stockpile of PFA in the reclamation of the LTPS site (as for any reclamation within the territory). Whether the material should be recovered for the commencement of site formation works in 1992, or not until in 1996 for construction of the coal stockyard (see below) requires consideration of site specific aspects, such as comparative costs of alternative fill materials etc. and environmental considerations of PFA leachate, (see Section V3/5.2) and alternative marketing options.

The transportation and economics of a scheme to recover the PFA from Tsang Tsui would most likely consist of slurrying the PFA, pumping it from lagoons to hopper barges and pumping the decantrate back into the lagoon where it would then be discharged via the existing route to the CPPS outfall. Offloading at Black Point would be a combination of bottom dumping and ship to shore pumping of the re-slurried PFA inside a containment wall. The economics of the operation have been determined conservatively at HK$30/m^3 as compared to Hk$25-40/m^3 if imported marine dredged sand were used. It is also feasible to use PFA production from the phased start-up of the eight 680 MW units in the reclamation of the LTPS site itself.

By using the PFA in the manner described above, significant benefits could be gained through cheaper reclamation costs and reduced capacity uptake in the storage lagoons at Tsang Tsui. There are also environmental advantages to the use of PFA in reclamations since the existing lagoons could be reused, thus deferring the need to construct additional lagoons. The use of PFA in the reclamation project will require the disposal of surplus rock fill materials generated as part of the site formation process.



Fill requirements after 2003 are unknown.

Figure V3/6.3(a) **Estimated Annual Fill Requirement and Territory Wide PFA Production**

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11th Floor, Hecny Tower
9 Chatham Road,
Tsimshatsui,
Kowloon, HONG KONG
ERL

o **PFA as a General Fill**

As part of the research programme by CLP into PFA utilization, a report[1] was commissioned to address the geotechnical properties of PFA as well as suitable uses in reclamation (see above), dry land disposal site and site formation. The findings for the latter two points are summarised below:

o **PFA in Dry Land Disposal**

Between 1985 and 1986 CLP completed a dry land disposal site at Siu Lang Shui, using some 250,000m^3 of conditioned PFA. The PFA was placed and compacted using conventional earth moving equipment consisting of trucks, a front end loader and 15 tonne vibrating roller. Water was added at site to aid compaction and suppress dust. The final site was over 40m high, with slopes of up to 1 in 1.7. Typically the PFA had an optimum moisture content within the range 22% - 32%, with dry density in the range of 1.2-1.4 tonnes/m^3.

o **PFA in Site Formation**

Site formation contracts at Tuen Mun; TM29, TM33, TM36, and Area 2a have all used PFA fill. In total some 200,000m^3 of conditioned PFA have been placed and compacted, in layers of 500mm using conventional earth moving equipment, to a minimum 95% dry density. It was reported that the degree of compaction achieved using PFA was less variable than that achieved with natural soft fill.

o **PFA in Concrete**

PFA is commonly used in most industrialised countries as a cement replacement in concrete. Research into the use of PFA concrete has been carried out over the last 50 years, while PFA has been used in structural concrete for more than 40 years.

In Hong Kong, the use of PFA in the manufacture of composite cements and in concrete is gaining acceptance, particularly in the public works sector. Over 2Mm^3 of concrete containing PFA have been used in both structural and mass concrete applications, in a wide variety of structures.

Currently PFA is an accepted component of concrete for use in the public road works sector and its use in roadbase and pavement quality concrete has been made mandatory in view of the technical benefits which it provides. However, the Government Housing Authority and the Building Ordinance Office retain some reservations over the use of the PFA in concrete, particularly on the question of quality control, and thus generally prohibit its use in structural applications.

At present PFA is only used on certain types of projects in the Public Works Sector accounting for some 2-5% of the total cement usage; with insignificant usage by the private sector. Therefore of the current 100 Mm^3 of concrete produced each year in Hong Kong less than 100,000 tonnes of PFA is used as cement replacement. To increase utilisation in this area the Government will need to reconsider their position in the light of current experience elsewhere in the world and recent studies completed in Hong Kong.

For the purpose of estimating how much PFA is likely to be taken up by the concrete industry post 1996 it is only possible to estimate the maximum, and minimum limits. It should be possible to forecast the value with more confidence closer to 1996 when industry practices are likely to be more firmly established.

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[1] "The geotechnical properties of PFA" Binnie Cons. Ltd. 1990.

Based upon present usage and a projected minimum growth of 5% per annum between 1990 and 1996 the quantity of PFA as a cement replacement would be some 125,000 tonnes per annum by 1996. The maximum possible PFA usage, based on 25% replacement for the entire annual production of concrete, would be of the order 1.25M tonnes per annum. Utilisation at this maximum rate would take up the entire production of PFA from the LTPS for each year from 1996 - 2001. Post 2001 PFA production from the LTPS would surpass this currently assumed maximum utilisation.

o **Other Applications of PFA**

Alternative uses of PFA have been investigated by CLP[1] and are being pursued where possible. The following alternative uses have been identified:

- reinforced earth walls;
- PFA in chunam (cement/lime stabilised soil);
- mortar and render;
- grouts;
- roadbase and pavement quality concrete;
- roller compacted concrete;
- fill in asphalt;
- lightweight aggregate concrete;
- water treatment;
- chemical waste management;
- export for use abroad;
- interleaving material for refuse tips.

o **PFA Disposal**

Of the three strategies considered in preliminary studies for PFA disposal from the proposed LTPS at Black Point – lagooning, dry land disposal and marine dumping – only lagooning is envisaged as part of the LTPS PFA disposal strategy since current EPD policy prohibits either of the other two options. It is intended that any PFA that cannot be marketed would be slurrified and pumped by pipeline to the adjoining lagoons at Tsang Tsui. Decantrate would be pumped back to Castle Peak Power Station where it would be discharged via the CW outfall in a similar manner to that currently practised. The environmental concerns associated with decantrate disposal are addressed in Section V3/5.2.

The ash lagoons at Tsang Tsui were designed to accommodate in the worst case the entire PFA production from Castle Peak Power Station over a ten year period of operation[1]. Current output of PFA at Castle Peak is about 2,200 tonnes/day of which approximately 1,850 tonnes/day (1989/90) are piped to the lagoons, the remainder being utilized elsewhere. Addition of PFA produced at Black Point will significantly shorten the working lifetime of the lagoons if no substantial additional utilization of PFA takes place. However, PFA produced by the first two units at Black Point (commissioned in 1996 and 1997) could be routed to Tsang Tsui without overburdening the lagoon capacity. This strategy will allow development of further disposal facilities for the post–2000 situation, if anticipated increases in PFA utilization do not come about.

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[1] "Disposal of PFA – Non–Conventional uses of PFA" Scott, Wilson Kirkpatrick and Partners, October 1988.

[1] Castle Peak Power Station – PFA Disposal – Lagoon at Tsang Tsui and Associated Works – Initial Assessment Report – LG Mouchel & Partners (1985).

Development of any additional ash disposal facilities would be the subject of site selection studies and a separate planning application. Initial use of the Tsang Tsui lagoons, which adjoin the proposed LTPS site at Black Point will allow time for the development of marketing strategies and/or alternative disposal facilities.

6.3.1 (ii) Ash - Scenario II

Furnace Bottom Ash (FBA)

Production of FBA by CLP, currently at about 100,000 tonnes/yr, would rise to approximately 200,000 tonnes/yr when the LTPS at Black Point is fully operational. It has been concluded that this entire production can be commercially utilized by the Hong Kong building and civil engineering markets.

Pulverised Fuel Ash (PFA)

The proposed LTPS construction schedule envisages that under Scenario II, the first coal-fired unit will start electricity generation in 2003 producing 196,000 tonnes/yr of PFA. In 2008, when the final coal-fired unit is commissioned PFA production from the LTPS will have risen to almost 786,000 tonnes/yr. The disposal strategies for this PFA will be broadly similar to those proposed for Scenario I above (V3/6.3.1(ii)) and would be based upon a policy of maximising commercial utilization, backed up by adequate lagoon capacity if disposal is required for all or part of the PFA production.

It is proposed that any PFA produced from the first two coal-fired units (commissioned in 2003 and 2004) that cannot be utilized elsewhere would be slurried and pumped to the existing lagoons at Tsang Tsui which would have excess capacity due to the partial utilization of PFA produced at CPPS. In the intervening period between the commissioning of coal-fired units 2 and 3 (2005 - 2007) additional disposal facilities would be sought if the remaining capacity at Tsang Tsui made this necessary. Any such additional facilities required would be the subject of a specific planning application to Government at the appropriate time.

6.3.2 (i) Flue Gas Desulphurisation By-Products - Scenario I

The by-products arising from possible flue gas desulphurisation (FGD) systems for the LTPS at Black Point are detailed in Section V3/6.2(i). Depending upon the FGD system selected, the principal by-products would comprise one or both of the following:

- **gypsum:** commercial and disposal grades;

- **effluent treatment plant sludge:** from a prescrubber or chloride purge stream.

Proposals for the management of these by-products are discussed below:

Gypsum

It has been estimated that a wet limestone/gypsum FGD system fitted to all eight units of the proposed LTPS would produce approximately 600,000 tonnes/yr of commercial grade gypsum and about 70,000 tonnes/yr of sub-specification disposal grade gypsum (based on a annual coal burn of 12.5 million tonnes and coal containing 1% sulphur, high merit order).

The gypsum that would be produced by a limestone/gypsum system is an inert and non-toxic substance. It would be in the form of a fine, white crystalline powder or, alternatively, in pelletised form. Commercial grades would consist of about 95% calcium sulphate dihydrate when calculated on a moisture free basis. Moisture content would be either 4% or 10% by weight, with 100–200 ppm chloride. Disposal grade would on average, contain only about 52% calcium sulphate dihydrate with larger quantities of calcium carbonate and inerts than the commercial grade. Both commercial and disposal grade gypsum contain trace quantities of toxic metals. Management options are marketing for commercial/beneficial uses or disposal.

Utilization

Commercial uses for large quantities of gypsum are limited to the cement industry and building trade, but other beneficial uses have been identified:

- reclamation fill;
- artificial reef construction.

The potential of each of these management proposals is discussed below.

o **Cement Industry/Building Trade**

In 1989, 126,000 tonnes of gypsum was imported into Hong Kong at a net value of HK$24 million. The principal source countries were Australia (18%) and Thailand (77%), with small amounts imported from USA, Japan and China. The main uses in Hong Kong for gypsum are in the production of cement (approximately 100,000 tonnes) and in the building trade as a finishing material (plaster). Gypsum is also used in the manufacture of plaster boards for use in the building industry. At present in Hong Kong all the plaster board is imported, mainly from the USA. In 1989 the value of plasterboard imported into Hong Kong was HK$34 million.

Commercial utilization by this means would only consume the output of FGD systems fitted to, at most, two units of the LTPS, assuming quality specifications could be met and a local plaster board industry were initiated. A degree of uncertainty would still remain since these sales would be dependent on a continuation of construction at present rates. Bulk export by ship to net importers of gypsum such as Taiwan might be possible, but would have an uncertain future. For example, Japan and West Germany both have large domestic industries using gypsum, but these are rapidly becoming saturated by FGD gypsum due to the effect of regulations requiring SO_2 abatement from utility power plants. It has been determined that long term markets for gypsum product could not be guaranteed.

o **Reclamation Fill**

A potential use for gypsum from the FGD system in reclamations would be in a mix with PFA (and possibly the wastewater treatment plant sludge). Such a scheme has recently been investigated by the Central Electricity Generating Board in the UK for a foreshore reclamation in the Humber Estuary, Humberside[1].

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[1] Source: Flue Gas Desulphurisation Solid Waste Disposal Study – Generic Disposal Option for Limestone/Gypsum Process" Ove Arup for CEGB, August 1987

The use of gypsum/PFA mixtures (sometimes stabilised with lime) in reclamations has the advantage of the formation of a more cementitious material under compaction which is less prone to leachate production. In addition any leachate would be of a higher pH than that from PFA alone and hence contain lower dissolved levels of some species.

Currently the HK Government's policy towards reclamations allows the use of PFA for above water level sections only. Hence, the use of PFA/Gypsum mixes would require detailed study and Government approval. To be of significant use as a disposal strategy for FGD gypsum it is likely that approval for the use of the mix in underwater sections of reclamations would be necessary. The engineering feasibility of PFA/gypsum mix reclamations would depend on the physical and chemical properties of the mix. Table V3/6.3(a) shows the results of tests conducted on the behalf of National Power, UK (formerly part of the CEGB). The important physical and hydraulic properties are bulk density, moisture content and permeability. Shear strength has implications for geotechnical (slope stability) considerations.

The environmental implications of reclamations of this type would centre on the leachate produced from the PFA/gypsum mix and its effects on marine water quality. Table V3/6.3(b) details the composition of leachates from power station solid by-products. Data is derived from a study conducted on a mix made from British PFA (from Drax Power Station) and German gypsum (from Voerde Power Station). These figures are indicative only and for comparison the leachate analysis from CPPS PFA is included (the coals to be burnt at the LTPS will be sourced from the same markets as those burnt at CPPS).

Note that the data presented refer to fresh water. In alkaline seawater (underwater sections) leaching of most metals from both PFA and gypsum would be reduced due to the higher pH of the leaching solution.

Overall the data presented in Tables V3/6.3(a) and (b) show that there are few additional engineering or environmental concerns with the PFA/Gypsum mix in reclamations than with PFA alone. However, the available data show such mixtures could make some additional (over that of PFA alone) contribution to background concentrations in the immediate vicinity of a reclamation site (these are indicated by an "*") :

	PFA/gypsum 1:1 mix	PFA/gypsum/sludge 1:1 with 3% sludge
Fluoride		*
Mercury		*
COD (Chemical Oxygen Demand)	*	*

Table V3/6.3(a)
Summary of Physical and Hydraulic Properties; PFA, Gypsum PFA, Gypsum Mix and PFA/Gypsum/Sludge Mix

Property	Drax PFA	Voerde Gypsum	Drax PFA and FGD Gypsum in 1:1 mix	Drax PFA and FGD-Gypsum and Sludge in 1:1 mix with 3% Sludge
Grading:				
D50 size (mm)	0.017	0.034	0.028	0.028
Uniformity Coefficient	3.3	1.7	3.0	3.0
Moisture Content:				
As Received (%)	minimal	8–10	4–6	4–6
Conditioned (%)	10	n.a.	10	10
Field Capacity (%)	23	n.a.	22	22
Absorption Capacity (mm)	200	n.a.	170	170
Optimum for Compaction %		15–20	18–20	18–20
Dry Bulk Density (kg/m^3):				
10% M.C. BS Standard Comp	1560	n.a.	1480	n.a.
15% M.C. BS Standard Comp	1600	1400	1500	1540
Permeability (m/s):	4.3×10^{-8}	1×10^{-6}	2.1×10^{-7}	n.a.
Shear Strength, 90 days:				
Cohesion, (kN/m^2)	115	n.a.	35	n.a.
Friction angle (deg)	39	n.a.	36.5	n.a.

Source: "Offsite Disposal of Ash and Gypsum, Drax Power Station" by L G Mouchel & Partners for National Power, May 1990.

Note: n.a. – not available.

Table V3/6.3(b)
Composition of Leachates from Power Station By-Products (mg/l except pH)

Parameter	Drax PFA	CPPS PFA	Voerde Gypsum	Voerde Sludge	PFA/Gypsum Mix
pH	4.7	7.1	4.6	5.4	6.6
TDS	1080	-	2500	7450	2830
Alkalinity	20	-	105	2100	355
COD	<20	-	470	4300	420
Calcium	160	-	610	1000	700
Magnesium	32	-	2.3	500	16
Sodium	48	18	2.3	25	29
Chloride	0.8	0.2	1.7	156	0.5
Fluoride	3.8	-	5.0	20	1.9
Sulphite	<5	-	<5	<5	<5
Sulphate	732	150	1430	1790	1400
Silicon	6.3	-	6.2	-	3.1
Iron	0.83	-	<0.03	0.03	<0.03
Aluminium	7.7	-	6.9	65	<0.2
Titanium	<1.0	-	<1.0	1.0	<1.0
Boron	2.9	1.6	<0.3	6.3	1.5
Chromium	-	0.01	-	-	-
Copper	1.4	-	<0.03	0.08	0.03
Cadmium	-	nd	-	-	-
Arsenic	0.01	nd	0.01	0.02	0.02
Mercury	0.0004	-	0.008	0.001	0.004
Molybdenum	0.2	0.3	0.1	<0.1	1.0
Lead	<0.03	nd	0.03	<0.03	<0.03
Selenium	-	nd	-	-	-
Total Inorganic Phosphate	<0.03	-	0.03	<0.03	<0.03
Nitrate (NO_3-N)	<0.1	-	0.1	2.2	<0.1

Source: "Flue Gas Desulphurisation Solid Waste Disposal Study - Generic Disposal Option for Limestone/Gypsum Process" Ove Arup for CEGB, August 1987

Note: nd - none detected

Toxic metals will have a lower solubility in seawater than in fresh water due to the alkaline pH of the former.

Section V3/6.3.1(i) identified that utilisation of the entire territory wide PFA production as fill was possible up to at least 2003, according to available data on proposed reclamations. These data also indicate that the entire production of PFA and gypsum (and sludge) from the proposed LTPS could be utilised in this way if approval were given by Government.

o **Artificial Reef Construction**

The idea of utilising power station wastes for fisheries enhancement via ocean reef construction has been studied in the United States, Japan, Bermuda and the United Kingdom over the past decade. However, no such reefs have been constructed on a commercial basis as yet.

In 1980, a project sponsored by the Marine Sciences Research Centre of Stony Brook University, New York built a 500 ton reef in the Atlantic from blocks comprising FGD stabilised sludge and PFA. It was intended to monitor the reef for several years to establish the degree of development of biological communities and assess environmental impacts which might occur. However, the project failed due to poor laying of the blocks which became scattered on the seabed. However, it was established that the blocks were stable in seawater and little leaching of heavy metals occurs, whilst biological overgrowth rapidly covered the blocks.

Artificial reefs are at present being investigated at Southampton University, in the United Kingdom. Initial studies have been undertaken with test blocks of different mixtures of cement, PFA, gypsum and FGD wastewater sludge to ascertain the chemical stability of the material in a marine environment. A reef was constructed in June 1989 in Poole Bay and comprises 50 tonnes of blocks in approximately 10m of water. To date the results have been promising with high colonisation of the reef by fish, crustaceans, algae etc with no appreciable bioaccumulation of contaminants.

Whilst not likely to be a feasible utilisation of FGD by-products until such time as it has been confirmed that no adverse environmental impacts are associated with the reefs, further study may lead to this strategy being proven viable in later years of LTPS development. Its potential benefit as a mitigation measure for impacts on marine ecology is identified in Section V3/8.3.

Disposal

Several disposal routes for FGD gypsum have been investigated in preliminary and later studies for the LTPS, principally these are:

- landfill/surface disposal (alone or with PFA and/or sludge);
- marine dumping;
- lagooning (alone or with PFA and/or sludge);
- dissolution in seawater and discharge via cooling water outfall.

These are discussed below.

o **Landfilling**

Landfilling either alone or with PFA and/or sludge is not a viable strategy for disposal. Discussions with the Environmental Protection Department (EPD) have confirmed that disposal capacity is very limited in Hong Kong and the space in planned large landfill sites (SENT, NENT & WENT) is all reserved for domestic refuse.

o **Marine Dumping**

Dumping of gypsum at one or more of three gazetted Marine Dump Sites off Hong Kong is similarly not a viable option. The capacities of the sites in question are insufficient for the wastes already likely to require disposal. The Marine Dump Sites are being reserved mainly for marine muds but with the limitation that significantly contaminated material cannot go there. Also there is a strong international trend away from dumping waste in the marine environment.

o **Lagooning**

Lagooning of the gypsum by-product of an FGD system could be accomplished in a similar manner to that proposed for PFA (Section V3/6.3.1(i)) via slurrification and pumping by pipeline to the existing lagoons at Tsang Tsui. Gypsum (or a gypsum/sludge mix) could be co-disposed with the PFA thereby forming a more cementitious material less prone to leachate production (see Marketing - Gypsum as Reclamation Fill above), but with the drawback of `contaminating' the potentially marketable PFA product. Alternatively the gypsum (or gypsum/sludge mix) could be placed in separate areas of the lagoon.

With either separate or co-disposal options the decantrate would be pumped back to Castle Peak Power Station where it would be discharged in conjunction with the seawater cooling via the CW outfall in a similar manner to that currently practised.

The existing lagoons at Tsang Tsui have capacity to take PFA and gypsum produced from the first two units of the LTPS, but this would significantly shorten the working lifetime of the lagoons if no substantial additional utilisation of power station by-products takes place. It is therefore intended that the existing lagoons act as a holding facility, until the post-2000 situation becomes clearer. Development plans for any additional lagoons required would be in place by this time and have been the subject of specific site selection and environmental studies together with a separate planning application.

Environmental considerations would be similar to those discussed for the use of gypsum in reclamations and centre on the potential for leachate to enter the marine environment and the resulting effects on marine life. Table V3/6.3(b) showed that the likely leachate from gypsum and a PFA/gypsum mix contains much higher concentrations of calcium and sulphate than from PFA alone (these two species are the main constituents of gypsum and are also major ionic species in seawater and hence do not pose a problem). It has much lower concentrations of some metals such as iron, aluminium and copper, but others, notably mercury and molybdenum, are higher. However, the effects of the decantrate on the marine environment around the existing lagoons is not likely to be of concern due to the presence of the low permeability liner designed to retain the leachate inside the lagoon.

Monitoring of boreholes in the vicinity of Tsang Tsui have shown no increases in metal concentrations in the groundwater and periodic tests[1], which examined metal concentrations both inside and outside the lagoons, showed that trace metals have been retained behind the containment liner and that metal concentration both inside and outside the lagoon were below the limiting values recommended in the recently superceeded Interim Effluent Guidelines.

o **Dissolution of Gypsum in Seawater Cooling**

A further disposal option for gypsum is to dissolve it in seawater and effect discharge via the CW outfall. This strategy has the advantage of negating the need to utilise or dispose to land large volumes of by-product, and essentially mimics the seawater based FGD options. However this strategy has not been tried commercially and will require further investigation to ensure adequate rates of gypsum dissolution. Calcium and sulphate are major aqueous constituents of seawater and hence environmental concerns centre on the loads of trace metals that would be discharged with the seawater. This issue is addressed in Section V3/5 and Annex V3/D.

Wastewater Treatment Sludge

As described in Section V3/6.2 it is possible that regardless of which FGD system is selected, quantities of waste effluent treatment sludge could be produced. For FGD systems using a prescrubber it has been estimated that each 680MW unit would produce up to 8,000 tonnes/year of sludge if waste water undergoes treatment (depending on plant design and ash loading).

The physical nature of these sludges depends on the degree of dewatering performed, which may be designed to suit the method of disposal. In its dewatered form a typical sludge would have a free water content of about 25% and a dry cake-like form.

The concentrations of the various metals in a typical sludge were given in Table V3/6.2(c). Concentrations of trace metals are all of the order of 0.1% or less by weight, with particularly environmentally sensitive metals cadmium and mercury being less than 0.01%. This analysis of a wastewater treatment sludge sample indicates that the major constituents are calcium, sulphate, magnesium, sodium and chloride. Major metal species are at similar concentrations to those found in PFA, but levels of the volatile elements fluoride and mercury are higher in the sludge sample. PFA has higher levels of arsenic, boron and copper than the sludge. Likely trace metals in any sludge produced at the LTPS are indicated in Annex V3/D.

In leachate tests (Table V3/6.3(b)) similarities are shown with both gypsum and PFA, with calcium and sulphate being the most soluble species. The toxic metal component appears to be less soluble. However, the chemical oxygen demand (COD) is high (in excess of four times the level given in the superceded Interim Effluent Guidelines) and treatment would be required before discharge of any leachate to a watercourse.

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[1] "Trace Metals Monitoring of Seawater Inside Tsang Tsui Ash Lagoons" CLP Scientific and Technical Services Department March 1989

As with gypsum, protection of marine and aquatic water quality would be the prime consideration in the determination of the optimum disposal route. The range of disposal options is also dependent on the management options selected for PFA and, in the case of a limestone/gypsum FGD system, gypsum. The alternatives for disposal are:

- dilution with PFA, gypsum or PFA/gypsum mix and co-disposal/utilisation;
- separate disposal;
- recirculation and removal with PFA.

Dilution options are discussed in Section V3/6.3.2(i) and the remaining options are addressed below.

Separate Disposal

An assessment of the sludge in relation to UK Special Waste Regulations (1981) was undertaken by the CEGB[1] and showed that concentrations of hazardous contaminants are typically an order of magnitude lower than would be required for the sludge to be classified as a Special Waste. Hence, it is likely that the sludge could be disposed of in a controlled landfill site, two options are available:

- dewatering and disposal of "dry" sludge at a controlled waste disposal site;
- encapsulation of the dewatered sludge in a cementitious matrix (for example, mixed with PFA and lime), followed by disposal at a controlled waste disposal site. (Encapsulation has the benefit of virtually eliminating leachate production.)

Whilst aware that landfill capacity in the territory is not sufficient to take large volumes of power station waste, the relatively small volumes of sludge (in comparison to PFA and gypsum) would appear to be compatible with land based disposal.

Recirculation

Recirculation of the sludge constituents back to the power station units and removal with the PFA in the electrostatic precipitator has the advantage of reducing the release to the environment of trace metals contained in the sludge and also avoids entirely issues relating to the transport and disposal of the sludge. Two methods of recirculation are available.

o **Recycling of the sludge to the unit furnace**: This method has successfully been carried out in the Netherlands where sludge is injected into the furnace with the coal. Initial concerns expressed at the possible revolatisation of the contaminants proved groundless.

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[1] "Drax Power Station - Proposed Flue Gas Desulphurisation Plant - Environmental Statement" CEGB, January 1988

- o **Mitsubishi Wastewater Evaporation System (WES)**[1]: This system has been successfully used in Japan and the manufacturers claim superior economics over traditional wastewater treatment. Wastewater from the FGD system is first neutralised and then sprayed under pressure in the flue gas duct to vaporise the wastewater. Impurities in suspension and dissolved in the wastewater are dried to solids by the heat of the flue gases and then removed with the PFA in the ESP. This system removes both the need to dispose of a solid sludge and wastewater stream.

However neither of thes systems have been widely proven to be commercially viable.

6.3.2 (ii) Flue Gas Desulphurisation By-Products - Scenario II

The by-products arising from possible FGD systems for the proposed LTPS were detailed in Section V3/6.2.2(ii). Management strategies for the gypsum and waste water treatment plant sludge will be as described in Section V3/6.3.2(i) but in accordance with the proposed scheduling for Scenario II.

6.3.3 (i) Summary - By-Product Management Strategy - Scenario I

The preceding pages have discussed proposed and possible management strategies for large volume waste products arising from the proposed LTPS at Black Point. The broad outline of management strategies are outlined below.

Furnace Bottom Ash

It has been determined that the entire output of the FBA from the LTPS can be commercially utilised by the Hong Kong building and civil engineering markets. In the unlikely event that this is not possible the preferred disposal route would be with the PFA at the existing lagoons at Tsang Tsui.

Pulverised Fuel Ash

The Overall strategy for the management of PFA arisings from the LTPS is to establish secure disposal facilities on a continuous basis whilst commercial outlets or beneficial uses are sought wherever and whenever possible. The management options are summarised as follows.

- o Disposal of the output from the first two coal-fired units could be accommodated at the existing lagoons at Tsang Tsui, up to at least the year 2000. In the event that marketing efforts fail to secure utilisation for significant quantities of PFA permission will be sought at the appropriate time for the construction of further lagoons.

- o Marketing of PFA will be conducted on a continuous basis. Significant options for utilisation are:

  - the use of PFA as a reclamation fill in planned reclamations - the entire territory wide PFA production predicted could be utilised in this way (up to at least 2003) if Government approval were given for use in underwater sections of reclamations;

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[1] "Technical Information - Mitsubishi Wet Flue Gas Desulphurisation System" Mitisubishi Heavy Industries, Ltd, May 1988

- the use of PFA as a fill at the proposed LTPS for reclamation of the proposed coal-stock yard area either via the utilisation of existing stocks at Tsang Tsui and/or the direct use of output from the proposed LTPS at Black Point and that from the Castle Peak Power Stations;

- PFA content in concrete could be substantially increased (from less than 5% to about 25%) in line with practice in many other developed countries if approval from Government was given, this could account for the entire PFA production from the LTPS for each year from 1996-2001.

Flue Gas Desulphurisation By-Products

It has not yet been decided which FGD system will be fitted at the proposed LTPS, but substantial quantities of gypsum and possibly wastewater treatment sludge may arise. Management strategies are therefore less clear than those for PFA, and it is likely that further consideration by Government will be required for the position to be clarified.

o Gypsum would be produced in the event of a limestone/gypsum FGD system being adopted. The Initial Assessment leaves the following potentially viable management options:

  - use in the Hong Kong cement industry and building trade could only account for the gypsum output of at most two 680Mw units at the proposed LTPS and further, quantities of disposal grade gypsum would also require management;

  - use as a reclamation fill has significant potential, but only in combination with PFA, (and possibly wastewater treatment sludge and/or lime) in underwater sections of reclamations - Government approval would be required.

  - the potentially viable disposal options would be lagooning with the PFA (subject to the same constraints as PFA lagooning, see section above) or dissolution in the seawater used for cooling and subsequent discharge via the cooling water outfall (see Section V3/5.2);

o Wastewater treatment sludge might be produced regardless of which FGD system is selected. Management options considered potentially viable are:

  - dilution with PFA, gypsum or PFA/gypsum mix and codisposal/utilisation which would require Government approval;

  - separate disposal in dewatered or encapsulated form at a controlled disposal site;

  - recirculation to the power plant and removal with the PFA which whilst avoiding potential environmental concerns requires an engineering feasibility study.

6.3.3 (ii) Summary - By-Product Management Strategy - Senario II

Management strategies for Scenario II are essentially similar to those for Scenario I summarised above, except that overall quantities of by-products will be lower and the timing later due to the reduced number of coal-fired units and alternative construction schedule. Scenario I represents the worst case and arisings from Scenario II will have similar or reduced environmental concerns associated with their management.

6.3.4 Additional Information

Notwithstanding the above, the consultants are aware of the EPD's concerns regarding the appropriate disposal of the PFA and gypsum arisings from the LTPS; these will be addressed within the Solid Byproducts Key Issue Report.

6.3.5 Miscellaneous Wastes, Tank Bottom Sludges and MARPOL Waste

With the opening of the Chemical Waste Treatment Centre (CWTC) on Tsing Yi Island, Hong Kong will have a privately-operated plant and waste collection service specifically for chemical wastes generated by industry and commercial enterprises.

The CWTC will also encompass collection and treatment of MARPOL Annex I and II wastes and will therefore meet Hong Kong's Treaty obligation under the UN MARPOL Convention.

The Hong Kong Government committed to the CWTC in November 1990 by accepting a tender from the private sector for the design, construction and operation of the facility. It is contracted to be fully operational by the beginning of 1993.

Tank bottom sludges would be containerised and conveyed to the CWTC by road or barge. MARPOL Annex I waste would be transferred from the ocean-going vessel at its anchorage or berth to a DSL barge operated by the CWTC contractor. The miscellaneous wastes would be disposed of as indicated in Table V3/6.2(g).

The DSL contains 3 tanks one of 500 tonnes capacity and two of 200 tonne each. The CWTC has two storage tanks for MARPOL Annex I waste each of 2800 tonnes capacity.

The MARPOL waste from the ultimate LTPS can be readily handled by the CWTC which has an annual treatment rate of about 10 times this storage capacity.

The design concept of the CWTC is that it is for 100% of the 1987 arisings of chemical waste in Hong Kong and that it must adapt to changes in arisings over time. It is recognised that the proposed Port Developments will significantly increase shipping in Hong Kong and with it, MARPOL wastes. Increases to the MARPOL reception and treatment elements of the CWTC will be required (or additional facilties provided elsewhere) to meet the increased demand.

Within the time span of Phase 1 of the LTPS there may be a second chemical waste management facility. This is the Chemical Waste Bulking & Treatment Facility (CWBTF) that EPD are proposing to establish on Area 38 Tuen Mun, adjacent to the proposed Steel Works at the far western end of Area 38. The CWBTF would not include an incineration plant but would have physical/chemical treatments including possible oil/water separation. This facility is in the planning stage and EPD anticipate it becoming operational in 1995.

As the CWTC will be operational before any chemical wastes are produced by the LTPS and the CWTC is specifically designed to deal with the types of waste discussed above, no problems are envisaged in adequately dealing with these wastes.

It is possible that from time to time non-routine chemical wastes may arise, such as spoiled regenerants chemicals from the demineralisation plant or spoiled boiler feed water conditioning chemicals. These will also be dealt with at the CWTC or CWBTF as necessary.

7. TRAFFIC

7.1 Introduction

Operations of the LTPS at Black Point will generate 100–200 trips per shift change and a total of 300 trips throughout the normal business traffic day. Such traffic will access the station from Tuen Mun along the Southern Access–Lung Mun Road and will increase the anticipated traffic load at major junctions, entrances, and turnings. The full LTPS workforce will number 1400 and will arrive at site either via the Southern Access Road. Traffic counts in 1989 recorded Average Annual Daily Trips of almost 11,000 vehicles on Lung Mun Road within Tuen Mun.

During the summer, wind, rain, and impaired visibility may occur for more than half the days and often during the morning shift changes, significantly reducing roadway capacities. At the same time high southerly winds, rain, and swells may interfere with ferry transport through the Urmston Road channel and passing the jetty, approaching bulk coal vessels, and berthed vessels at the LTPS area.

Computerised numerical analysis has not been conducted for assessing effects of LTPS operations traffic. Preliminary review indicated that the volume of new traffic is insufficient to warrant intensive computerised evaluation. Periodically the Transport Department shall conduct traffic counts and conduct regional traffic assessments for the Tuen Mun New Town area. Such assessments will be important to final designs and scheduling of new road improvements which have been planned.

7.2 Potential Sources of Operations Impact

7.2.1 Introduction

Operational road traffic will connect with the public road system by means of entry gates on the frontage road, connecting with the Southern Access Road at Lung Kwu Sheung Tan. Traffic generated by LTPS operations will approach from the LTPS and depart to the southeast along the Southern Access Road–Lung Mun Road to Tuen Mun. Current road traffic for CPPS is about 300 roundtrips per day (see Table V3/7.2(a)). Because of various efficiencies, the staff of the LTPS will be equal to or less than that of the CPPS and generally would be expected to generate approximately the same traffic load.

Table V3/7.2(a)
Vehicles routinely entering CPPS

Type	Number
Coaches, Buses	
- CLP GEN	62
GPD	16
- Contractor	22
Private Car, Vans	
- CLP Employees	20
- Visitors	50
- CLP vehicles	40
Lorries, Trucks	
- Silo, coal plant	40
- Goods delivery	45
- Rubbish collection	5
Total	**300**

7.2.2 Local Road Traffic

Some traffic will be local and will only travel between LTPS and CPPS and between LTPS and the WENT Landfill. Local CLP traffic load would be expected to be between 20-30 trips per day for normal weekday business coordination between the two CLP facilities. This traffic will interact with through-traffic going to LTPS and to WENT Landfill and will cross north-bound loaded refuse trucks both at the LTPS and CPPS entrances.

The Area 38 Development Study Area 38 proposes road improvements in the form of a four-lane dual carriageway from Lung Mun/Wong Chu intersection to CLP-Castle Peak Power Station CPPS entrances. The Environmental Assessment for the China Cement Co. works at Pillar Point estimated the traffic generation of the site to be 150 truck trips (ROTs) per day (less than 20/hr).

7.2.3 Distant Road Traffic

Distant traffic is that generated by the LTPS operations, travelling through the Lung Mun/Wong Chu and Lung Mun/Wu Shan/Wu King junctions. This traffic will contribute to the existing congested levels along the Lung Mun Road and particularly at the junctions serving transit terminals for light rail and ferry, the adjacent Wu Shan-Wu King estate area and Butterfly Beach.

Traffic related impacts may include an increase in congestion on existing roadways and at major junctions. Increasing congestion will indirectly increase the risk of vehicle accidents and injuries to pedestrians. Increasing traffic levels will also have the potential to generate a secondary effect of intensifying roadway barrier effects such as noise, severance, intimidation upon local residents, increased isolation of residential communities.

7.2.4 Marine Traffic

Marine traffic will increase in stages throughout the life of the station, as new units are completed. The figures presented in this section relate to full development of Scenario I in 2008. Development of Scenario II would involve half the total marine vessel movements predicted for Scenario I, from the date of Phase 2 completion in 2008, onwards.

With an installed capacity of 6000MW the annual coal consumption is estimated to be about 13,000,000 t. If this were all delivered in 200,000 dwt bulk carriers, the number of ship arrivals would be about 65. This is, however, an unrealistic scenario as coal will be delivered in a variety of vessel sizes, depending to some extent on the coal source. For assessment purposes the following ship mix has been assumed:

- 60,000 dwt ships will make 40% of the delivery resulting in 87 ship calls;
- 120,000 dwt ships will make 40% of the delivery resulting in 44 ship calls;
- 200,000 dwt ships will make 20% of the delivery resulting in 13 ship calls;

This gives rise to a total of 144 ship calls per annum.

With regard to the limestone, it is currently anticipated that, if a limestone gypsum FGD system is used, a total of 560,000 tonnes of limestone could be required per annum. Up to twice this volume of gypsum is likely to be exported. It is likely the limestone will be shipped in bulk carriers of up to 60,000 dwt with average vessel sizes being 10,000–20,000 dwt. The number of ship calls resulting from this activity, therefore, will be approximately 40 per annum.

A total of approximately 185 large carriers are likely to be serving the LTPS in 2008, under Scenario I. In 2000, or in 2008 with Scenario II, the number will be approximately half. This will result in an average of 3 deliveries or 6 vessel movements per week.

7.2.5 Concurrent Construction Traffic

During construction of Phase 2 (in either Scenario), a four-year construction schedule could double daily traffic levels and vessel movements to and from Black Point (by either Lung Mun Road or Urmston Road). Such traffic has been generated during the concurrent operations of CPPS-"A" and construction of CPPS-"B" units. As with Phase 1 confinement of bulk materials and workforce transport to marine vessels will ensure impacts remain insignificant.

7.2.6 Scenario II (Gas and Coal) Operations

Differences in road and marine traffic for operations will be significant during the Phase 1 period. In Scenario I, extensive coal, limestone, and ash handling operations would require marine deliveries. Scenario II would not have this requirement. Following construction of Phase 2 in Scenario II, the categories in work force, operating activities, and traffic for both scenarios would be similar, although vessel deliveries in Scenario II will remain one half of those for Scenario I.

7.3 Sensitive Receptors

7.3.1 Introduction

Sensitive traffic receptors consist of the congested streets, junction entrances and turnings and other infrastructure using or served by the same transport facilities (buses, light rail trolleys, and ferries). For the LTPS, the most sensitive receptors are the Lung Mun-Southern Access Road serving the southwestern shoreline of Tuen Mun and the westernmost New Territories and the existing and future intersections and entries to/from this road.

7.3.2 Road Traffic

Intersections allowing right-turns from the north-bound lanes into the villages (generally along the eastside of the road) will prove to be sensitive for both the village-bound traffic and the heavy operating vehicles to and from the landfill and the LTPS; the two planned intersections for Pak Long (Lung Kwu Tan) and Lung Kwu Sheung Tan. Within the nineteen-year construction and operations phase, other junctions will be added to improve service to eventual commercial and industrial developments to the west. The entrance for the LTPS is not considered a "sensitive traffic receptor", since traffic will be much more limited north of Lung Kwu Sheung Tan and all LTPS-bound traffic will have a left turning into the entrance. Departing LTPS traffic may cause some congestion but modes will be similar and south-bound landfill trucks will be empty.

The short 800 m corridor north of CPPS is a critical section of road The narrow corridor is physically limited by the very large uphill slope such that excavations would be required for expansion. Measures are currently required to protect traffic from boulders and debris falls onto the roadway. This narrow corridor occurs at the entrance to the CPPS. This section and the entrances along it are a sensitive receptor since any congestion in this area may be subjected to a higher geotechnical risk. Any geotechnical damage to this corridor would have profound adverse effects upon transportation to the entire area to the north, and any improvements for this corridor will involve higher costs for and congestion during construction.

Since all road traffic travelling to and from the LTPS must pass through Tuen Mun, the Lung Mun Road entrances and intersections along this road are classifiable as sensitive receptors. Several intersections are, or are forecasted to be, congested, especially when considering traffic and modal increases from additional planned developments in Area 38 and the PADS areas between Castle Peak and Black Point. Most developments are for industrial facilities contributing to heavy goods truck movements and requiring an increase in bus services. Local residential traffic will represent minor components and will increase the modal congestion. Major sensitive receptors include: Wong Chu Road (P3), Wu Shan Road, Wu King Road (28A) with the LRT entrance, Pillar Point Landfill Road 46B, entrances to Wu Tip Wan (Butterfly Beach), Areas 38/47 and 40/46, China Cement Works (Area 49) and the Castle Peak Power Station.

7.3.3 Marine Traffic

The Brothers and Ma Wan channels do not appear to warrant assignment as a sensitive traffic receptor, since current and projected future traffic use (even with the Chek Lap Kok development) do not approach the channel's theoretical navigational capabilities identified in the Ma Wan Channel Improvement Study for the classes of vessels forecast to serve the LTPS.

7.4 Statutory Criteria and Requirements

7.4.1 Recommended traffic loads and classifications assume non-congested conditions when the traffic load is less than 1.2 times the Vehicles/Capacity ratio. However, these ratios are generally applied to "typical" urban traffic mixes and do not reflect the impacts of modal mixes where large trucks, tractor-trailer, double-decker buses, and company buses dominate the general traffic loads. Earlier reports indicate that the through-traffic loads will be acceptable but that congestion may occur at junctions. Improvement of junctions and signalling are required. Double dual carriageways are anticipated to be necessary along some sections.

Existing and projected traffic loads attributable to other development projects will cause the junctions and portions of Lung Mun Road to exceed guidelines and to be generally designated as "congested". Any traffic load contribution from the LTPS would be considered significant if traffic planning has not developed acknowledged capacity expansion.

7.4.2 Growth in Background Levels

Realisation of the planned industrial growth will have profound effects upon the transport resources of the far-western shore of the New Territories. Some capacity improvement measures have already been anticipated but no specific design programs have been implemented. This is especially critical for the points either side of the CPPS entrance; the narrow physical corridor will require a massive excavation and transport of fill programme in order for expansion to be carried out. This expansion, would only be required for a major expansion of maritime industrial uses along the Castle Peak to Black Point shoreline.

Transport Department plans include the improvement of Lung Mun-South Access Road as a single-lane dual carriageway from CPPS, double-lane dual carriageway from the west edge of CPPS to the west edge of Area 38, and triple-lane dual carriageway through Area 38 and up to Wong Chu Road. Separated grade intersections will be constructed at several intersections in the residential/LRT areas and a specific points in Area 38; intersections and entrances along the double-lane dual carriageway will be at grade and could be signalised.

Traffic generated from the CPPS has not increased over the basic load of 50 vph and 300 vpd during the weekdays and about 25% of these at the weekends. No growth is forecasted in these loads during the next 20 years. A basic annual 2% growth can be used for conservative estimates, 50 vpd per 10 years. Various plans have forecasted major marine frontage development from Tuen Mun to Black Point. Both maritime and land transportation facilities will be affected by and will be improved to serve these developments.

7.5 Significance of Impacts

7.5.1 Introduction

The western shore of the New Territories will experience substantial growth similar to that seen in numerous "new town" or "new port" developments in other New Territories and Hong Kong areas. This previously planned and approved development sets the background into which the operations of the LTPS fits as one part of the development. Although traffic will increase in the area, these increases will occur with or without the LTPS project.

7.5.2 Road Traffic

Effects of LTPS operations are likely to be very small (<5%) compared to overall planned development. The significance of the potential adverse impacts is very low and these will be further mitigated by planned facilities and procedures for the proper control of both CLP's marine and road traffic for LTPS and CPPS. Current forecasts beyond the year 2000 indicate some unacceptable congestion at major south Tuen Mun intersections. Planned road improvements in the vicinity of Area 38 and eventually in Tuen Mun will provide substantial increased capacity, and improvement of existing constrained road capacity and congested junctions.

LTPS operations will adversely affect and cause interference across the lanes of the Southern Access Roads and the landfill truck traffic. Refuse-loaded trucks on the Southern Access Road will pass at grade and without signals both the CPPS and LTPS entrances.

The morning LTPS commuter buses should not interfere with landfill truck traffic but may contribute to congestion at the CPPS at-grade intersection. Government plans to provide dual carriageways with grade separation at intersections should reduce any interference east of the CPPS entrance. Coordination of CLP operational activities will lessen congestion and interference with the landfill traffic but this will still remain an area of significant impact on transportation until a widened corridor is provided. This corridor and any improvements will depend on future implementation of PADS development between CPPS and Black Point.

Evening traffic and possible interference with loaded trucks may be avoided or reduce by staggering shift changes between 4-7pm and by reduction of individual car usage, for example by limiting onsite parking.

7.5.3 Marine Traffic

Increasing maritime traffic within the Urmston Road-Ma Wan Channel route will require increased controls of maritime movement, similar to those within the major routes in other areas of Hong Kong and New Territories waters. Coal and limestone deliveries amounting to one large vessel movement per day through the Ma Wan-Brothers Channel.

7.5.4 Concurrent Construction

During construction of the Phase 2 units, construction-related traffic (both road and maritime) will involve the use of CLP buses from the Wu King LRT and ferry terminals or by marine barges and ferries. Road deliveries of heavy equipment will be scheduled for nighttime or weekend low traffic periods. Most heavy equipment and materials will be deliveried by barges.

7.6 Mitigation Measures

The LTPS entrance will be located so as to allow maximum exit/entry visibility. All CLP drivers should be trained to give way to loaded north-bound landfill trucks at the entrances and to avoid sharp left-turnings in front of loaded trucks. Entrance approaches and outbound turning lanes will be provided with suitable road surface markings and physical lane separators. Mitigation of transport involves standard easily implemented measures.

7.6.1 LTPS Facilities

CLP could implement the following measures as part of the LTPS standard facilities and operations procedures:

- Staggered shift changes 6–10 am and 3–7pm
- Regular/frequent CLP buses (space available for others)
- CLP buses (inter-station)
- Improved turnings for entrances
  - Stacking/Merge Lanes
  - Road surface markings and Separators
  - Signals
- Off-peak deliveries

7.6.2 Castle Peak Power Station

CLP should coordinate activities, measures, and procedures between the two power stations in order to reduce or minimise their combined effect on the traffic along the southwest shore of the New Territories. These CPPS measures will include those stated above for LTPS.

8. ECOLOGY

8.1 Introduction

The principal concern regarding impacts associated with the operating LTPS on the terrestrial ecosystem is from its atmospheric emission. It is unlikely that noise emanating from the operating plant will have significant adverse effects on the terrestrial ecosystem. It is only when the noise levels are very high or contain impulsive components that birds and mammals are significantly affected.

While the study of construction phase ecological impacts focuses on the Black Point area, the study area for operational phase ecological impacts is much wider due to the dispersion of the stack plumes. The study will cover the terrestrial ecosystem over the whole territory especially the NW New Territories and North Lantau. Although there is not much information regarding the vegetation pattern in Shenzhen and Shekou, it is believed to be very similar to Hong Kong as the climate, soil and development pattern is very similar. As the ecological impact on the terrestrial ecosystems will be related to the dispersion pattern of the stack gases, the assessment of the impacts is based on the preliminary predictions of ground level pollutant concentrations presented in V3/3.

The effect of the LTPS on marine ecological communities is likely to be more direct than for the terrestrial system. Impacts will arise from changes in the hydraulic regime around Black Point and from the effects of the cooling water discharge and other operational effluents. At this stage of the EIA an outline of potential sources of impact can be presented. Final assessment can only be made, however, when the results of water quality and hydraulic modelling are known. Whilst the overall assessment will be based on full development of Scenario I it should be noted that development of Scenario II will involve, initially, a different reclamation shape and that the volume of cooling water discharge will only be approximately two-thirds of that for Scenario I.

8.2 Impacts to the Terrestrial Ecosystem

8.2.1 Introduction

The principal atmospheric pollutants with the potential for effects on the terrestrial ecosystem and on human health are sulphur dioxides, nitrogen oxides, particulates and metals associated with the particulates.

The effects of significant dust and trace metals deposition on the terrestrial vegetation and ecosystem are well documented. When dust and particulates are deposited on the leaf surface of the vegetation, the intensity of light received by the leaves is reduced. The photosynthetic rate of the vegetation is then lowered which retards the growth of the plant and affects biomass production and, consequently, any dependent animals.

If particulates are deposited onto agricultural products the associated metals may enter through consumption into the human body in sufficient amounts, to constitute a risk to human health.

Although the effects of SO_2 and NO_2 on the terrestrial ecosystem are fairly well established in other countries, there is still considerable uncertainty as to the mechanisms which produce observable effects. In general, the main types of impact are:

- direct effects (growth retardation, 'scorching' effects) on vegetation exposed to elevated ambient levels of pollutants, mainly SO_2 and NO_2;

- acidification of waters by deposition of acidic species related to emissions of SO_2 and NO_x;
- acidification (from SO_2 and NO_x emissions) of soils (also resulting in nutrient deficiency);
- indirect effects on vegetation through soil acidification.

8.2.2 Potential Receptors

Studies and research in other countries, especially Europe and North America have indicated that the natural or man-made ecosystems which have sustained damage from SO_2 and NO_2 inputs include inland water bodies (lakes, rivers, ponds and reservoirs), natural vegetation covers and agricultural products. The assessment here will discuss the effects of the stack emissions on each ecosystem and their sensitivities, with emphasis on the general vegetation covers and the sensitive SSSIs.

o **Cultivated fields**

Apart from the Lung Kwu Tan and Sheung Tan, the nearest areas where abundant cultivated fields can be found are in Mai Po, Yuen Long and northern New Territories, generally more than 8 km away. Yuen Long is on the other side of the Castle Peak range which is likely to offer some protection to the low lying arable land there. Considering the great separation distance, the amounts of particulate and their associated trace metals deposited on the crops will be minimal. Thus, it is unlikely that the productivity of the crops will be reduced due to loss of sunlight as a result of dust deposition, or that human health will be affected by consumption of metal-contaminated products. Assessment of the impact of air pollutants from the operating plant will focus on NO_2 and SO_2 which may affect arable land in the mid-and far-field range.

o **Fish Ponds**

As with cultivated fields, the nearest areas where most fish ponds are to be found are in Mai Po, Yuen Long and the northern New Territories. They could potentially be affected by plumes from the LTPS in mid or far-field and the pollutants of main concern are SO_2 and NO_2.

o **Streams and Rivers**

The size of the inland moving water bodies in Hong Kong is generally very small and except for the Shenzhen River, can seldom be classified as 'rivers' when compared with other counties. The largest river is the Shenzhen River along the border with the PRC which drains into the Yuen Long and Sheng Shui lowlands. There are quite a number of surface runoffs in the HK hillsides which become streams during the summer wet season. In general, streams in Hong Kong are well buffered with a natural pH value of about 6[1], except those which are heavily polluted.

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1 Peart, M.R. (1991) in preparation.

o **Natural Vegetation**

Due to the relatively small size and fragmentary nature of vegetation areas, vegetation cover over the whole territory is very difficult to map accurately. The best available information is the vegetation and landuse map of Hong Kong published by the government. The vegetation map of Hong Kong classifies the rural area into woodland, scrubland and grassland, apart from the specialized coastal communities, such as marshland. Of the rural vegetation cover, 70% is either scrubland or grassland, most of which is a fire maintained ecosystem. The high fire frequency in the Hong Kong countryside has confined remnants of primary forest to remote and inaccessible areas. Patches of the remnant forest are scattered over Hong Kong but most are in the western New Territories and north Lantau. Most areas of apparently natural forest are enriched by tree-planting and usually lie within the Country Park areas. Tai Lam (9 km to the east) and Lantau Country Parks (15 km to the south) are the nearest Country Parks with dense woodland.

o **SSSIs**

The characteristics and significance of the SSSIs in NW New Territories are presented in V1/2.3. The Mai Po and Inner Deep Bay SSSIs are considered to be the most important. This is because, in terms of area, Mai Po together with Inner Deep Bay is the largest SSSIs in the territory. While the other SSSIs in the NW New Territories have SSSI status because of the occurrence of one or two particular plant and animal species, the Mai Po marshland contains the largest and most important dwarf mangrove communities in Hong Kong, which is a rare and highly productive ecosystem.

8.2.3 Standards Concerning the Effects of Atmospheric Pollutants on Ecosystems

AQOs for SO_2, NO_2 and particulate levels are mainly set in order to protect human health. It is not believed that concerns regarding the effects of pollutants on the ecosystem were considered in deriving the standards. In other countries, the "Critical Loads" concept is becoming popular when describing the sensitivity of the environment to acid deposition. Critical Load is defined as[2]:

"A quantitative estimate of an exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur according to the present knowledge."

There is no known research, local to Hong Kong, on the critical loads or the vulnerability of native species, communities and ecosystems to acid rain. Information is generally only available for countries in temperate areas. The sensitivity of the local ecosystem to acid rain in general terms can only be extrapolated from recent experience in Europe and North America. Local vegetation is likely to be more vulnerable to acid deposition due to the specific climatic (V1/3.2) and geological conditions of the Territory:

o *Geology and Soils;* the tuffs, lavas and granites which make up the bulk of the geology of Hong Kong are highly weathered, resulting in a low base cation generation rate; the resulting soils are usually Red-Yellow Podsols which are naturally acidic (pH5) and are susceptible to being made more so by the addition of mineral acids via atmospheric deposition.

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2 Agreed by United Nation ECE Working Group on Nitrogen Oxides at its Eigth Session in February 1988.

- *Climate;* Annual rainfall in Hong Kong is above the amount considered to increase sensitivity to acid deposition (1200mm); the pattern of precipitation is highly seasonal with most rain falling in the warmer months, increasing the potential for solute dissolution and leaching effects.

By comparing the Hong Kong situation with information on critical loads which has been proposed for protecting the natural environment in Europe, it is likely that soils in Hong Kong are, in general, quite sensitive to acid deposition. In Europe a critical loading of 20–30 $keqH^+/km^2/yr$ might be applied but this cannot necessarily be applied to Hong Kong. Individual areas are likely to vary significantly depending on the natural vegetation cover, the ecosystem and the landuse pattern of the specific area.

Regarding trace metals, there are no legal binding criteria in Hong Kong against which to assess the significance of deposition rates. A range of indicators from other guidelines has been assembled to assist the assessment and is shown in Table V3/3.6(a).

8.2.4 Significance of impacts

The assessment of the significance of impacts on the ecosystem is based on the preliminary results of the air quality assessment presented in V3/3.

- **Cultivated Fields**

  - Particulates

Although the modelling of stack emissions for Scenario I and II indicates that the resultant particulate concentrations at ground level, for both LTPS and CPPS, is highest at Yuen Long where most arable land is found, the concentration is predicted to be very low (0.3 μg/m) and well within the AQOs (130 $\mu g/m^3$) in the Yuen Long area. In view of such a low level of particulate concentration, the impacts on the productivity of the cultivated crop due to loss of sunlight will be negligible.

  - Trace Metals

Only selenium is predicted to be higher than rural levels but is below urban concentrations. With the exception of selenium the predicted levels of the trace metal concentration are safely below typical rural levels and are much less than urban concentrations. It can be reasonably concluded that deposition rates will not cause any significant uptake of the metals through the soil and into agricultural products. No health impacts will result through this route.

  - Sulphur Dioxides and Nitrogen Oxides

Based on study in other areas regarding the responses of different crop plants to these gases, the range of threshold levels for producing acute crop and other plant damage is very wide. It may lie between 800 $\mu g/m^3$ and 11000 $\mu g/m^3$ for SO_2 and 2000 – 6000 $\mu g/m^3$ (1 hour) for NO_2. The hourly maximum for NO_2 from the combined emission of LTPS and CPPS is currently predicted to be 350–600 $\mu g/m^3$ whereas for SO_2 the level is 80 $\mu g/m^3$. The predicted levels are well below the estimated concentration levels potentially leading to acute damage to crops.

Threshold levels for chronic injury to crops, however, are considered to be much lower. In some cases annual average SO_2 concentrations as low as 20 μg/m^3 were reported (V3/3.7), but these probably take account of any synergistic effects with ambient NO_2. It was concluded that a conservative threshold level which could be applied as a general indicator for Europe would be 20–30 μg/m^3 as an annual average. The annual average SO_2 concentrations for Scenarios I and II are less than 1 μg/m^3 and 4 μg/m^3 respectively which are also within a threshold level range. Thus, we can conclude that there is no evidence to suggest that direct damage would result from the increase in ambient SO_2 and NO_2 from the power station emissions.

The other potential impact resulting from SO_2 and NO_2 emissions is acid deposition onto crops. The principal effect of dry and wet acid deposition is the increase of soil acidity which may lead to nutrient leaching. However, soil management practices in cultivated field either promote acidification in soil to a greater extent than would the atmospheric input or routinely neutralize the acidity generated by artificial fertilizers. Thus, the impacts due to the acid deposition on cultivated fields will be negligible.

o **Streams**

As the emission from the LTPS and CPPS will not increase the ambient particulate and trace metal levels to a significant extent, their consequent deposition onto streams will not lead to a significant increase of the concentration of trace metals and suspended solids in the inland water bodies. No impact is therefore expected.

Regarding acid deposition, streams on Hong Kong hillsides are generally very well buffered with natural level about pH6, although individual streams will show great variation depending on the extent to which they are affected by other pollution sources. It is unlikely that the acidity of streams will be affected by the atmospheric SO_2 and NO_2 and acid deposition.

o **Fish Ponds**

As concluded for streams, the effects of the atmospheric particulates and trace metal emissions from the operating LTPS and CPPS will be minimal.

Although the critical acid loading into the fish ponds is not certain, it is considered that the emission from both power plants will not cause a significant increase in pH. Ponds associated with Mai Po marshes have sulphur-rich muddy sediments and the anaerobic organisms in the mudflats are capable of converting the sulphate in water into reduced sulphide and hence suppress the acidity increase. Only when the ponds dry out during fish harvest, will the acidity of water be elevated significantly. It is therefore considered that as the loading rate from the stack emission is not particularly high, it should not lead to any significant change of the pond water acidity.

o **Natural Vegetation**

– Particulate

The effects of particulate emission on the general rural vegetation cover in Hong Kong will be very similar to those on agricultural field and are unlikely to result in any adverse effect in view of the low ambient particulate level.

- Trace metals

The concern over trace metal contamination on the rural vegetation is not substantiated as, firstly, the increase in ambient trace metals concentration is not significant and secondly, there is no large scale animal grazing activity on New Territories grassland. It is thus concluded that no significant amount of trace metals will be deposited on vegetation and enter into the food chain,

- Sulphur Dioxides and Nitrogen Oxides

When the aerial parts of plants are exposed to high concentrations of SO_2 and NO_2 even for a short period, symptoms of acute injury can appear, caused by the acidic nature of the gases. The sensitivity of the plant to the gaseous pollutants varies greatly with different plant species and plant parts, but, in general, young leaves and seedlings are usually most sensitive. The symptoms first developed are chlorosis (yellow leaves), then abscission (loss of leaves) and stunted growth. As mentioned earlier, study on the response of plants to the gases in other areas indicates that there is a wide range of threshold concentration levels where observable injury for both SO_2 and NO_2 occurs. In most cases, the concentration levels are over 1000 $\mu g/m^3$ which is higher than the predicted hourly maximum levels due to the combined effects of LTPS and CPPS, that is, 400 $\mu g/m^3$ and 80 $\mu g/m^3$ for NO_2 and SO_2 respectively.

Threshold levels for chronic injury to trees are much lower and long-term concentrations likely to cause damage are in the range of 100-500 $\mu g/m^3$ annually. Such a range is much higher than the predicted annual combined maximum from LTPS and CPPS, and is also higher than the stipulated AQO standards. It is thus considered that the impacts of gaseous pollutant on the plants or trees will be minimal.

- Acid Deposition

The modelling results indicate that the maximum total dry deposition rate (sulphate plus nitrate), to the northeast of the site (using Lau Fau Shan climatological data) would be in the order of 20 $keqH^+/km^2/yr$. Across most of the study area, however, the predicted deposition rate is much less than this. Although, as explained in section V3/8.2.3, the critical loading for sensitive Hong Kong soils is possibly about 20-30 $KeqH^+/km^2/yr$, this will vary quite significantly from one area to the next. To the northeast of the site is the Mai Po area and the Yuen Long lowland which has a significant amount of arable land and fish ponds. The likely impacts of the stack emission on the arable land and fish ponds are already presented in the above sections. It is likely that the soil associated with the Yuen Long lowland is similar to Mai Po areas and probably has a higher buffering capacity to acid deposition than the general area. Thus, it is unlikely that there would be significant impacts due to the dry deposition of the LTPS emission. Elsewhere, the predicted dry deposition rates are well below any critical load which might reasonably be proposed and it is most unlikely that any of the impacts described above would occur to any significant degree.

There is also the contribution of wet deposition to take account of, however. At the distances from the source which have been considered, wet deposition from power station emissions would not normally be expected to be a significant contributor to total (dry plus wet) deposition. However, rainfall in Hong Kong is already quite acidic and it is not clear how much of this is due to emissions in the PRC. In the same way it can not be concluded with certainty at this stage that the power station emissions will not affect the acidity of rainfall over the territory due to the nature of the summer – rainfall systems. Neither is it clear to what extent the emissions might affect rainfall acidity at more distant receptors (i.e. in the PRC). At this point it is considered that the final emissions control measures decided upon to mitigate human health impacts are more than likely to satisfy requirements for controlling acid deposition. Nevertheless, this aspect of the assessment will require more detailed evaluation during the KIA, taking account both of the wind-tunnel dispersion modelling results and climatological data from the Royal Observatory.

o **Mai Po Marshes**

Of the SSSIs, Mai Po is most important. It contains the largest number of dwarf mangroves in Hong Kong and is the only area in the territory where large numbers of duck, shore and marsh birds can regularly be seen. Hong Kong is also party to two international conventions relating to the conservation of Mai Po Marshland. These are:-

(a) the 'Ramsar' Convention on Wetlands of International Importance, especially as a Waterfowl Habitat, and

(b) the 'Bonn' Convention on the Conservation of Migratory Species of Wild Animals.

The modelling results predict the maximum dry deposition rate at Deep Bay (northeast of the site) would be in the order of 20 keq/km^2/yr.

The soil of Deep Bay and Mai Po has high levels of sulphide compounds naturally, due to the anaerobic condition in the marshland. The percentage of sulphur in Deep Bay soil varies considerably with the precise location but may exceed 3% of the total dry matter. If the sediments dry out, sulphuric acid is formed from other sulphur compounds. The surface soil is maintained at slightly alkaline level of pH 7-8. It is considered that Mai Po marshes should have higher buffering capacity for change in pH and be less sensitive to the acid deposition than the other areas. The critical loading should be much higher than 20 - 30 keq/km^2/yr that is the estimated critical loading for general ecosystem in Hong Kong and the predicted deposition rate is most unlikely to create significant impacts.

8.3 Marine Ecological Impact

8.3.1 Potential Sources of Impact

Operation of the LTPS at Black Point has the potential to affect the marine ecological community via the following:

- the physical effects of reclamations;
- the thermal effects of cooling water discharge;

- the chemical effects of operational effluents; and
- disturbance.

The way in which these LTPS components may affect the marine environment is outlined in the following sections.

- **Physical Effects of Reclamations**

The LTPS development will result in a change in the form of approximately 2.5 km of existing coastline. During operations, the new coastal form will have a continuing effect in terms of the altered hydraulic regime around Black Point. Tidal behaviour may be altered and the present gradual change from coastal shallows to deep water channel will have been replaced by a steep rock coastline. As a consequence, the marine community structure in the area may change. A change in current speed is likely to have an influence on the marine organisms capable of exploiting the environment.

Permanent physical changes in seafloor and shorelines generate induced physical changes in the ecology of the surrounding marine environment and may cause erosion or burial of the existing biota and alteration of food types and availability for bottom and open water feeders. Biota which can tolerate such variable conditions will displace the existing communities but will generally be less diverse. Estuarine biota in the dredged channels, deep soft sediments, and coarse sand bottoms of Deep Bay generally tolerate rapid physical and chemical changes but are generally less diverse and less productive.

- **Cooling Water Discharge**

The LTPS is anticipated to require approximately $15Mm^3$ of water for cooling daily. It will be discharged at about 10°C–12°C above the intake temperature. The potential for a thermal impact will depend on the volume of water in which the temperature will be increased and the size of the increase. The significance of the temperature rise will depend on the species inhabiting the body of water. Any temperature sensitive species may be replaced by other species, provoking a change in community composition.

The possibility of interactions between the cooling water plume and other discharges planned for the area, such as the NWNT sewer outfall exists.

Prediction of the extent and severity of cooling water effects will form a major output of the hydraulic and water quality modelling exercise currently underway. The effects on the marine ecological community will be assessed and presented as part of the Water Quality Key Issue Report.

Other impacts may result from the operation of the cooling water system, such as entrainment of floating and weakly swimming species in the cooling water intake, leading to impingement on the intake screens, or passage through the system and damage or death.

- **Operational Effluents**

  Effluent from a number of sources within the LTPS will be combined and introduced into the cooling water effluent. Effluents will arise from coal stockyard run-off, treated sewage effluent, ash lagoons etc and are considered in full in V3/5. It is considered that no chemical constituents of seawater will have their concentrations significantly altered by passage through the LTPS. However, the potential for any effects are being actively considered and the behaviour of conservative pollutants will be assessed as part of the water quality modelling exercise. The potential for toxic oil spills is addressed in Section V3/5.10.

- **Disturbance**

  Largely as a result of operation of the sea berth, regular disturbance to marine communities will be produced from a number of sources. Underwater noises, movement of propellers and other submerged equipment and induced currents from equipment and vessels movements will disturb marine organisms. Disturbance by barge and other vessel deliveries will be less frequent and of shorter duration than those during earlier construction stages and are likely to be minor. Maintenance dredging will occur approximately every four years and will destroy any recolonising benthic organisms in the area of the access channel and the turning basin. It may also disturb the use of the the area during spawning periods or may interfere with other marine migrations around Black Point.

8.3.2 Sensitive Receptors

The existing marine community at Black Point was sampled in late January 1991. The results of this survey are summarised in V1/3.8 and presented in detailed in Annex V1/G. Further survey work will be carried out in 1991 in order to obtain a comprehensive understanding of the species composition and productivity of the area. Of particular interest will be the importance or otherwise of the Black Point area as a spawning ground. If this is established, then the significance of any changes in water quality in terms of ecological change is likely to be higher.

The position of Black Point makes it possible that the area is important not only for species at the site. Lying in the transition zone between the estuarine waters of the Pearl and Shenzen Rivers, and the fully marine waters of the South China Sea, it is likely to experience wide daily variations in water chemistry, as a result of tidal movements, together with seasonal variability, chiefly as a result of summer freshwater discharges from the rivers. If the water body surrounding Black Point is a key migration route for certain marine species, the potential for impact will be higher.

No rare fish species have been observed to date in the area but considerable interest attaches to sightings of the Chinese White (Pearl River) Dolphin.

The dolphin appears to represent the northernmost geographical population of the Indo-pacific Hump-backed Dolphin (South Africa to Fujian, PRC). This species and many other riverine and coastal dolphins (including the Finless Porpoise (Neophocaena phocaenoides, also known in the coastal waters of China) are generally restricted to coastal and estuarine waters. The Yangtze River Dolphin (Lipotes) is a different genus from the Dolphin in the LTPS area, but all river, estuarine, and coastal dolphins are amongst the rarest cetaceans in the world and the Yangtze River Dolphin is a fully protected species (First Order, as is the Panda) in China.

During the last three months, the World-Wide Fund for Nature (Hong Kong) has solicited sighting records for the "Chinese White Dolphin" and has received more than 20 records (see Figure V3/8.3(a)). The sightings show a high degree of concentration in the Ma Wan to Black Point area.

Little is known of the dolphin's habitat requirements. Virtually all observations are during the day and under favourable weather conditions and their habits and requirements during storms, high river flows, and at night are unknown. One report for south of Lantau near Ngan Kwong Wan (Discovery Bay) and one for Victoria Harbour appears to suggest a coastal/estuarine dolphin rather than a "true" river dolphin, restricted to freshwater habitats, and can use much of the coastal area of Hong Kong. Restrictions of sightings to the western New Territories may indicate either a foodchain preference or perhaps needs for periodic freshwater (e.g., removal of marine/freshwater parasites) or for more turbid water (avoidance of predators).

With increasing coastal urban growth, dolphins can be subjected to increased stress, being killed in nets and fishtraps and by severe habitat changes due to competition for food species and physical/chemical changes in their habitat. Biotic losses and ecological changes resulting from the presence and operations of the LTPS in the northern end of Urmston Road and southwestern Deep Bay may adversely affect the Dolphin.

Also of interest is the reported use of the beaches at Lung Kwu Tan and Lung Kwu Sheung Tan to the south of Black Point, by the Giant King Crab[1]. No evidence of the species was discovered during the first stage of the marine survey but it is believed that the beaches are the only known breeding area for the crab in Hong Kong, and as such warrant designation as SSSI. If these beaches are an important breeding area then the potential exists for the LTPS to bring about changes which could affect the breeding pattern of the species.

8.3.3 Assessment Criteria and Requirements

Assessment criteria and requirements for marine biota have focused largely on the economic value of oysters, other commercial shellfish, and general commercial fin-fisheries. The requirements of the Deep Bay Mariculture Subzone have been referred to in V1/2.3. The criteria exist to protect the oyster fishery. No direct or indirect operational impacts will affect commercial fisheries; regulations have not been specifically directed at the large unregulated "catches" by the cooling water systems. Hong Kong complies with various treaties and agreements regarding protection of rare and endangered species, including marine mammals. Habitat destruction is recognised as an important adverse impact on rare and endangered species, even without the direct loss of the individuals of the species.

8.3.4 Significance of Impacts

The significance of LTPS operational effects on the marine ecological community cannot be determined at this point. The results of further marine surveys and the predictive out-put of the water quality modelling exercise are required and will be presented in the Water Quality Key Issue Report.

At this stage, however, several conclusions can be drawn. Based on earlier assessments of CPPS Station A, cumulative marine biological effects may potentially be significant when all elements are included: entrainment and impingement losses, and changes of ecological conditions producing reduced productivity.

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1 Morton, B. 1990 (pers comm)

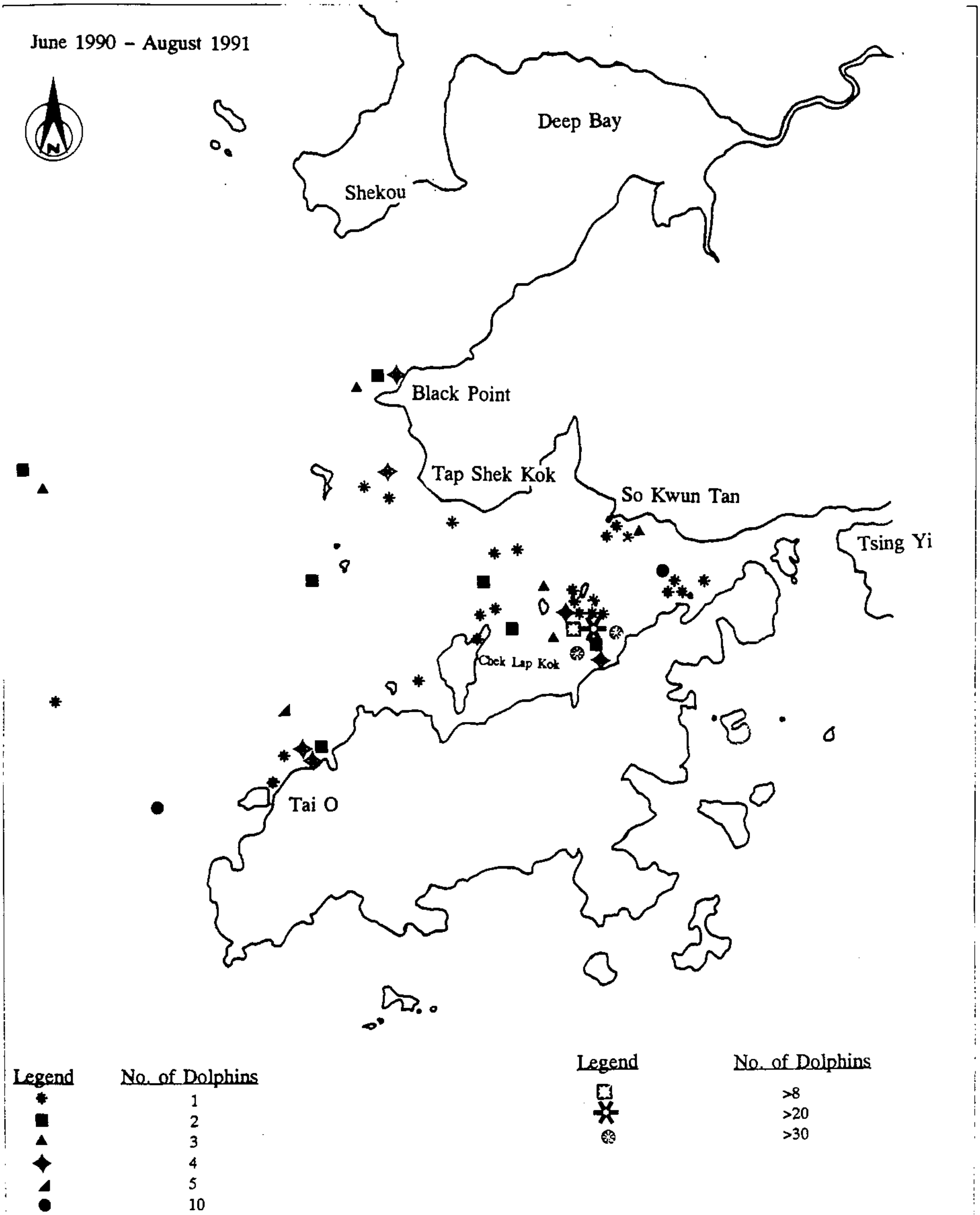


Figure V3/8.3(a)
Location Map of Chinese White Dolphin Sightings

ERL (Asia) Ltd.
11th Floor, Hecny Tower
9 Chatham Road,
Tsimshatsui,
Kowloon, HONG KONG
ERL

The LTPS, individually or in combination with other projects, may adversely affect the Chinese White or Pearl River Dolphin. The dolphin is well known in Urmston Road, the southwestern corner of Deep Bay, and Ma Wan-Brothers Channel and may depend on this deep water channel for daily migrations between the Pearl River Delta, Deep Bay, and coastal marine waters of Hong Kong. The importance of the dolphin and the potential operational (and construction) impacts from CPPS and LTPS operations warrant additional studies.

8.3.5 Mitigation

Measures to minimise marine ecological effects have been incorporated during the development of the site layout. Location of the LTPS to the north of the point has avoided direct physical disturbance in the bays to the south. The bays to the south show much greater littoral ecological diversity than the Yung Long beach. Furthermore, the reclamation shape should do little to modify existing flows around Black Point so that the balance between erosion and deposition in the bays will not be altered significantly. Hydraulic modelling will be carried out to confirm this.

Additional detailed ecological monitoring of the specific location of the cooling water intake may provide information to help locate and design the intake openings so as to minimise the entrainment of important bottom-dwelling (crabs) and near-surface species (shrimp, jellyfish, etc). Provision of maximum intake sizes with minimum intake velocities can reduce the entrainment of many floating and swimming species.

Adverse effects of direct losses from impingement can be reduced by installation of fisheries diversions commonly installed on major marine water intakes. Such facilities only require changes in the type and orientation of intake bar screens and provision of "fish" educator pumps and piping back to the marine environment where the organisms will not be re-entrained.

Discharge of cooling water may cause major changes in the ecology surrounding the outfalls and perhaps as far away as 500m. Outfall structures can be designed to minimise induced physical changes and to maximise dispersion of the cooling water. Both approaches reduce the effects on the local ecology. Any improvement of the dispersion of cooling water discharge will further mitigate the adverse effects of discharges.

Maintenance dredging and other open water activities will generate temporary increases in turbidity which can be controlled by various methods. Use of cutter suction dredgers reduces the turbidity compared to grab dredgers but require controls on the discharge of entrained sea water. Direct controls (e.g., silt curtains) around turbid activities have been used to control dispersion of suspended solids and other pollutants. Effects of turbidity can be reduced by scheduling activities with the normal peak turbidity periods (e.g., summer peak river runoff).

Navigational and existing commercial fisheries uses in Urmston Road and Deep Bay would prohibit habitat improvements in areas immediately adjacent to Black Point. Shallow (3-5 m) areas along the west side of Urmston Road, however, (South East Bank north of Lung Kwu Chau to the banks northwest of Chek Lap Kok) lie outside the normal navigational channels and have restricted access because of their proximity to the territorial/provincial boundary. Such areas could be developed for fisheries habitats and would contribute directly to improvement of fisheries within Urmston Road and the eastern Pearl River estuary. Development of marshlands would require greater care since attracted birds could pose hazards to future airport operations at Chek Lap Kok.

Assessment of likely effects on the Pearl River dolphin are difficult because very little is known about their feeding habits, behaviour, requirements and tolerance. Effects may arise, because of the dolphins' position at the top of the food chain. Also, as a sensitive marine mammal its tolerance of adverse conditions is unlikely to be high. Furthermore, the effects brought about by LTPS operations are part of a far larger change in regime likely to be brought about by Area 38, PADS developments between CPPS and the LTPS and dredging activities in Urmston Road.

In view of this it is suggested that mitigation for effects on the dolphin could take the form of a research programme involving direct observation, collation of data, and specimen analysis, as outlined below:

- o monitoring of dolphin use of Ma Wan–Brothers–Urmston Road; CLP will occupy ideal locations from which to observe:

  - times tidal/swell state, water conditions
  - first/last observed location, duration at any particular site, direction of travel,
  - speed, number in herd, body sizes, and colouration

- o acquisition and review of other observations made by:

  - marine police, helicopter pilots, ferry/hovercraft pilots
  - AFD staff, trawler operators, etc

- o review of current status and plans for protection in the PRC

- o direct body observations and dissections of trawler landings or strandings to determine food requirements.

- o literature review of reported ecological requirements, predation and parasites.

9. CIVIL AVIATION

9.1 Stack Heights

The approaches to Hong Kong's present international airport at Kai Tak, and its proposed replacement at Chep Lap Kok are maintained by a series of "obstacle limitation surfaces", which decrease in altitude with decreasing distance from the airport; structures may not project above these surfaces without the agreement of the Civil Aviation Department (CAD). Due to the highly variable topography of Hong Kong, these surfaces in places approach the height of the terrain on which they are superimposed, and so structures which project above an obstacle limitation surface, but which could be considered as being an extension to, or shielded by, an existing topographic feature may under certain circumstances, be permitted by the CAD.

Since the LTPS site lies within the boundary of the 155m altitude obstacle limitation surface for the proposed Chep Lap Kok airport, and approximately 2km to the west of a range of 300-400 m hills, the compatability of the LTPS stack heights and the obstacle limitation surface is being assessed in consultation with the New Airport Masterplan Study consultants and the CAD. The possibility of the exhaust gases from the LTPS affecting aircraft operations is similarly under investigation as part of the Air Quality Key Issue Assessment.

9.2 Thermal Plume Effects

The CAD has expressed concern that the hot exhaust gases emitted from the stacks may have an effect on aircraft engine performance. This issue was investigated in the Site Search Study, drawing on information obtained for a similar assessment of impacts resulting from CLP's gas turbine power plant at Penny's Bay. It was concluded that there will be no risk of any significant impacts for the Black Point site. In summary, this conclusion was reached as follows :

o Although no official criteria exist for assessing this potential impact, guidelines were derived from discussions with two organisations which can claim to understand the issues. The UK Civil Aviation Authority's (CAA) Flight Department has advised that exposure of engines to hot air up to 20°C above ambient, for periods of up to 5 seconds will not affect climb performance of commercial aircraft seriously. A very temporary loss of climb gradient could occur but the momentum of the aeroplane would not cause a dangerous loss. Consultation with test pilots at CAA indicated that 50°C above ambient for one second would be considered insignificant, such that the crew would hardly notice it. To put this in perspective an aircraft could throttle back completely for one second with no power on at all, and on re-applying power would only have lost a knot or two of speed. This could not cause any detrimental effects on engine performance.

  These views were generally confirmed by a major engine manufacturer whom the CAA consulted. The CAA were advised that the following general guidelines should be borne in mind :

  - elevated temperatures in the order of 40°C above ambient, for a duration of about one second, would have no adverse effect on commercial aircraft engine performance;

  - for more prolonged periods the elevated temperatures might cause a temporary drop in thrust, e.g. 1/6 for 20°C above ambient and 1/3 for 40°C above ambient.

- o Detailed computer modelling of the thermal characteristics of the power station plumes was undertaken for a range of meteorological conditions so that their influence on the thermal structure of the surrounding atmosphere could be estimated. The results indicated that the greatest influence would result from the infrequent gaseous emissions from the gas turbine stacks. This is because these exhaust gases will have a much higher exit temperature and velocity than those from the main stacks.

- o The modelling results showed conclusively that the plumes from the stacks will not significantly affect the ambient temperature of the atmosphere at the altitudes at which aircraft will be overflying the power station, i.e. about 1500m. For a light wind of 1m/s, the 20°C–above ambient contour extends no higher than 400m for the main stacks and 500m for the gas turbine stacks.

9.3 Cloud Creation

9.3.1 Particulate Effects

Concern has been expressed that particulates emitted from the LTPS stacks could act as hygroscopic nucleii which may cause fog or clouds to form in super saturated air. This cloud could then be blown into an area where it could be a navigation hazard to aircraft. This is considered most unlikely, however, because;

- o the particulate emission rate for the LTPS of 50 μgNm^{-3} will not significantly increase ambient suspended particulate concentrations in the atmosphere;

- o super saturated conditions are rarely encountered in the boundary layer of the atmosphere;

- o winds and atmospheric turbulence would in any event act to disperse the nucleii.

9.3.2 Moisture Redistribution by the Plume

Concern has also been expressed that, because they are at a higher temperature than the ambient air, the stack gases will absorb moisture from the air through which they rise, and, on cooling, release this in the form of visible moisture droplets (cloud or fog) formed around the particulates (see 9.3.1 above) within the gas, again leading to cloud or fog formation.

However, this scenario entails the plume of gas moving through the atmosphere as a discrete entity, taking up moisture and later condensing it out elsewhere en masse, which is not the case. After emerging from the stack, the plume mixes continuously with the atmosphere, becoming increasingly less defined as it does so. Any uptake and subsequent release of moisture during this process takes place over short distances as the plume is cooled and dispersed in the atmosphere, such that "reservoirs" of moisture do not develop.

10. SOCIO-ECONOMICS

10.1 Introduction

Any socio-economic effects resulting from the operation of the LTPS will be broadly the same for either Scenario I or II. In Scenario II where half the ultimate development will be gas-fired the coal stockyard will be smaller and employ fewer staff. However the staffing level overall will not be much different.

This section identifies and assesses likely socio-economic effects resulting from operation of the LTPS. The word 'impact' usually has a negative connotation in environmental assessment. However the socio-economic impacts can be good rather than bad and the term, as used in this section applies to either.

The potential for adverse socio-economic impacts has been minimised by the selection of Black Point as the site for the LTPS. Population in the vicinity is low, as is the scale of agricultural, commercial fishing and recreational activity.

10.2 Potential Sources of Impact

10.2.1 Power Supply

By far the most important impact concerns the product of the LTPS.

The LTPS will only be built if the Hong Kong Government agrees the need for it. Under these circumstances the provision of the LTPS will be a profound element in the continued social and economic well-being of Hong Kong.

The expansion of industrial land and transport links at a variety of locations throughout the territory, implies increased demand for electric power. In this sense the LTPS can be considered as more fundamental to Hong Kong's property than the new airport or the new container ports as between them, with all the other developments they may strain the existing electricity supply system.

The socio-economic impacts of **not** having sufficient power in Hong Kong are likely to be very negative indeed.

10.2.2 Employment

There are other beneficial impacts namely:

- employment of site staff;
- spin-off employment.

The Castle Peak A & B Stations currently employ between them around 1400 contract staff. Table V3/10.2(a) indicates the breakdown by function. Associated services provided by outside contractors, such as catering, cleaning and maintenance, provide several hundred further jobs. It is anticipated that the ultimate LTPS development would employ about the same number of people, with the first pair of units (2 x 680 MW coal or 2 x 600 MW combined cycle gas units) employing about 450.

Table V3/10.2(a) **Castle Peak Power Stations - Workforce Breakdown**	
Staff Group	**Number of employees**
Management Staff and Senior Engineers	59
Technical, Engineering and Supervisory Staff	514
Skilled, semi-skilled and unskilled staff	666
Contract staff (skilled and unskilled)	135

The new staff will be partly drawn from reassignment within CLP and partly from new recruitment. In most cases the reassignments will result in the need for new recruitment except where it can be balanced by phasing out of old plant e.g. the Tsing Yi Station.

Inhabitants of Tuen Mun, Yuen Long and eventually Tin Shui Wai, would be potential recruits, as would people from further afield.

Spin-off employment would arise out of supplying goods and services to the station. These would comprise:

- marine and road transport;
- catering;
- vehicle and plant maintenance;
- office supplies and services;
- building and equipment maintenance;
- landscape maintenance.

Such business would be amplified were the PADS development of Tuen Mun port to go ahead.

10.2.3 Pollution

As identified in the Site Search Report, the only potentially negative socio-economic impact is the possible effect on mariculture activities in Deep Bay, resulting from changes in water quality caused by the discharge of cooling water and other effluents. This aspect is still under investigation in the Key Issues Study on Water Quality but it is a priority in the engineering design, specifically to minimise any such effect.

The preferred layout has located the LTPS in such a way that visual impact, noise and fugitive dust emissions from handling of coal, ash and materials associated with air pollution control systems (e.g. limestone and gypsum), will not be a pollution nuisance to the small numbers of local inhabitants. Therefore the LTPS is not likely to adversely affect local property values.

10.3 Mitigation of Impacts

Impacts in the Tuen Mun/Yuen Long area would be positive, through direct and indirect employment, therefore mitigation is not necessary.

The same applies to the fundamentally positive socio-economic effect of avoiding a power shortfall in Hong Kong.

The possible adverse impact on commercial mariculture activities in Deep Bay is being addressed in the Key Issues Study on Water Quality and it is a priority in the engineering design of the cooling water and other waste-water disposal systems to minimise this.

11. CULTURAL HERITAGE AND FUNG SHUI

11.1 Archaeological and Cultural Impacts

The nature of impacts on cultural resources is such that they usually occur during construction. Once the plant is built the potential for impacts at the site is limited as no additional land-take will be required. Operational impacts to cultural resources may be considered to occur from site traffic but traffic levels are insignificant and cultural resources are not evident along the Southern Access - Tuen Mun Road. As a consequence, operational impacts arising directly from the site are predicted to be minimal.

The impact of gases emitted by thermal power stations is recognized to have an adverse effect on stonework and other building materials (V3/3.6.3(i)). Statues and ornate building decoration, particularly in materials such as limestone, may undergo loss of definition as a result of accelerated acid-weathering. This type of impact has been observed most frequently in European cities where elevated levels of acid gases once persisted. The rare occurrence of this of type building in Hong Kong means the potential for this type of impact is very low.

11.2 Fung Shui

The potential for Fung Shui impacts during the operational period of the LTPS persists. This will be less a function of the loss of existing features and more to do with the form of the LTPS and its interaction with its setting. CLP are currently consulting a Fung Shui expert and local villagers representatives with a view to incorporating suggestions made into the detailed site layout and building treatments as appropriate.

12. VISUAL IMPACT

12.1 Introduction

12.1.1 Background

Following the assessment of the short-term visual impacts arising from the construction works and initial erection of the LTPS in Volume 2, Section 13, the longer-term impacts on landscape resource and visual amenity are now examined.

The principal differences between the two Scenarios in visual terms is centred on the coal-fired units; Scenario I, comprising 8 coal fired units, requires more extensive excavation of the northern flank of Black Point, with a larger resultant cut face requiring mitigation works, and resulting in 4 chimney stacks, some 250m in height, rather than the 2 equivalent stacks required for Scenario II's four coal units. The 4 CCGT units comprising the first Phase of Scenario 2 are not considered as significant in visual terms as the coal units, by virtue of their generally smaller size, and far shorte chimney stacks (about 70m).

12.2 Sources of Impact

The assessment is based on information about site layout, principal structures and plant operation available at the time of writing. Where data has been unavailable, assumptions have been made on the basis of parameters established during the Site Search phase. Plant design is still evolving, however, and it is possible that the detailed findings of this section will change.

12.2.1 Site Layout

The site occupies the northern part of the Black Point promontory and the bay lying immediately to the north. The generating plant itself would be located on the promontory, with coal stockpiles occupying most of the reclaimed bay. Coal vessels would berth either at a wharf along the north-western side of the promontory or at a jetty projecting westward into Urmston Road.

The principal visual elements of Scenario I would comprise four pairs of coal-fired generating units, each consisting of a sequence of turbine hall, boiler house, flue gas desulphurisation (FGD) plant and chimney, aligned on a north/south axis. Coal stockpiles, liquid fuel tank farm, limestone preparation plant and gypsum storage would be arranged on a series of north-east/south-west axes on the reclaimed bay and adjoining area. The adjoining ash lagoons serving the Castle Peak power station which are located on the coastline north-east of Black Point, may be extended in the future to accommodate ash from the LTPS.

Senario II would comprise two pairs of coal-fired generating units, with similar associated structures as for the Scenario I units, but with correspondingly smaller coal stockpiles and limestone/gypsum facilities, and four combined cycle Gas Turbine units each consisting of a chimney, heat recovery steam generator, a gas turbine building, a steam turbine building, all of which are considerably smaller in physical size than the coal-fired unit components. A key aspect with regard to visual impacts is the difference in chimney stacks heights between the two types of power generating unit; the CCGT chimneys are expected to be about 70m in height, whereas those of the coal-fired units are expected to be around 250m. Thus, whereas the CCGT unit stacks will be screened from view by Black Point ridge and its eastern extension to the Castle Peak range, those of the coal-fired units will overtop the adjacent topography and their upper portions will be silhouetted again the sky-line.

The principal features of the site layouts for the two scenarios are shown in Figures V2/10.2 (a) and (b).

12.3 Visual Envelope

12.3.1 Introduction

The visual envelope defines the area within which the visual impact of the LTPS is likely to be experienced. It corresponds to the maximum extent of potential visibility of the site, and is defined primarily by topography and atmospheric conditions. *Actual* visibility from any point within the visual envelope depends on the detailed disposition of terrain and landuse features such as vegetation.

The visual envelope for the LTPS at Black Point was delineated initially from topographic maps, and was refined by on-site verification and by the production of photomontage showing predicted views from selected locations.

12.3.2 Key Determinants of Visibility

- **Weather conditions**

  As a coastal area, Hong Kong is subject to seasonal constraints on visibility due to haze and low cloud. A study of meteorological data indicated that 8km could be regarded as the maximum effective viewing distance in a typical year.

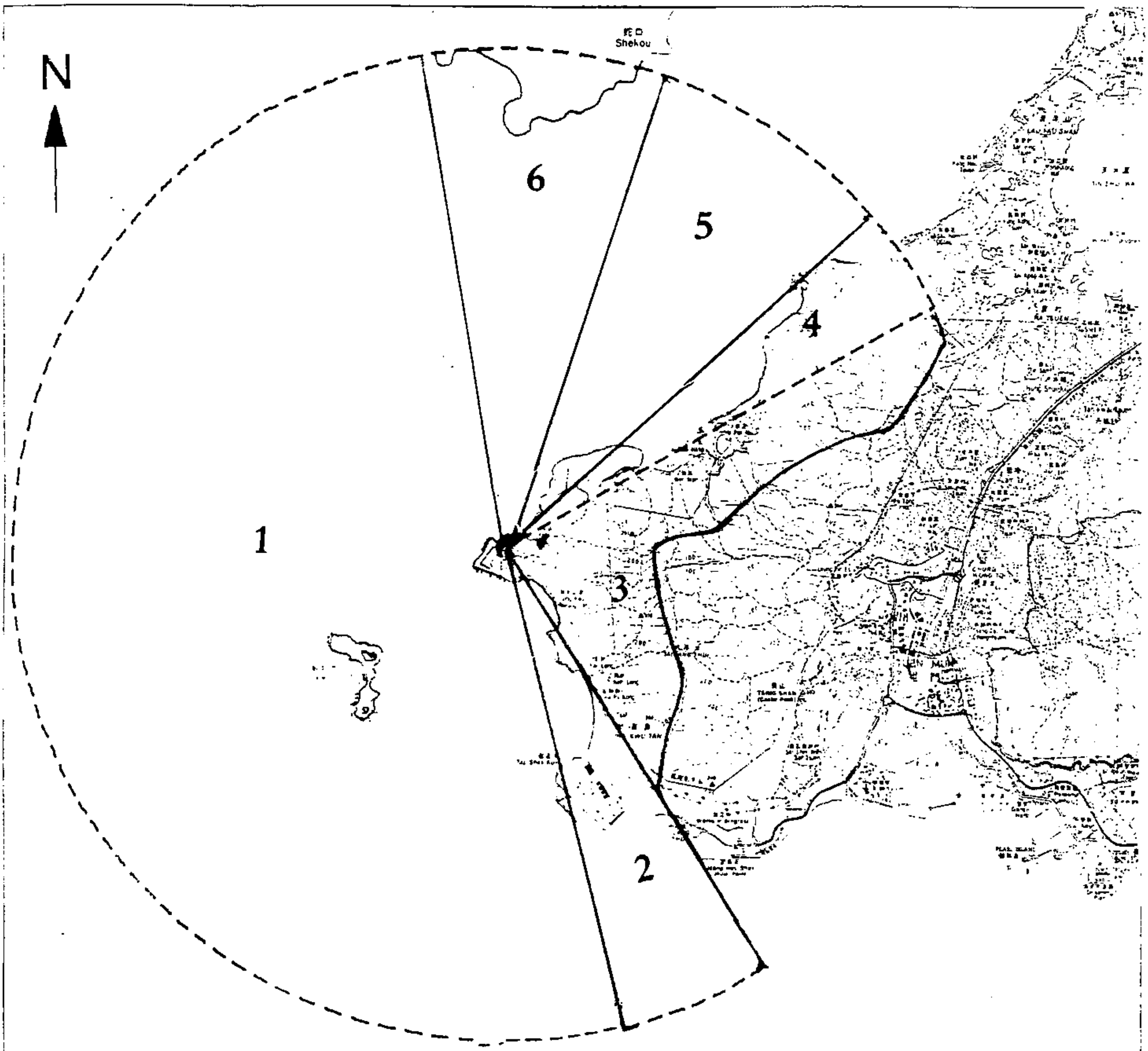
- **Topography**

  The relationship between land and sea, and the nature of the terrain immediately surrounding the site, will be the primary determinants of visibility within this 8km radius.

  Black Point projects westwards into the Pearl River estuary, with the Shekou peninsula lying 8km to the north across Deep Bay. To the south, Urmston Road forms the channel between Lung Kwu island and Tap Shak Kok. To the east, Black Point joins a distinctive ridge which becomes part of the dissected upland of the Castle Peak Range.

12.3.3 Description

The visual envelope of the site is shown in Figure V3/12.3(a), and is described in Table V3/12.3 below, in terms of six sectors, within which different viewing opportunities and receptors may be encountered.



- - - - - Limit of Visual Envelope defined by atmospheric conditions

——— Limit of Visual Envelope defined by terrain.

Numbers refer to sectors described in the text.

Scale 0 2 4 6 8 10 km

Figure V3/12.3(a) The Visual Envelope of the LTPS Site

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Table V3/12.3
Visual Envelope Analysis

Sector	Viewing Opportunities	Receptor Population
1	Extensive views across Pearl River and Urmston Road, with Lung Kwu Chau providing the only obstruction.	Small; confined to fishermen, passengers and crew of passing vessels, some recreational sailors.
2	Views mainly from protruding and more elevated parts of the coastline. Southern flank of Black Point would provide screening for view points south of the site.	Substantial; comprising residents of villages such as Sha Po Kong, users of nearby beaches and employees of the existing power station at Castle Peak.
3	Very high degree of obstruction by terrain, though potential for views from elevated positions.	Small; apart from hamlet at Lung Kwu Sheung Tan, the area is unpopulated; access road to quarries and ash lagoons; Castle Peak Range is used for army gunnery practice and is not accessible to public.
4	Low level views mainly from protruding parts of the coastline.	Substantial; comprising residents of village such as Tai Shui Hang, Ha Pak Nai and Sheung Pak Nai.
5	Unobstructed views across Deep Bay	Small; confined to the crews of fishing and trading vessels.
6	Views across Deep Bay to the Shekou peninsula.	Substantial; Shekou is a sizeable urban centre.

12.3.4 Landscape Character

The prevailing character of the area within the visual envelope is typical of Hong Kong, comprising a combination of long seaward views, prominent terrain and an indented coastline. Urban landuses are confined to Shekou, which lies some 8km to the north across Deep Bay, and to the New Town of Tuen Mun, which lies about 6km to the south-east. The latter, however, is affected by the "visual shadow" of the intervening Castle Peak Range, and does not fall within the visual envelope of the site. The New Town of Tin Shui Wai may lie within the visual envelope, but it is located some 11km to the north-east of the site; a distance over which any impact is likely to be dissipated by atmospheric conditions.

The coastlines north and south of the site vary substantially in their landuse character. The north beyond the existing ash lagoons, is characterised by traditional rural settlements set in gardens and Fung Shui woodland. The lagoons at Tsang Tsui, which have reclaimed a large section of the shoreline, represent one of several industrial intrusions in the vicinity of Black Point which continue to the south of the site, including quarries, a cement works and the Castle Peak power station.

Landscape is rarely a static medium, and the vicinity of the Black Point site is likely to undergo a number of changes during the next few years. The PADS (Port and Airport Development Strategy) includes the reclamation of the foreshore to the south of Black Point, and its development for port activities and related industry. The cessation of gunnery practice on the Castle Peak Range, however, is unlikely to be followed by a change in land use as quantities of unexpected munitions litter the area.

12.3.5 Introduction of a New Industrial Feature

The introduction of the LTPS will not result in a fundamental change in the character of the surrounding landscape. From the north the LTPS will be seen in the context of the adjoining industrial developments of the Tsang Tsui ash lagoons, and WENT. From the south, the LTPS will be predominantly screened by the Black Point ridge, and viewed in the context of the existing Castle Peak power station and of future PADS-related development. The contrast with its setting will therefore be less marked, whilst the Castle Peak power station will provide a strong alternative focus for views. Consequently, impacts on landscape character within the visual envelope are likely to be no more than moderate.

12.4 Prediction of Impacts

12.4.1 Key Viewpoints

Visual impacts were predicted by selecting principal land-based viewpoints providing views of the LTPS over a range of distances and from different aspects (see Table V3/12.4 below). For each view a photomontage was prepared to show the completed, operational LTPS within its landscape setting. The 'all-coal' Scenario has been illustrated, since this represents a 'worse-case' view; Scenario II can be envisaged by disregarding the two "inland" chimneys. These montages were used as indicators of potential impact within the visual envelope, from which obstruction or intrusion were assessed.

Table V3/12.4
Selected Viewpoints

Location		Viewing Distance (km)	Description
A.	Lung Kwu Sheung Tan	1.0	View from hamlet to the south-east experienced by residential receptors closest to the site; tests the degree of screening provided by the southern slopes of Black Point.
B. & C.	Lung Kwu Tan	3.0	View from substantial residential community and popular beach; tests degree of screening provided by Black Point and intervening ridge.
D.	South of Sheung Pak Nai	5.0	View from road south of substantial residential community to north-east; tests degree of screening provided by coastal slopes and ash lagoons.

In view of its distant location from the LTPS site, at the maximum effective viewing distance, a montage of the view from Shekou was not considered necessary. Similarly, a view from the sea has not been simulated as freight shipping was not considered to be a sensitive receptor to visual impacts.

The viewpoints are shown on Figure V3/12.4(a). The predicted views from each are shown as Plates V3/12.4(a)-(d).

The photomontages were prepared assuming 250m high coal-fired unit chimneys; the exact height required will be one of the outputs of the Stack Emissions Key Issue Assessment, and consultations with the CAD and the New Airport consultants (see Section V3/9.1).

12.5 Assessment of Impacts

Impacts were classified as severe, moderate or slight on the following basis.

- o Severe impacts would occur when a large number of highly sensitive receptors experience substantial obstruction of, or intrusion into, their existing views.

- o Moderate impacts would occur when receptors of mixed sensitivity experience some obstruction of, or intrusion into, their existing views.

- o Slight impacts would occur when receptors are few, or of low sensitivity, and experience minor intrusion into their existing views.

As indicated by Plates a, b and c, the retention of Black Point ridge will result in the extensive screening of the LTPS from southern receptors, such that only the upper portions of the coal fired unit chimneys will be visible against the skyline. Views from locations at Lung Kwu Tan (Plates b and c) will be further screened by the unnamed rock outcrop immediately to the north.

Views from the north, (plate d) are similarly restricted by the curvature of the coastline and the low lying nature of the settlements concerned. In addition, views of the power station are relatively distant (4-5 km). These views already include be industrial element of the Tsang Tsui ash lagoons and the borrow area east of Yung Long. The colouring and finishes of the LTPS assist in merging it with the adjacent natural topography. The site boundaries and cut back slope of the site are to a considerable extent camouflaged by landscaping and planting, and planting has been used to restore and enhance the Black Point ridge line. The coal-fired chimneys remain the principal visual element from these view points.

From the above, the visual impact of the LTPS from both southern and northern view points is considered slight to moderate.

12.6 Mitigation recommendations

12.6.1 Key Issues

The visual impact of the LTPS will result primarily from :

- o Change to local terrain and coastal morphology;
- o Introduction of the LTPS itself into particular views; and
- o Generation of visual relationships between the LTPS and its landscape setting.

The mitigation response has focused upon five key tasks:

- o Retention of surrounding terrain to provide screening;
- o Site planning to maximise on-site screening of intrusive features and to achieve an acceptable architectural composition;
- o Landscaping to screen sensitive views and planting to disguise cut rock faces;
- o Architectural enhancement of major structures; and
- o Management of site and processes to reduce potential sources of impact.

The first two key tasks have already been incorporated within the development location and layout, with the retention of Black Point ridge providing extensive screening of the LTPS from views to the south and east, and maintaining the visual links between the coastline and the Castle Peak range. The layout of the coal fired-plant in particular has been developed so that the visually unattractive components of the power generating units face the cut slope of the ridge, whilst the less obtrusive components face the sea. Similarly, the architectural finishes, intended to be in muted earthy tones in greys and greens, will reduce the overall visibility of the plant. These measures are described in more detail below. It should be noted that finalisation of the mitigation package will be developed in consultation with CLP, the development architects and the project landscape architects.

12.6.2 Screening

Views from potentially sensitive locations may be screened either by planting at some distance from the LTPS or by a combination of planting and bunding in the immediate vicinity of major buildings. The latter may require bunding for safety reasons, and this could be designed to provide additional screening, reinforced by planting.

Planting around the site periphery is likely to provide the most effective opportunities for screening, since it will be closer to potential viewpoints and may be integrated more readily into the landuse pattern of the area. Visual amenity and screening should be primary objectives of any landscape plan for the site. Planting should aim to :

- o use primarily native species;
- o reinforce existing screening provided by terrain (e.g. along ridge lines);
- o link with existing vegetation patterns.

The following locations for priority planting have been identified :

Location	Mitigation Objective
Crest and southern slopes of Black Point	To reinforce screening by terrain from southerly viewpoints, especially from the nearest residential receptors.
Crest of ridges flanking the eastern side of the site	To reinforce screening by terrain from south-easterly viewpoints.
High ground immediately south of existing ash lagoons	To provide screening from north-easterly viewpoints along the coast.

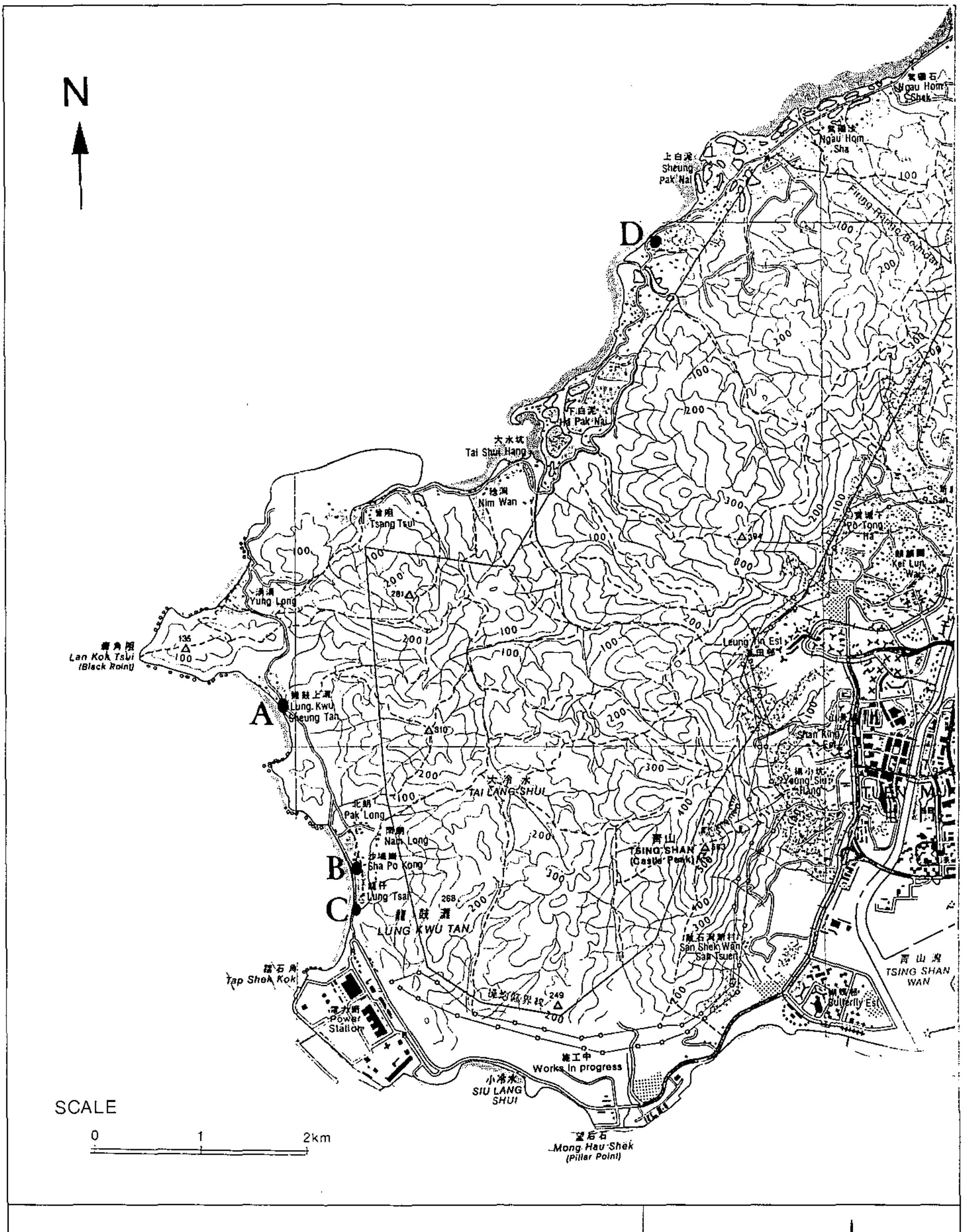

Figure V3/12.4(a) **Photomontage Viewpoints**

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Plate V3/12.4(A)

Photomontage from Lung Kwu Sheung Tan

Plate V3/12.4(B)

Photomontage from Central Lung Kwu Tan

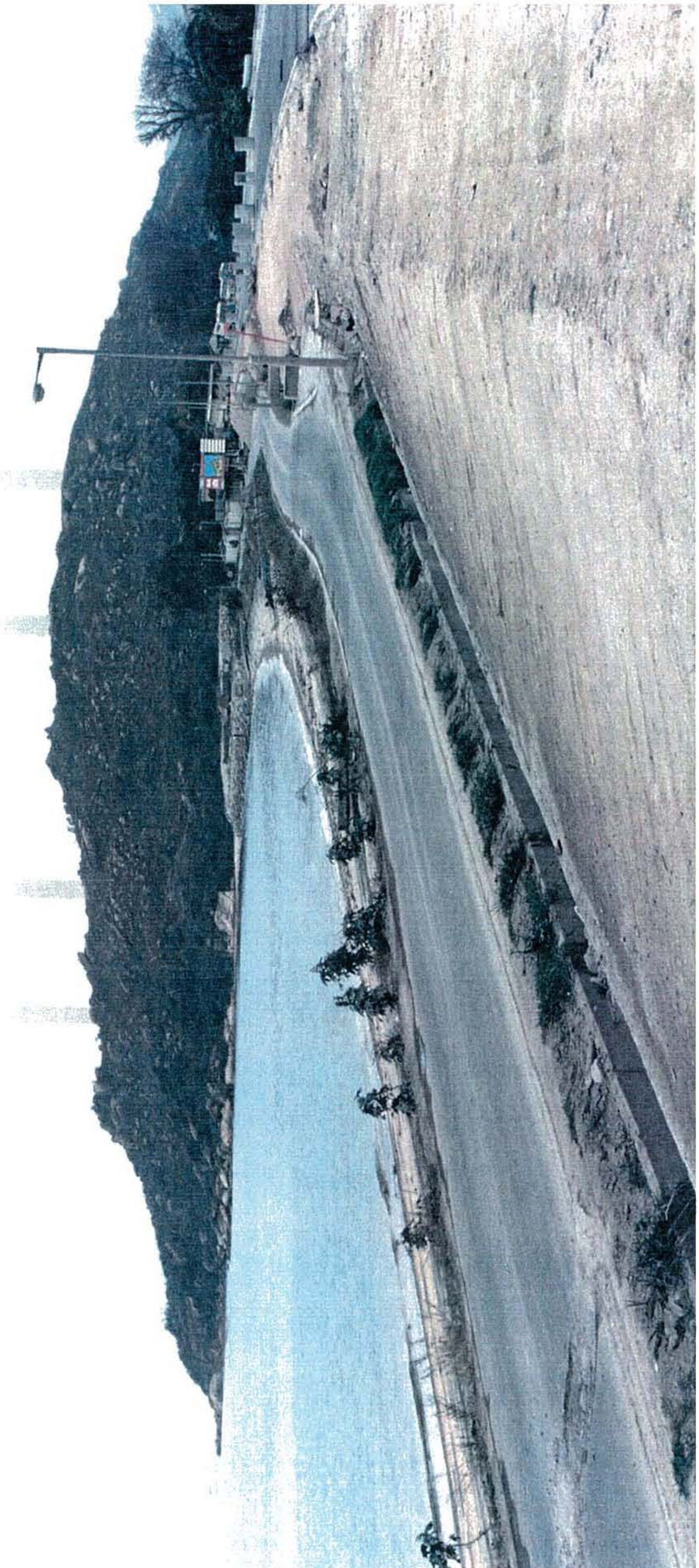

Plate V3/12.4(C)

Photomontage from South Lung Kwu Tan

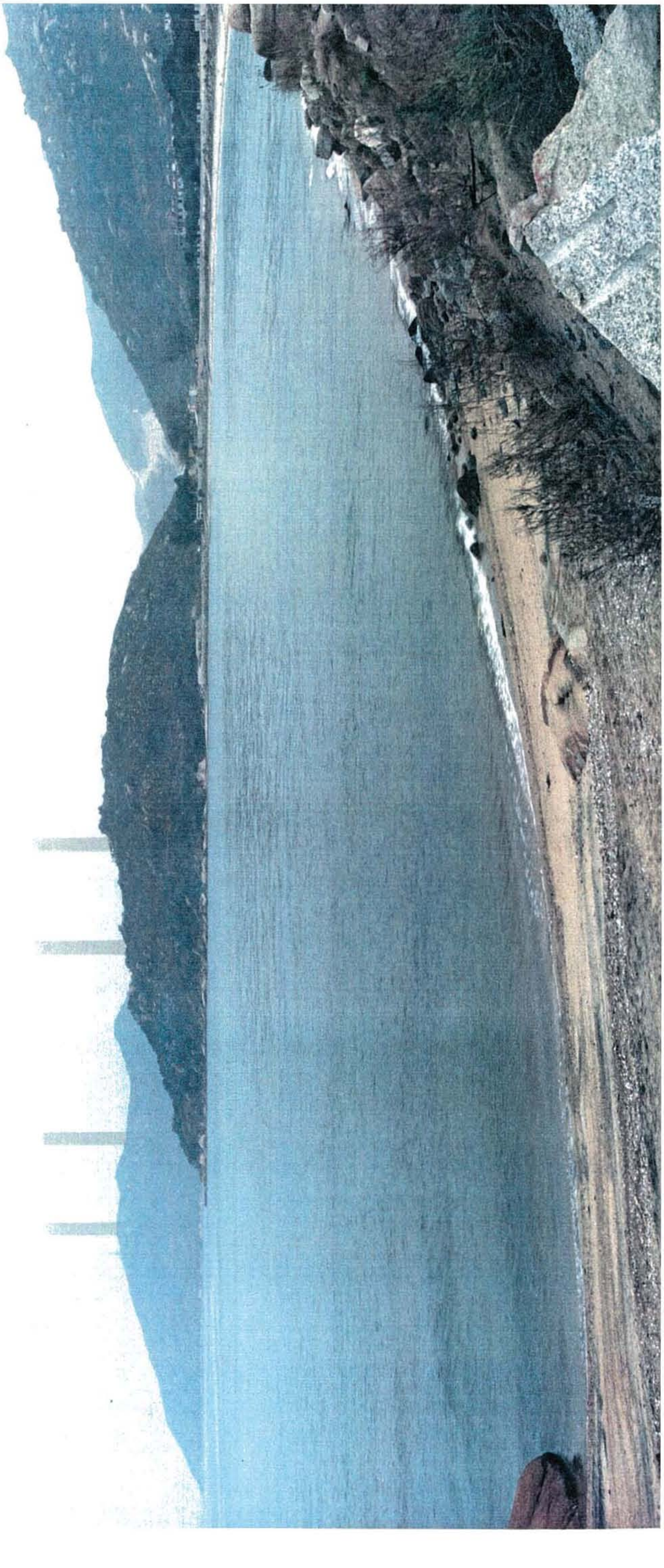

Plate V3/12.4(D)

Photomontage from South of Sheung Pak Nai

Planting and terracing is also recommended to assist in the rehabilitation of the north facing cut slope forming the "back wall" of the LTPS site, in addition to general recontouring and hydroseeding of cut slopes on the site wherever possible.

12.6.3 Site and Process Management

- o Design and positioning of lighting so as to avoid off-site glare and to reduce within feasible levels, the overall extent and duration of its impact.
- o Provision of visitor information/tour facilities, to emphasise the positive visual aspects of the LTPS, its development and setting, similar to those provided at CPPS, which received over 14,000 visitors in 1990.
- o Efficient site housekeeping, particularly with regard to maintenance of landscaping measures and planting should be employed in conjunction with visitor facilities.

12.7 Conclusions

The LTPS will be located within a visual environment which already features several major industrial developments, and which is likely to become far more industrialised in the future. The surrounding landscape is to be retained where possible to provide visual screening, but is not in itself of particular scenic value. No part of the area has been designated for its landscape quality.

Views of the operational LTPS from sensitive receptors to the south will be screened by Black Point ridge and other intervening topography, such that only the upper portions of the chimney stacks will be visible above the ridge.

Views from the northern receptors are limited by the curve of the coastline, are relatively distant (3-5km) and already contain industrial elements. The layout of the LTPS has been developed so that the most visually intrusive elements of the power station are screened from these views by other elements, and the colours and finishes used will complement the site surroundings.

Planting and landscaping of the site will be provided, particularly with regard to the cut slopes on the northern side of Black Point ridge, to assist in establishing the facility within the existing landscape.

It is considered that the operational visual impacts of the LTPS at Black Point will be slight to moderate and do not constitute a significant environmental issue.

13. RISK ASSESSMENT

13.1 Introduction

If Scenario II is adopted, 2400 MW of the base load capacity will be provided by combined cycle gas turbines, burning natural gas as the principal fuel, supplied from a terminal in the southern waters of Hong Kong via the island of Lung Kwu Chau. A subsea pipeline of up to 0.75m diameter would probably transmit gas from the island with the final approach to site either being direct to the sea wall or via a short overland route from the south. The gas supply to the island would be a 100 bar pipeline, and a pressure regulation valve would affect a reduction to around 30 bar in the supply from the island. It is assumed that this valve will have some form of automatic feedback control to maintain the desired pressure.

In addition, it is intended that the power station would be provided with on-site oil storage facilities for up to 250,000 tonnes of oil. This oil is to be used as contingency fuel for the combined cycle units. The oil would be delivered to Black Point by ship, typically involving 400–1500 tonne barges, though possibly by tankers of up to 40,000 tonnes dead weight. An oil spill contingency plan will be developed as appropriate, however, since the gas pipeline and the oil import and storage vessels present the potential for a large release of hydrocarbons, and it is the purpose of this analysis to quantify the consequences of these possibilities.

13.2 Potential Receivers

At the present time, the centers of population nearest to Black Point are Lung Kwu Sheung Tan, at 1.2km, a small settlement of approximately 70 registered inhabitants although only one property appears to be regularly occupied; and the village of Lung Kwu Tan, at 2.7km, with 800 inhabitants. Yung Long, which lies within the proposed site boundary, would be removed as part of the development.

The coastline between Black Point and Castle Peak Power Station has been identified for land reclamation purposes under the Port and Airport Development Strategy (PADS). It is expected that the area within about 750m of Black Point will have little if any development, due to the sewage outfall currently under construction there. The remainder of the bay has been earmarked for Deep Waterfront Industry, 1–2km from Black Point, with an employee density of approximately 30 people per hectare; and a Cargo Working Area, 2–3km from Black Point, with about 40 people per hectare.

13.3 Causes of Failure of Inventory Holders

In this section, the range of factors that can lead to a release from pipelines, storage tanks or supply ships are summarized. This establishes a set of 'worst case' release scenarios as presented below.

13.3.1 Natural Gas Pipeline Failure

The principle factors affecting the failure of hydrocarbon pipelines are :

- o Defects in the piping material (pinholes, dents, gouges) and in the assembly, mostly at the welds. These defects tend to be revealed in the early life of the pipeline, and usually cause small to medium leakage rates.

- o Erosion and corrosion. These defects are time dependent and can frequently be regarded as incipient if the pipeline is subjected to regular inspection. Erosion and corrosion both cause a reduction in the pipeline wall thickness until the internal pressure bursts a small hole. If the hole size equals or exceeds the critical size for structural stability of the pipeline, propagation to full bore rupture will take place. External corrosion can occur to exposed steel work if applied protective coatings break down.

- o Damage due to external causes, natural (for example, earth movement and river erosion) and third party, mostly drilling and excavation. Full bore rupture or a major leak can often result.

- o Operational factors, such as failure to maintain a proper cathodic protection system or pipe over-pressurization.

The generic contribution of each failure mode in natural gas transmission and gathering lines is illustrated in Figure 13.3(a). These data are drawn from the U.S.DOT-OPSR 20 day incident report form (DOTF7100.1) for the period 1970 through to June 1984, analyzed by the Battelle Columbus Division (BCD) (1986) an independent research body, in work sponsored by the American Gas Association. The reported incidents include only those where ignition took place, caused US$5,000 or more damage, required immediate repair and resulted in death or injury requiring hospitalization.

Figure V3/13.3(a) clearly shows that whereas small diameter pipes are most likely to fail due to outside forces, as pipe diameter increases to approximately 0.75m, the contribution of each failure mode becomes roughly equal. Several factors account for this trend : larger pipes have thicker walls and so are more resistant to external forces; they are less likely to pass through urban or industrial areas where a higher risk of impact might arise; and they are generally buried deeper, easier to detect and more frequently surveyed than small pipes.

Whilst the Battelle Columbus Division report does not specify whether it refers only to onshore pipelines other work has concluded that the contribution of the various failure modes is more dependent on pipeline diameter (wall thickness) and age than the external environment. In particular, Mare and Anderson (1980) of Det Norske Veritas concluded that "for pipelines of the same diameter, there was no discernible evidence to prove that the failure rates and modes of failure, for different pipeline systems involving different petroleum commodities and different environments, were different" on the basis of a comprehensive review of CONCAWE, US Geological Survey (USGS) of the Gulf of Mexico, US Department of Transport (USDOT), North Sea and Arabian Gulf data. This is illustrated by a comparison of Gulf of Mexico (USGS) and USDOT data in Table V3/13.3(a). The USDOT data refers primarily to onshore US pipelines. Although the two schemes used different categorization procedures it is apparent that the generic contribution of failure modes between different environments is within a factor of two or three of each other for most failure modes. Mare and Anderson found that the balance of failure modes between different environments, such those represented by the tabulated data, leveled out after taking account of the range of pipe diameters in each location.

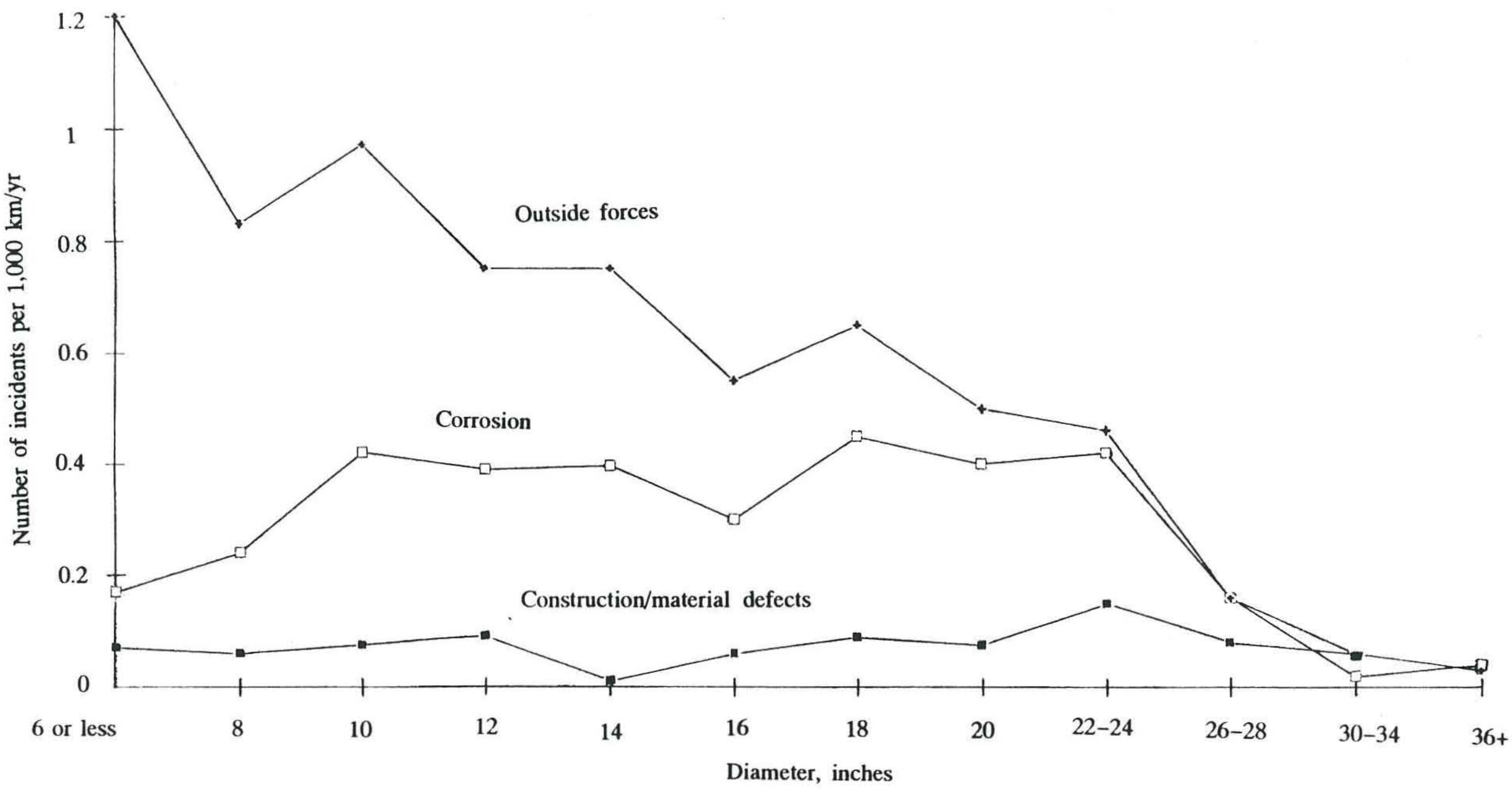

Figure V3/13.3(a) **Pipeline Failure Mode Contributions, 1970 - 1984**

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Table V3/13.3(a) Comparison of onshore and offshore Failure Modes		
Failure Mode	Gulf of Mexico (USGS)	USDOT
Outside force	38	53.5
Material failure	4	16.9
Corrosion	28	16.6
Other	30	7.4
Construction defect	?	4.8
Construction or material defect	?	0.8
TOTAL	**100**	**100**

Due to the small number of incidents reported involving large diameter pipelines, a more detailed analysis of the failure mode statistics is available only for the full spectrum of pipeline sizes. Nonetheless, such analysis is informative when considered with the trends shown in Figure V3/13.3(a). The following remarks therefore relate to all the reported incidents, regardless of pipeline size.

Regarding incipient ageing (wearout), the Battelle Columbus Division analysis of the corrosion failures indicates that 40% involve external corrosion, 27% internal corrosion and 17% stress corrosion. For internal and external corrosion pitting is the primary cause, accounting for 90% of such failures. 76% of corrosion incidents occur on cathodically protected pipelines, which highlights the risk of poor maintenance leading to the breakdown of pipelines protection.

Similarly 67% of the corrosion failures reported by the USGS involved external corrosion and only 33% involved internal corrosion. They did not separately identify stress corrosion.

Failure due to external force is clearly more likely in areas of high activity or ground instability. An analysis of such incidents by BCD sub-divides as follows :

Equipment operated by outside party	67.1%
Earth movement	13.3%
Weather	10.8%
Other	1.5%

Impact by machinery operated by third parties accounts for the great majority of externally initiated incidents, with 41% of these incidents involving pipelines buried at depths of between 24 and more than 60 inches. Thus, deep burial does not necessarily provide significant protection against outside forces.

The proposed natural gas pipeline is routed under a busy shipping channel, and across a shallow stretch of water north of Urmston Road, making landfall in an area where considerable activity is to be anticipated at later dates in relation to land reclamation and possible extensions to the power station. External forces are therefore expected to be the most likely cause of rupture of the proposed pipeline and are considered in (i) and (ii) below. However, construction defects, material defects, corrosion, erosion and ground movement could also lead to rupture.

(i) **External Impact causing Pipeline Rupture**

Due to the sparsity of data on 0.75m pipeline ruptures an analysis of the impact strength of a 0.75m pipe, is presented in this section, to verify the credibility of a full bore rupture of the proposed pipeline due to external forces.

Local collapse of a pipeline occurs as a progressive ovalisation of the section directly involved, regardless of possible displacements of the pipe axis. Following the approach of Enis *er al* (1980)[1], built on the experiments by Peech *et al* (1977)[2], local collapse is resisted by two additive mechanisms :

- Ring crushing, which generates a force proportional to the crushed length.
- Indentor crushing, which is the strength contribution by the rest of the pipe outside the crushed length, an effect which is independent of the crushed length.

For the impact calculations, two grades of pipe, were considered API 5L Grade B, and API 5XL Grade X60, with respective yield strengths 241MPa and 414MPa, and modulus of elasticity 210GPa. In accordance with The Institution of Gas Engineers recommendations ("Steel Pipelines for High Pressure Gas Transmission", 1984), a wall thickness of 9.52mm was assumed for a pipe of 762mm (30") diameter. It is generally accepted that rupture will occur if the ratio of indentation size to radius exceeds 0.7, and since large objects impacting the pipeline are the principal concern in this case, it was assumed that the impact ring length was equal to the pipe diameter. The results for the energy or thrust required to rupture the pipe are as follows :

	API 5L Grade B	**API Grade X60**
Thrust/T	5.1	8.9
Energy/kNm	8.2	14.5

These data can be related to the possibility of objects being dropped onto the above ground section of the pipeline. Thus, for objects dropped from 10m, the minimum masses necessary to cause rupture are 84kg and 150kg respectively. Dropped from 5m, the masses are 170kg and 300kg respectively.

(ii) **Subsea Rupture Due to Anchor Impact**

Although anchoring would be inadvisable near the pipeline, it would nonetheless be possible for an anchor to be set inadvertently across the pipeline or dropped in the case of emergency. The likely burial depth achieved when anchoring in the Urmston Road area has therefore been investigated, in comparison with the proposed burial of the pipeline to between 5 and 10m below the sea bed.

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1 Enis, R.O., Bernal, D.B. and Burdetter, E.G., "A design guide for evaluation of barriers for impact from whipping pipes", *Proc. 2nd ASCE Conf. Civil Engineering and Nuclear Power*, Paper 5-6, Knoxville, Tennessee, September 1980.

2 Peech, J.M., Roemer, R.E., Pirotin, S.D., East, G.H. and Goldstein, N.A., "Local crush rigidity of pipes and elbows", *Trans. 4th Int. Conf. SMIRT*, Paper F3/8, San Francisco, California, August 1977.

Anchor embedment depth is a function of :

- The anchoring vessel and the environmental forces acting upon it;
- Anchor weight, shape, dimensions and type;
- The nature of the sea bottom, in particular it mechanical properties;
- The scope of chain cable used.

The local windspeed can vary considerably, due to tropical storms and typhoons, although ships would normally leave the area in anticipation of such circumstances. Tidal currents of 1–2 knots are common; 3 knots in a suggested peak value. It is assumed that the effect of waves will be small in this confined area.

The size of anchor required for a ship is defined by the Classification Society Rules via an Equipment Number, which is derived from various dimensions of the ship. Table V3/13.3(b) shows anchor sizes for the tonnage of ships commonly in Urmston Road. (It is emphasised that these are only indicative values).

Table V3/13.3(b) Indicative Anchor Sizes and Environmental Forces

Vessel Size (DWT)	Stockless Anchor Weight (T)	Thrust (T): Wind 25m/s Current 2.5/ms Acting Head-on	Thrust (T): No Wind Current 2.5m/s Acting Head-on
25,000	6.5	30–60	15–48
50,000	8.7	38–83	19–63
100,000	12.3	50–115	28–90
125,000	14.0	65–125	30–105

Core samples taken in the vicinity of the pipeline route indicate that the sea bed in the area is generally mud. Down to the maximum envisaged burial depth for the pipeline(10m) the material is generally described as soft clay. No material properties are available for the samples taken. However, other samples taken in the Hong Kong area show very low shear strength.

Currently there is no complete and validated model of anchor burial which fully represents all the above factors. In the absence of bottom material strength data, the best indication of burial depth is provided by documented anchor tests in similar material, i.e. soft mud. Data from Taylor (1981)[1], Vold (1983)[2] and Puech *et al* (1978)[3] are shown in Table V3/13.3(c).

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1 Taylor, R.J., "Performance of Conventional Anchors", *13th Offshore Technology Conference*, Houston, May 1981.

2 Vold R.C., "Anchor Holding tests in the Norwegian Trench", *15th Offshore Technology Conference*, Houston, May 1983.

3 Puech A et al, "Behaviour of Anchors in Different Soil Conditions", *10th Offshore Technology Conference*, Houston, May 1978.

Table V3/13.3(c) Results of Anchor Tests			
Anchor Type	**Weight (T)**	**Mooring Load (T)**	**Max Penetration (m)**
Stevin*1	3.75	50	11
Flipper Delta*1	3.75	54	11
Bruce	3.75	22	5
Baldt	3.75	26	6-8
Navy	2.7	18	4
Stockless	2.7	18	6
	5.2	26	5
STATO	0.5	10	4
	1.6	33	6
	3.0	48	7

*1 - these anchors are high holding power anchors normally used in offshore activities.

Whilst some quite commonly used anchors do not appear to generate much holding power in such material, those that do will do so by burying quite deeply into the bottom. The above test data show that the 'normal' anchors (i.e. excluding the Stevin and Flipper Delta), all have burial depths around 5 meters. As indicated in Table V3/13.3.1(b), vessels in the vicinity of Black Point are likely to have substantially larger anchors and mooring loads than those in these test, and so it is expected that the anchors in question will bury themselves at least as deeply.

It is therefore concluded that, even allowing for the uncertainties inherent in this analysis, in order to generate sufficient holding power in soft mud for the vessels in questions, anchors will bury themselves to depths which may bring them into contact with the gas pipelines, if it is buried between 5 and 10m below the sea bed.

Furthermore, it is clear from the impact strength calculations presented above that, even in the absence of wind, the mooring force exerted by any of the sizes of ship considered here would be more than sufficient to rupture the steel pipeline.

It should also be noted that the above has not considered the use of bucket dredgers in the vicinity of the proposed pipeline. Dredging in the vicinity of the pipeline would be strictly controlled, however, it is anticipated that if such a dredger were to impact the pipeline, rupture would be very probably occur.

13.3.2 Oil Storage Tank Failure

The following factors can lead to a major leak or a catastrophic rupture of a storage tank :

- o External Forces. Examples include damage due to missiles, fires, and subsidence. Missiles may be generated by on-site incidents, and can lead to a serious escalation of the original hazard.
- o Spontaneous structural failure, due to material or construction defects.

13.3.3 Oil Supply Ship Failure

The principle causes of accidents involving a supply ship, leading to a cargo spillage, are :

- o Shiphandling associated events such as collision with other vessels; striking floating objects; impact against fixed objects such as a jetty; grounding; ranging of a moored vessel relative to its berth, causing damage.

- o Onboard fires and explosions; spontaneous cargo tank or hull fractures; compartment overpressure due to failure of safety relief valve(s).

- o External factors such as aircraft crashes, fires and explosions (overpressure and missiles), lightning strikers, sabotage or military aggression.

Whilst the majority of accidents involving oil supply ships or oil storage tanks lead to only a partial release of hydrocarbon inventory, there are numerous well documented incidents involving the loss of a complete compartment or tank. Therefore it is not considered necessary to carry out an analysis of the forces that would be required to cause a rupture.

13.4 <u>Consequence Analysis of Failures of Inventory Holders</u>

13.4.1 Gas Pipeline Rupture Consequence Analysis

A consequence analysis has been carried out for the full-bore rupture of the 5km of pipeline nearest to shore, assuming that the pressure at Lung Kwu Chau is 30 bar, and that the flow rate is the maximum specified, 50MMscfhr, equivalent to $320kgs^{-1}$. Such a rupture could occur either under water or above ground. By calculating the rate of release of gas due to rupture, and modelling the gas dispersion, the range achieved before the concentration drops below the lower flammable limit (LFL) of 5% has been estimated. The analysis has been focussed on the potential fire hazard, rather than the explosive potential, because an unconfined natural gas explosion is not considered to be a credible event, and hence the fire hazard represents the 'worst case' scenario.

For the purposes of these calculations, it was assumed that the gas would normally be at an ambient temperature of 20°C (sea bottom temperature in Urmston Road ranges between 16–28°C), with density 0.8034 kgm^{-3} at 1.013 bar, and that the ratio of specific heats is 1.27 (both from Crane, 1977). The speed of sound under these conditions is $400ms^{-1}$. The gas velocity at 30 bar corresponding to the specified maximum flow rate is $30.5ms^{-1}$, giving a Reynolds number of approximately $5x10^7$, so that the appropriate Moody friction factor for clean commercial steel pipe is 0.011.

Using the simplified compressible flow model for natural gas in long pipelines (Crane, 1977)[1], under normal supply conditions, the pressure at Black Point will be approximately 20.3 bar at the maximum specified flow rate. The associated gas density is $16.1kgm^{-3}$, and the flow velocity is $45.1ms^{-1}$.

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1 Crane, "Flow of Fluids through valves, fittings and pipe", Crane Ltd, 1977.

(i) Full Bore Rupture Above Ground

Should a full bore rupture occur above ground, a similarity flow would be established (Landau and Lifshitz, 1959)[2], the sudden pressure drop forming a rarefaction wave which would move back up the pipeline at the local speed of sound. This wave would take 12.5s to reach the pressure control valve, during which time the outflow would be sonically choked, so the actual outflow pressure would exceed atmospheric pressure. Allowing for the initial gas velocity, adiabatic similarity flow gives an outflow rate of $1110kgs^{-1}$, with an associated density of $7.05kgm^{-1}$, pressure 7.10 bar, and temperature 234k. The gas would then expand outside the pipe to atmospheric pressure in a series of shocks, cooling further to 155k, with density $1.52kgm^{-3}$. The outflow rate would be constant during this period.

When the rarefaction wave reaches the pressure reduction valve, the controls would act to maintain a pressure of 30 bar at the island, causing additional rarefaction waves to travel the pipeline until a steady outflow is established, supplied by the inventory in the 100 bar supply pipeline. Thus the above outflow rate would be maintained for 25s, after which it would decrease to the steady state value, approximately 1 minute after rupture; the steady state release would still be sonically choked, but the outflow pressure would drop to 3.1 bar with an outflow rate of $430kgs^{-1}$.

Following rupture, the force acting on the pipe due to the jet of escaping gas would be equivalent to approximately 90 tonnes initially, dropping to 30 tonnes during the similarity flow, and to 14 tonnes when steady flow is re-established. These reaction forces might be sufficient to cause the pipeline to break loose from it fixtures, and whip about in various directions. The jet may also be broken up by buildings.

To allow for this uncertainty, two scenarios were considered, corresponding to different limiting cases. Firstly, a high momentum horizontal jet release, and secondly, a release with negligible momentum, in which a plume is formed and then carried by the wind.

- **Horizontal Turbulent Jet Dispersion**

  Using the standard jet dispersion model (TNO, 1979)[3] and the above similarity flow results, the furthest distance to the LFL concentration would be 280m for the initial outflow rate of $1110kgs^{-1}$. The model used for this scenario also permits calculation of the jet velocity, giving a time of flight to 280m of 10s, i.e. less than the duration of the initial discharge rate, confirming assumption used in the model of continuous discharge. Also, the dispersion would still be momentum-dominated because the jet velocity would be $15ms^{-1}$ at 280m, much more than the usual wind speed.

  Soon after the rupture, the outflow rate would begin to decrease, and the jet would become less extensive. When steady state flow is re-established, the LFL concentration would not extend beyond 180m.

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2 Landau, L.D., and Lifshitz, E.M., "Fluid Mechanics", Pergamon Press, 1959.

3 TNO (netherlands Organisation for Applied Scientific Research), "Methods for the Calculation of the Physical Effects of the Escape of Dangerous Material", 1979.

The likely range of a jet release from a small leak was also examined. In such cases, the flow in the pipe is negligibly effected by the leak, so the standard (time independent) gas outflow model is appropriate (TNO, 1979)[1]. For a 3cm diameter leak at 20.3 bar, the LFL range is approximately 10m. If there were an ignition source within this distance, an explosion could occur if any surrounding buildings provided sufficient confinement. This could cause a full bore rupture.

o **Plume Dispersion**

Immediately after release, the gas would be denser than air because of its lower temperature. However, for the case of a slowly dispersing plume, heat transfer would occur on contact with the ground or surrounding buildings, causing the gas to become neutral and then buoyant - the density of natural gas relative to that of air at the same conditions is approximately 0.67. This phenomenon is not relevant to a momentum dominated release, as considered above, because the velocity of the released gas is so much greater in that case.

A major issue relating to a buoyant plume is whether or not it will lift off from the ground. If lift-off does occur, only a short range hazard is posed at ground level. In relation to this, Briggs has presented a criterion in terms of a lift-off parameter, L_p (briggs, 1976)[2]: if L_p is greater than around 2.5, lift-off is likely to occur. L_p is a function of the density of the released gas relative to air, the height of the released plume, and the local wind speed. Assuming that the plume height would be equal to its radius, for a $3ms^{-1}$ wind speed, $L_p = 20$, and for a $2ms^{-1}$ wind speed, $L_p = 30$. In either case, lift-off is therefore to be expected.

However, in practice it has been found that lift-off does not always occur in this manner, at least not for some time after rupture. A case example clearly illustrates this point. In 1978 a 60 cm natural gas pipeline operating at 35 bar developed a leak due to internal corrosion, near a gas processing plant in Abiqaiq, Saudi Arabia. The leak expanded and a large gas cloud formed. After about seven minutes ignition occurred from a flare 500m downwind (M&M Protection Consultants, 1988)[3].

This example is particularly pertinent because although the pipeline was smaller, it was operating at a higher pressure than the proposed CLP pipeline. It clearly demonstrates that a flammable gas cloud can form to distance of the order of 500m before buoyancy effects take over. At present there is no completely satisfactory theoretical account of the behaviour of potentially buoyant gases released at ground level. This historical example is therefore an important precedent as to the potential hazard distance resulting from a jet release, converted into a low momentum release by its surroundings.

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1 Op Cit.

2 Briggs, G.A., "The Lift-Off of a Buoyant Release at Ground Level".

3 M&M Protection Consultants, "100 Large Losses, A Thirty Year Review of Property Damage Losses in the Hydrocarbon-Chemical Industries", eleventh edition, 1988.

As the Abiqaiq pipeline operated at 35 bar rather than 30 bar it is possible that a low momentum release from the Lung Kwu Chau to Black Point pipeline would not travel as far as 500m. Also, it cannot be stated with certainty that the Abiqaiq pipeline did not contain a small proportion of heavier gas such as propane. The presence of heavier gases would decrease the chance of the cloud lifting off. Notwithstanding the latter proviso's it is apparent that a low momentum release of natural gas from a 30 bar pipeline could travel up to 400 to 500m in a flammable state.

(ii) **Subsea Rupture**

If rupture of the pipeline were to occur on the sea bed, the gas outflow would at first be hindered by the momentum of the surrounding water. However, the initial pipeline pressure is sufficiently large that the water would be accelerated vertically to the above ground sonic release velocity and out of the path of the escaping gas in 2-3 seconds. Similarly, any infill covering the pipe would be blown clear very rapidly. Once a steady release is established, the outflow rate would then be approximately the same as that for an above ground rupture, with a small correction due to the overpressure of water above the pipeline - no more than about 1 bar.

A vertical momentum jet would be formed, projecting above the sea surface and only a small fraction of the momentum would be lost to recirculating water currents. As for the above ground rupture, the gas would initially be denser than air, due to its low temperature. However, the consequent negative buoyancy force would have only a very small impact on the vertical momentum. The small amount of low momentum gas near the sea surface would rapidly be heated and become buoyant. **The hazard presented at sea or ground level by a subsea release would therefore be limited to a distance of no more than some tens of meters from the point of release.**

As described above, following isolation of the ruptured pipeline, the outflow rate would decrease exponentially. This would be accompanied by a reduction in the vertical momentum component of the jet release, so that a plume could form at about sea level. However, the gas would also become buoyant more quickly, encouraging gravitational lift-off. It may also be argued that as there would be a lapse of time before this scenario developed, the opportunity for escape would mitigate any additional hazard posed at sea level.

(iii) **Operator Intervention**

As explained above, the initial rate of outflow following rupture would be in each case independent of any action taken to shut down the supply; in the absence of such measures, a steady flow would be re-established in the pipeline after approximately 1 minute. It is estimated that the isolation value would take at least 30 seconds to close, and more probably 2 minutes; thus it is unlikely that the gas supply would be shut down in less than 3 minutes after rupture, giving due allowance for the period before closure is initiated. The time lapse could be much longer as a result of operator delay and/or failure of the valve to close. If the valve is closed, the outflow rate would then decay exponentially.

By comparison, a high momentum jet would achieve its maximum range in around 10s, as established in V3/13.4.1(i) above. For a low momentum release lasting more than a minute the distance travelled downwind by the resulting gas cloud is dependent principally upon the local weather conditions, rather than the release duration. Therefore in either case, any operator action to shut down the gas pipeline would have little impact on the hazard range.

(iv) Discussion of Off-site Impact

Although both scenarios envisaged for an above ground release clearly present some off-site hazard, the range of this impact, (about 100m - about 300m) is considerably less than the distance to the current nearby population centers (1.2 - 3km). The area between Black Point and the sewage outfall, which has been identified for reclamation, could be affected, depending on the final route the pipeline follows.

However, since the Black Point ridge is to be retained, if the pipeline were to make landfall on its north west shore, this area would be shielded from any jet release. The ridge will also tend to encourage the lift-off of any low momentum gas cloud, in the manner of a stack release, so decreasing the range of potential impact. However, the topography would offer no protection to this area from an above ground release if the pipeline makes landfall on the south west shore.

If a sub-sea rupture occurs very close to the shore, a hazard would be presented to the adjacent area. A rupture in the Urmston Road shipping channel would similarly pose a hazard to any vessels passing immediately by (i.e. within about 100m) of the point of release.

13.4.2 Oil Release Consequence Analysis

If a delivery ship or a storage tank were damaged by collision or corrosion, substantial quantities of oil could be released, and whilst the oils to be used have high flash points, in either case a large pool fire might occur. For both these cases, the resulting heat radiation, and its potential threat of life are quantified below. Explosions can also occur in oil storage vessels, generating missiles that can cause escalation of the incident. However, the immediately ensuring fire would represent the greatest hazard to off-site populations.

The fuel oil examined in this study is of very low volatility. Therefore, the chances of an oil release being ignited is very low. However, there are examples of ignition sources, such as engines room explosions, being of sufficient strength to ignite fuel oil and cause casualties. Therefore, the ignition of a spreading pool of oil is a valid limiting worst case event. In the case of a release upon the sea surface from a ship it is likely that the oil would not be flammable at a thickness of less than 1cm due to the cooling effect of the sea and pool break up. This is therefore used as a limiting factor for the extent of oil barge/tanker release hazard.

(i) Oil Release from Storage Tanks

Gas oil is to be stored in four tanks, each of up to 62,500 tonnes capacity. These tanks are to be bunded, with capacity for 110% of the largest storage tank. For pool fire calculations, it was assumed that the bunds will be 2m high. A conservative estimate for a light oil is in the range C_6 to C_8, with density approximately $850 kgm^{-3}$, this equates with a bunded area of $45,000m^2$. A higher bund wall may be installed to maximise land use, although this has not been confirmed yet. Therefore, it is possible that there would be a much reduced combustion area and hazard posed by the storage tanks than that estimated here.

To calculate the heat radiation resulting from a release of all the oil in one storage tank, the WHAZAN implementation of the standard TNO bunded pool fire model was used, which is considered to provide conservative estimates of heat flux distances. The distance from center of the fire versus heat flux relationship would be as follows :

heat flux/kWm^{-2}	**4**	**12.5**	**37.5**
distance/m	**510**	**290**	**170**

The fire would last for roughly 5 hours. Other storage tanks might well be damaged during this time, but it is assumed that any evacuation would be affected before such escalation occurs.

(ii) Oil Release from Delivery Barge

Oil release from one compartment of a 1,500 tonne delivery barge would form a spreading pool on the sea surface. Using the TNO spreading pool model (TNO, 1979), and assuming that the pool would be flammable out to the distance where it is 1cm thick, an 800 tonne release could result in a pool fire of radius approximately 120m. Roughly 5 minutes would elapse before the pool would spread to this distance. Using the same model as for the storage tank release, the resulting heat radiation would be as follows:

heat flux/Kwm^{-2}	**4**	**12.5**	**37.5**
distance/m	**420**	**180**	**60**

The distances cited assume that the center of the fire is a pool radius (i.e. 120m) out to sea, and are onshore distance. Thus onshore locations less than 420m from the shoreline would be exposed to a heat flux of at least 4kWm^{-2}.

Such a fire would last for approximately 4 minutes. If the pool were ignited soon after the spillage occurred, the oil would clearly spread less far. The fire would therefore be less extensive, and the hazard distance reduced.

(iii) Oil Release from Tanker

Maximum compartment capacity of a 40,000 dwt has been assumed to be 2500t. The worst case of a release of the entire compartment inventory, could result in a pool fire of radius approximately 200m. Roughly 7 minutes would elapse before the pool would spread to this distance. Following ignition, the heat radiation would be as follows :

heat flux/Kwm^{-2}	**4**	**12.5**	**37.5**
distance/m	**660**	**290**	**80**

These distances are measured as before.

The fire would last for approximately 5 minutes.

(iv) Discussion of Off-Site Impact

In assessing the dangers posed by levels of heat radiation, it is usual to consider an exposure of 30s duration, for which 4kWm^{-2} poses a negligible threat to life; 12.5kWm^{-2} causes fatality in 1% of cases; 37.5kWm^{-2} is most often fatal.

Applying these criteria, we see that the hazard resulting from a release from a tanker compartment would be approximately as extensive as a release from a storage tank: in both cases a major hazard would be posed at distances of less than approximately 300m, but beyond about 600m, there would be negligible hazard. The potential heat load experienced as a result of a spill from a barge would be somewhat less, with negligible hazard beyond about 400m.

There are no centres of population close enough to Black Point for either of these two pool fire scenarios to pose a significant hazard to the inhabitants. The proposed area of reclaimed land to the south of the sewage outfall would be beyond the major hazard distance. However, some part of the area between the outfall and Black Point may fall within the major hazard distance for both oil fire scenarios, depending on the final location of the tanker and barge berths.

13.5 Conclusions and Mitigation

It is unlikely that a release from either the natural gas pipeline or the oil transport and storage vessels would pose a major hazard to current off-site populations. Similarly, even given a worst case release scenario, it is unlikely that there would be a major hazard at a point south of the sewage outfall. However, in a worst case release scenario, both the gas pipeline and the oil tanks/ships could pose a hazard to life between Black Point and the sewage outfall, depending on the final pipeline route and berthing locations.

This impact can thus be avoided by locating the pipeline route and berthing facilities such that the hazard distances involved (taking account of shielding effects provided by topography) are fully within the LTPS site.

14. CONCLUSIONS AND RECOMMENDATIONS

14.1 Introduction

The significance of the impacts associated with the operation of CLP's LTPS at Black Point is determined both by the nature and scale of the development and by the characteristics of the environment into which it will fit. In this regard it is important to consider the stages of site selection and layout refinement which were carried out prior to the site-specific EIA. For operational impacts, the potential sphere of influence of the LTPS is larger than for construction impacts.

Environmental and planning considerations were a major component of the decision framework that resulted in the choice of Black Point during the Site Search. During detailed site design, as is explained in V2/2.4, the evolution of the final site location and layout options were influenced by environmental factors. Of particular importance with regard to operational impacts was the decision to develop north of Black Point whilst maintaining a large part of the ridge. This decision substantially reduces the likelihood of significant noise and visual impacts to the sensitive receivers in Lung Kwu Tan and Lung Kwu Sheung Tan. The proposed reclamation shape should serve to minimise changes to the hydraulic regime around Black Point, and modelling is being carried out to confirm this.

It should be noted that tne final assessment of a number of issues will be presented in the Key Issue Reports on Stack Emissions, Water Quality and Solid Byproducts which are due for completion in late-1991.

14.2 This section presents a summary of the significance of the impacts considered in each section of this volume: The need for monitoring, further assessment, or mitigation is indicated where appropriate:

o **Air Quality**: Assuming that the EPD's BPM of emissions control are implemented, it is considered that the potential for human health impacts is only possibly significant with respect to the short term, i.e. 1-hour average concentrations. The extent and type of mitigation measures required cannot be determined at this stage, however, because of the significant levels of uncertainty attached to the predictions made so far. This uncertainty should be reduced to manageable levels by undertaking wind tunnel tests during Phase 2 of the Stack Emissions Key Issue Assessment.

Preliminary output from simple wind tunnel tests will be available for review during April. At this stage a second series of much more complicated tests will be made providing detailed information of how the plumes from both Black Point and Castle Peak will disperse across the complex terrain of the New Territories, Lantau Island, and if necessary Shekou (this will depend on the implications of results obtained for Lantau). By August or September it is expected that a comprehensive set of tests will have been completed and the results presented in a Phase 2 Report. If short-term impactsare proven to be unacceptable, this report will provide detailed information on the potential benefits, technical feasibility and costs of a range of mitigation options.

The only other potential impacts that are recommended for further study in the Stack Emissions Key Issue Assessment are those associated with acidification. It is considered that the power station emissions are unlikely to result in any significant impacts, based upon the predicted dry deposition rates and understanding of the sensitivity of the territory's soils and water supplies to acidification. However, the contribution of wet deposition requires further investigation.

- o **Noise**: The assessment indicates that no significant impact will result either during the day-time or at night, from the operation of LTPS plant. Plant operations will, however, be audible at Lung Kwu Tan but the level of noise increase this represents will be minimal and unlikely to constitute a nuisance.

- o **Water Quality:** The work of the Initial Assessment has reinforced the consultants' view that the site is acceptable with regard to marine water quality. The results of mathematical modelling currently underway concerning the two key issues of the effect of the physical presence of the LTPS on sea flow patterns, and the extent of the thermal plume from the cooling water discharge, are expected to confirm this.

- o **Waste Disposal**: Appropriate disposal locations for MARPOL wastes have been identified. Beneficial uses of PFA and gypsum have been identified but will be subject to government review and approval. The suitability of disposing of gypsum FGD by-product by dissolution in the cooling water discharge was discussed and the practicability of avoiding gypsum disposal requirements by using a seawater scrubbing system was examined. These issues are still the subject of study and findings will form part of the Key Issue Report on Solid Byproducts.

- o **Traffic**: Operational road traffic from the LTPS is not considered to have a significant impact. Traffic generation will be light and potential hazards will be avoided by appropriate design of site exits, signalling and site exiting procedures. If PADS developments between CPPS and the LTPS site proceed, the existing road will be inadequate. It is assumed, however, that such development would include the provision of an adequate road link. Marine traffic generation is not predicted to be significant.

- o **Ecology**: No significant impacts on terrestrial vegetation as a result of particulate, metal or dry acid species deposition were predicted. Potential impacts, however, will be further investigated as part of the Stack Emissions Key Issue Study, in particular, those relating to wet acid deposition. The marine ecological assessment is still some way from completion. Future scheduled surveying and the results of a detailed hydraulic and water quality monitoring programme will be required in order to determine the likely impact of the LTPS. A number of issues have emerged to date. Marine ecological losses can be minimised by appropriate location and design of cooling water intakes and outfalls. The Chinese White (Pearl River) Dolphin makes use of the Urmston Road channel, and the development and operation of the LTPS, in conjunction with other deep waterfront industrial activities has the potential to affect the dolphins' environment. Mitigation in the form of an appropriately equipped viewing platform at the LTPS is proposed. Further study on marine ecological issues will be presented in the Water Quality Key Issue Report.

- o **Civil Aviation**: Although the LTPS stacks for the coal fired units will project above the obstacle limiting surface of the new airport at Chek Lap Kok it is not considered significant due to the shielding effect of the hill range to the east, the peaks of which will be well in excess of the stack heights. Recommended stack heights will be developed from the Stack Emissions Key Issue Study and will be discussed with CAD and the consultants for the new airport. The LTPS is not considered to pose any significant risks to aircraft from thermal or cloud generation effects.

- **Socio Economics:** Operation of the LTPS will provide positive socio-economic impacts by enabling a future power shortfall in Hong Kong to be avoided, and providing direct and spin-off employment. Possible adverse impacts on commercial mariculture in Deep Bay is being addressed in the Water Quality Key Issues Study and is a priority in the engineering design of the cooling water and other waste-water disposal systems to minimise these potential effects.

- **Cultural Heritage and Fung Shui**: No significant cultural impacts are anticipated as no additional land take will occur as a result of LTPS operation. The Fung Shui impacts and mitigation requirements that could be incorporated into the detailed design and layout of the LTPS are currently under investigation by CLP and local experts.

- **Visual**: The location and layout of the LTPS permits a substantial part of the Black Point ridge to be retained; this will result in views from the south being restricted to the upper portions of the coal-fired unit chimneys. From the north-east, views from the Nim Wan road will be distant. In the context of the semi-industrialised nature of the site the visual impact of the LTPS is considered to be moderate. Should PADS developments proceed, the LTPS will be compatable.

- **Risk**: The nearest population centres are under no significant hazard from the consequences of gas or oil incidents at the LTPS. Risks to potential PADS users immediately south of Black Point may be avoided by locating the gas pipeline route and oil berthing facilities such that the hazard distances involved lie wholly within the LTPS site.

ANNEXES

ANNEX V3/A

LTPS AT BLACK POINT: SITE EVOLUTION DIAGRAMS

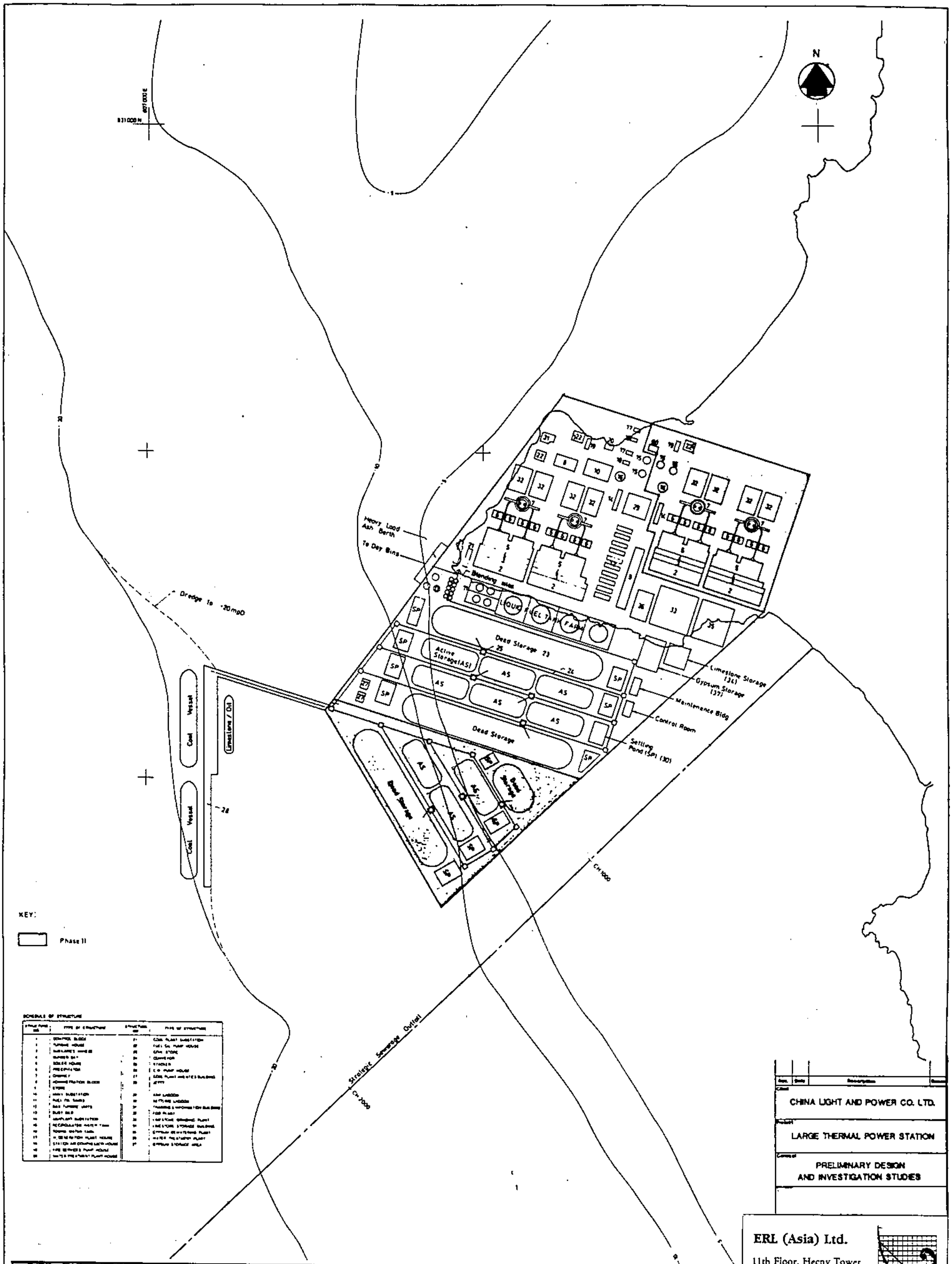

Figure V3/A1 LTPS at Black Point: Stage 1, Scenario I Option 1

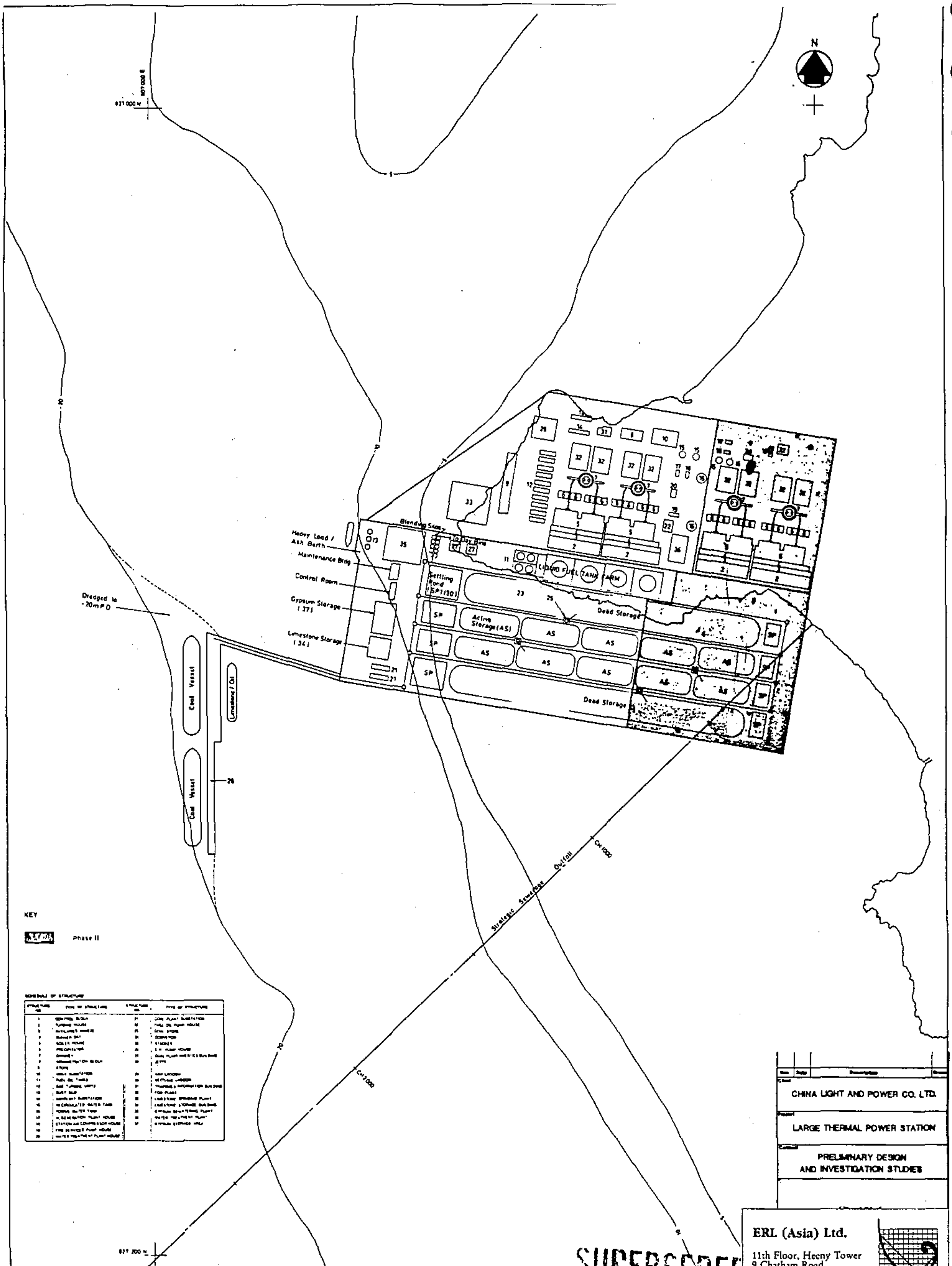

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Figure V3/A2 LTPS at Black Point: Stage 1, Scenario I Option 2

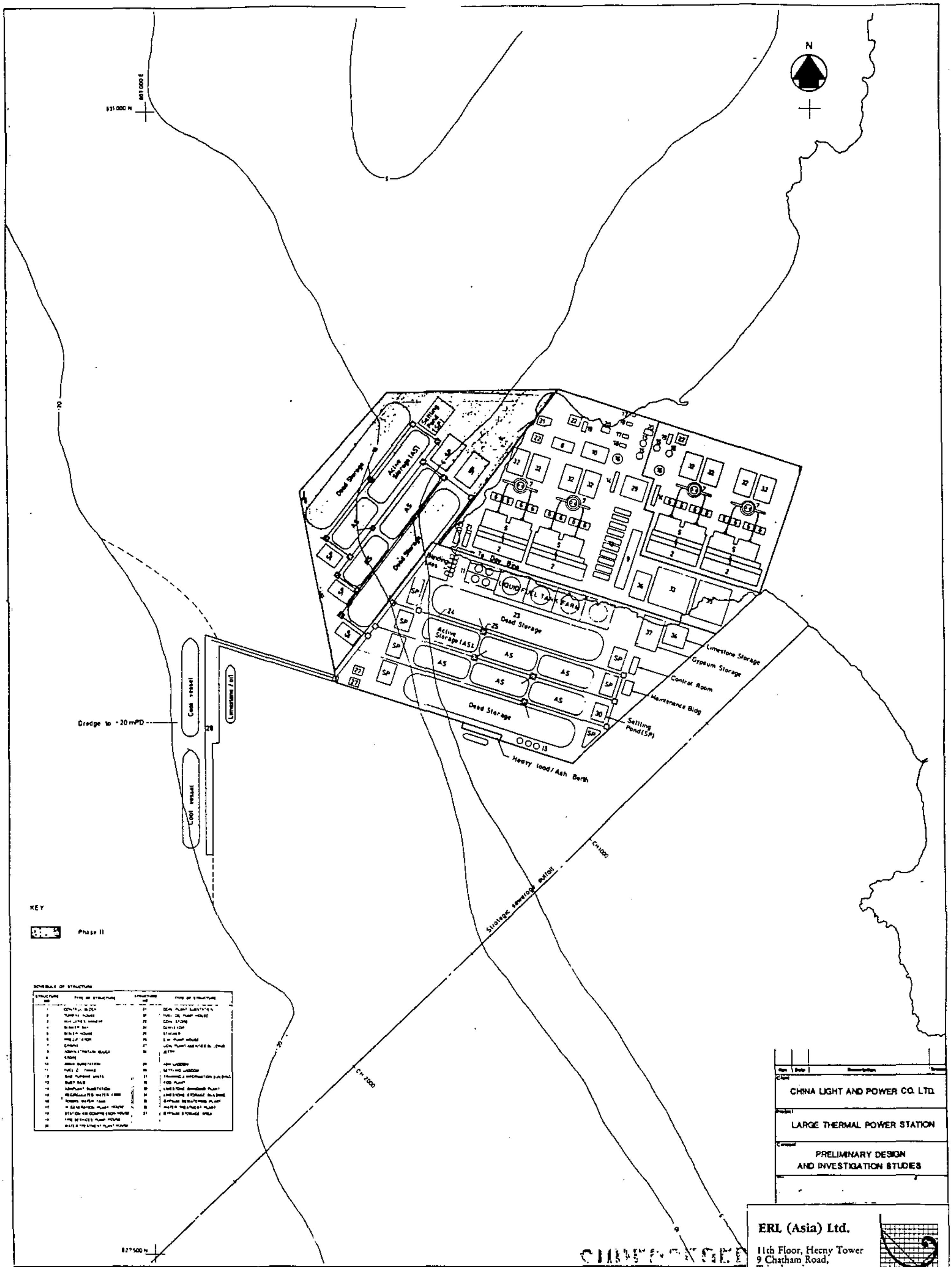

Figure V3/A3 LTPS at Black Point: Stage 1, Scenario I Option 3

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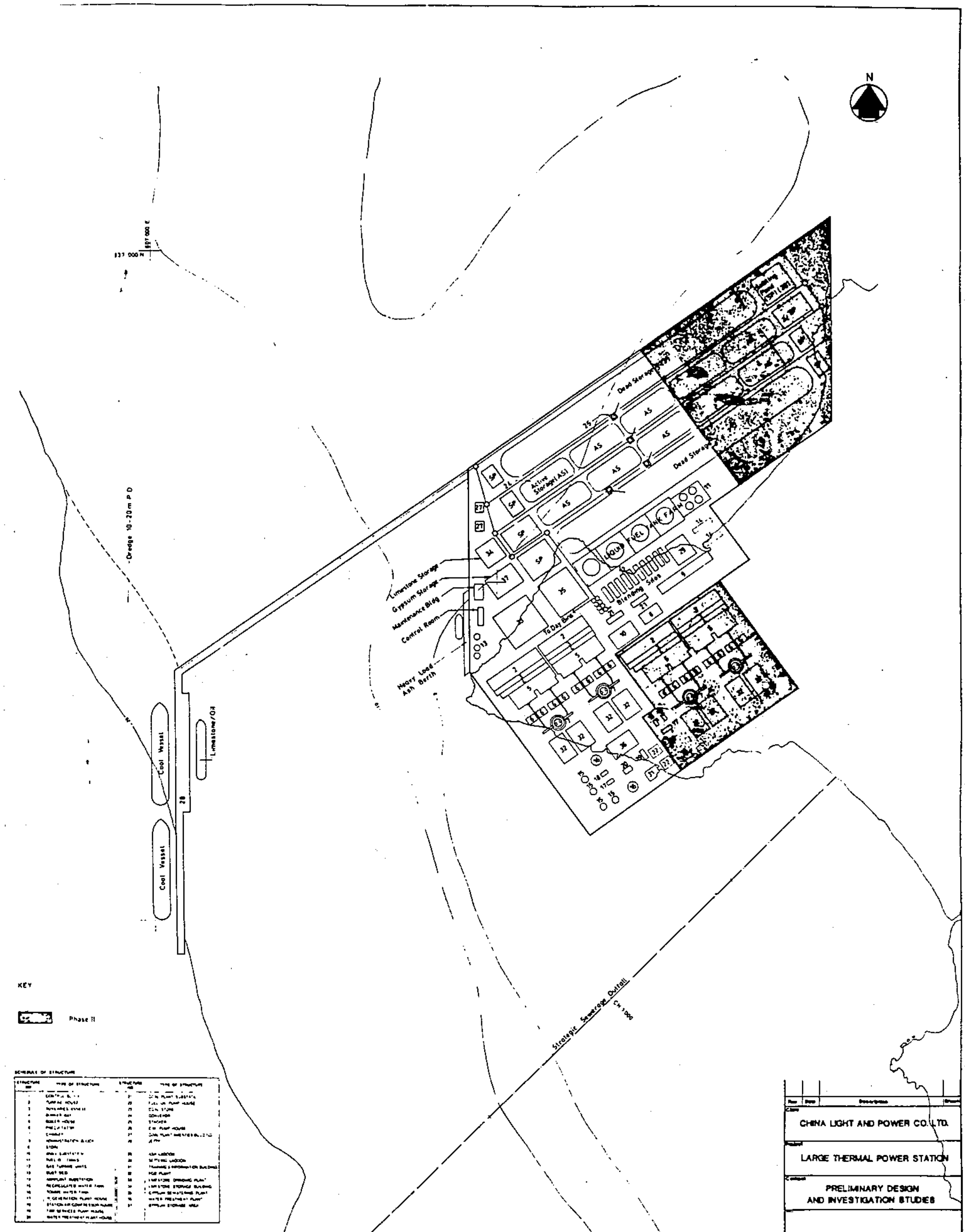

Rev	Date	Description	Sheet

Client: CHINA LIGHT AND POWER CO. LTD.

Project: LARGE THERMAL POWER STATION

Contract: PRELIMINARY DESIGN AND INVESTIGATION STUDIES

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Figure V3/A4 LTPS at Black Point: Stage 1, Scenario I Option 4

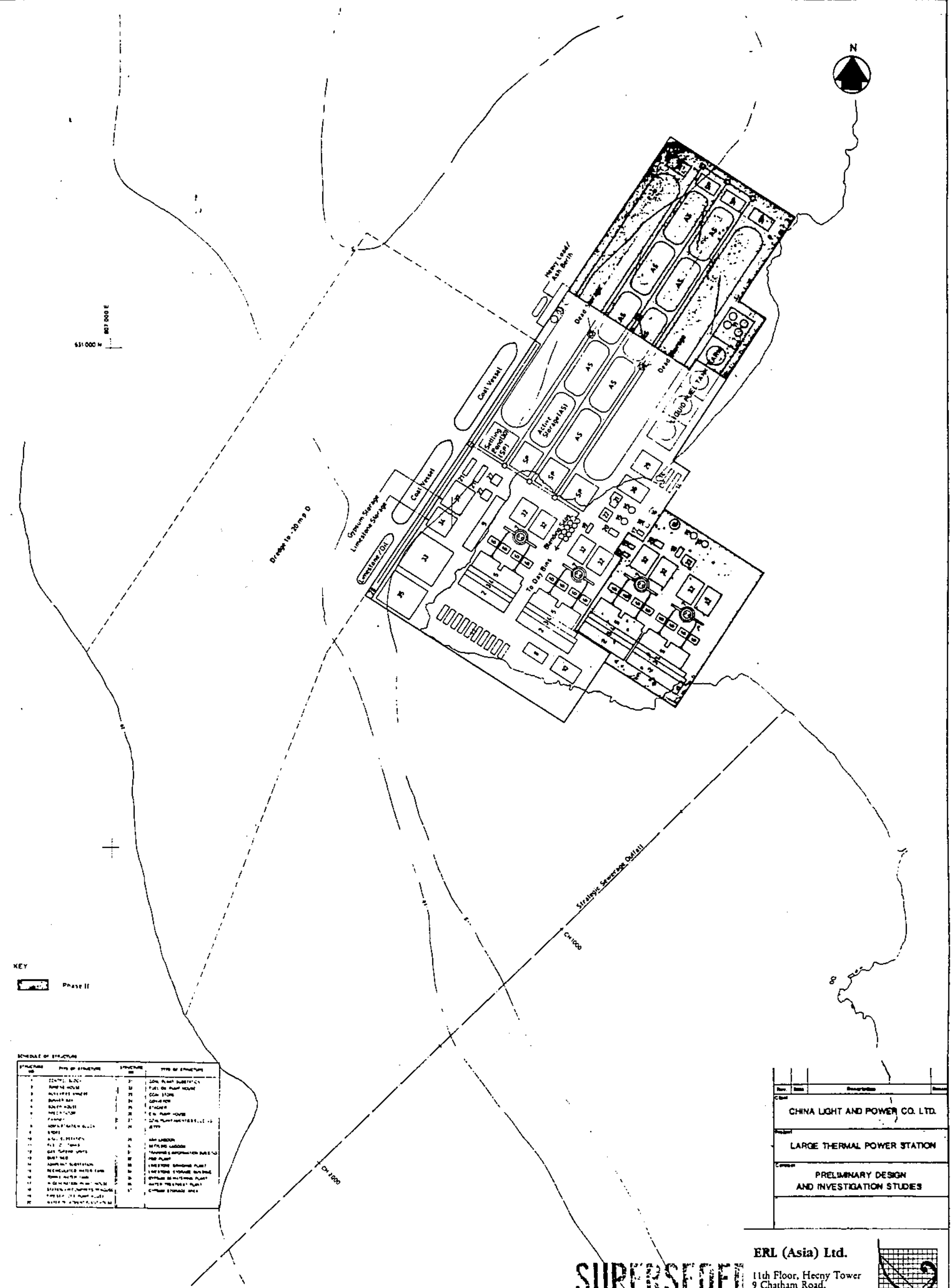

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Figure V3/A5 LTPS at Black Point: Stage 1, Scenario I Option 5

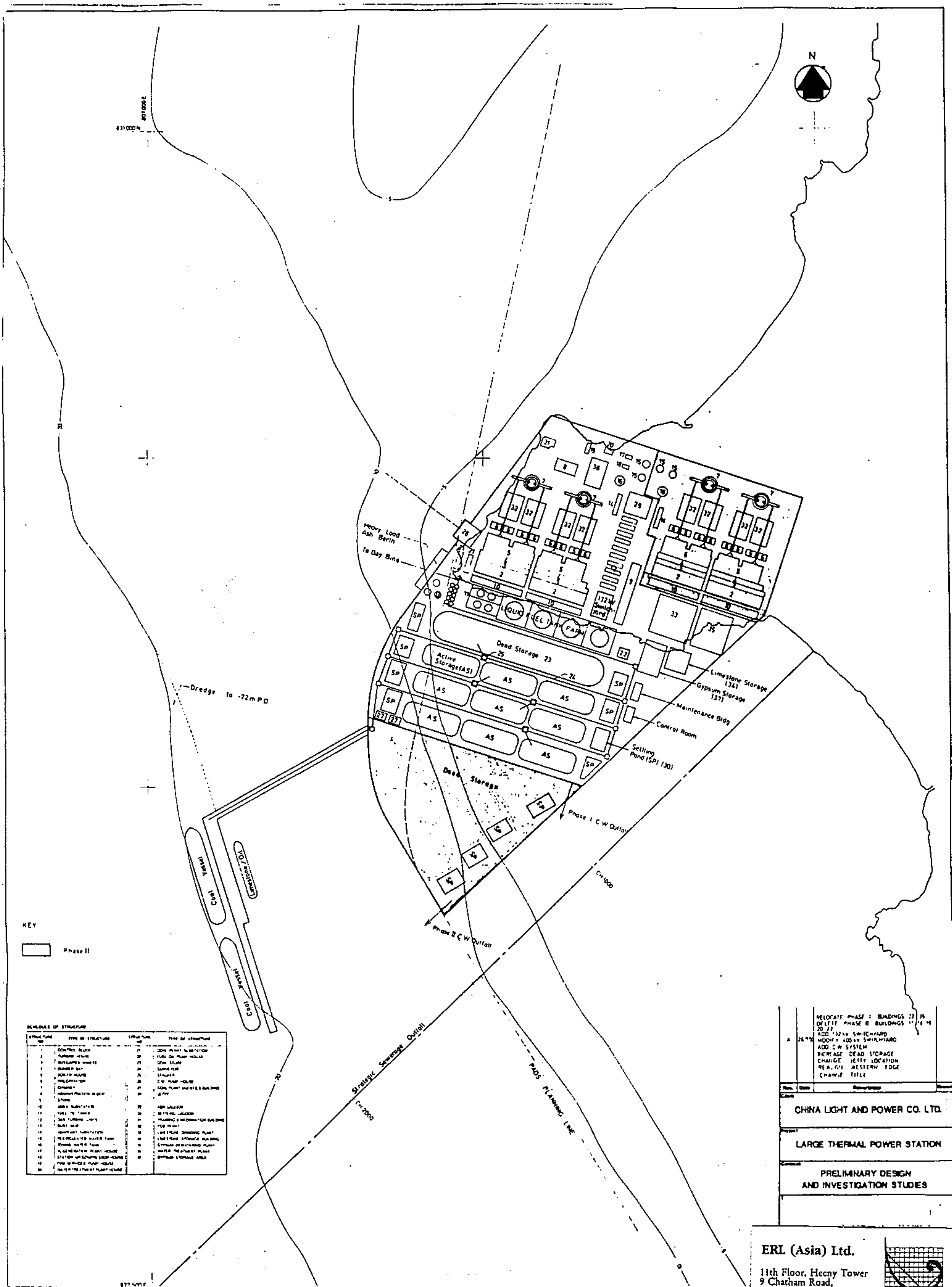

Figure V3/A6 LTPS at Black Point: Stage 2, Scenario I Option 1

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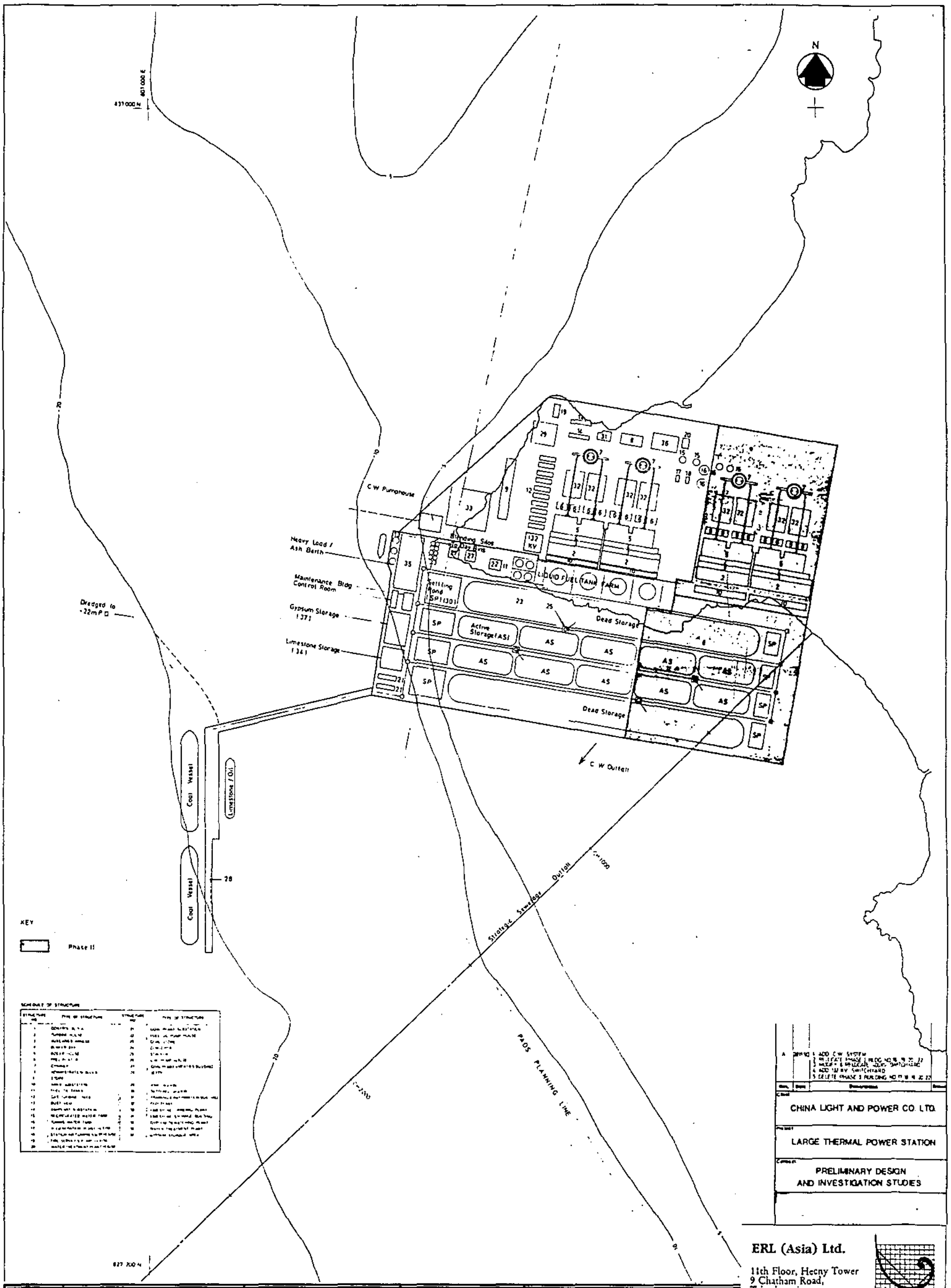

Figure V3/A7 LTPS at Black Point: Stage 2, Scenario I Option 2

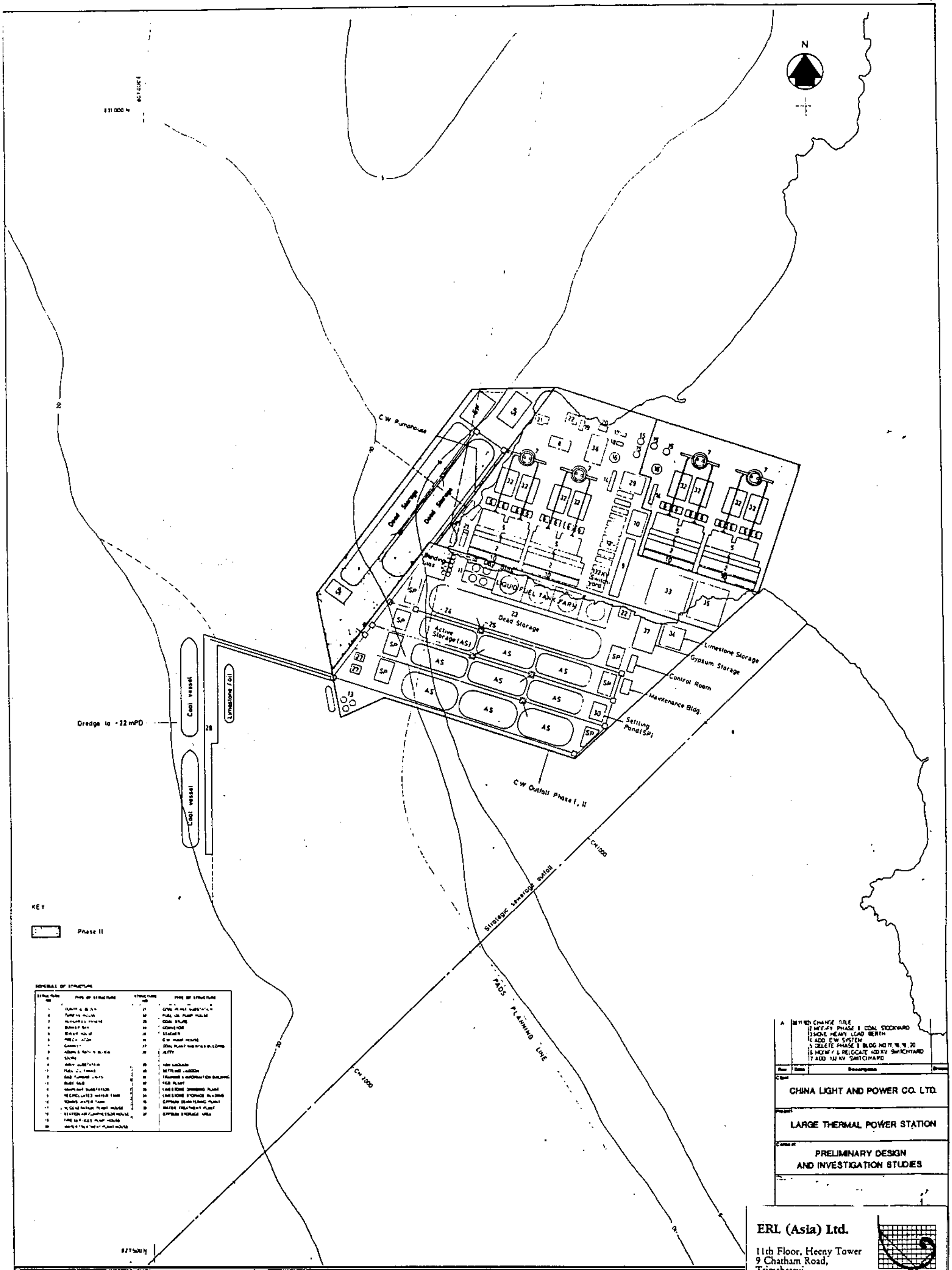

Figure V3/A8 LTPS at Black Point: Stage 2, Scenario I Option 3

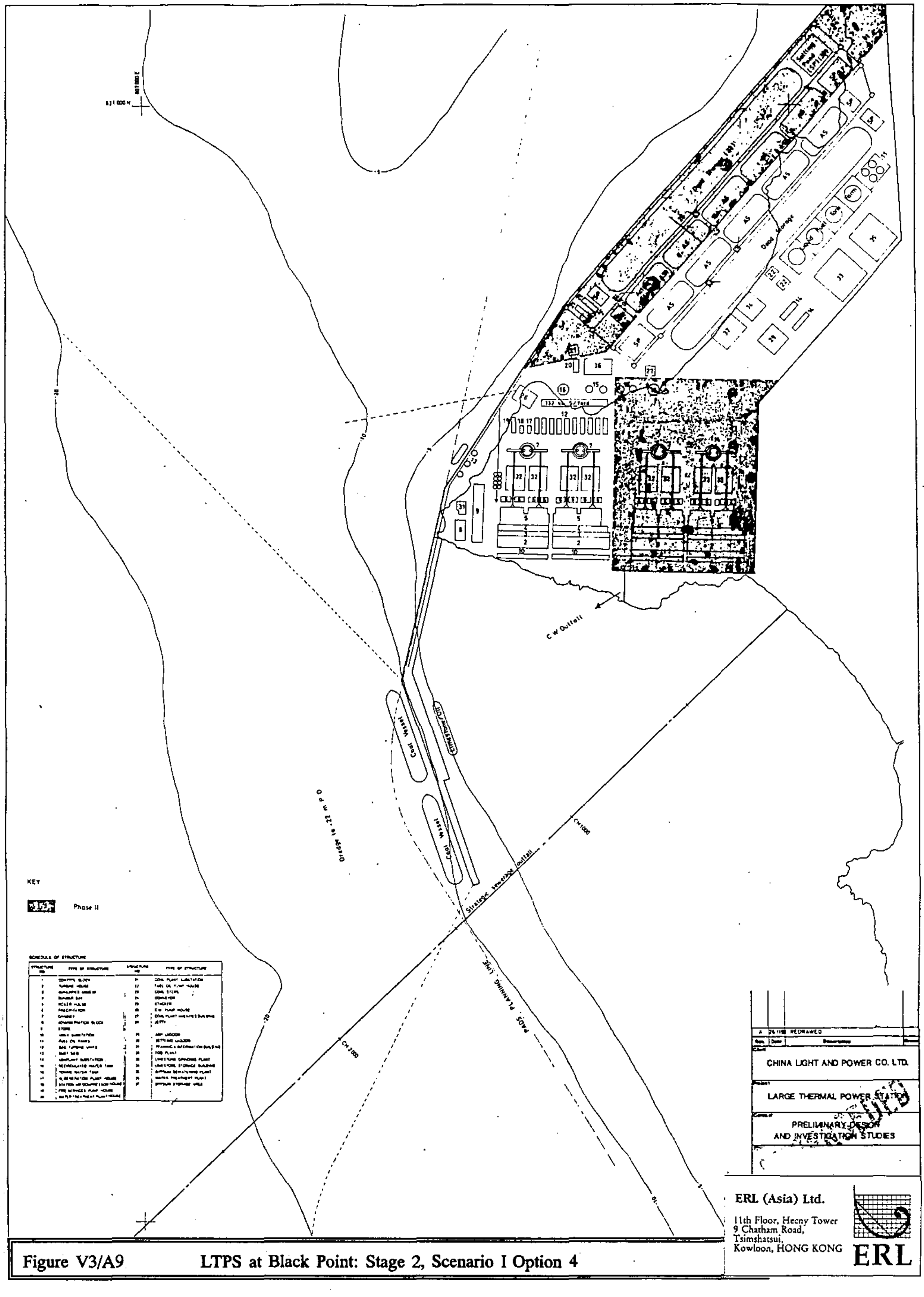

Figure V3/A9 LTPS at Black Point: Stage 2, Scenario I Option 4

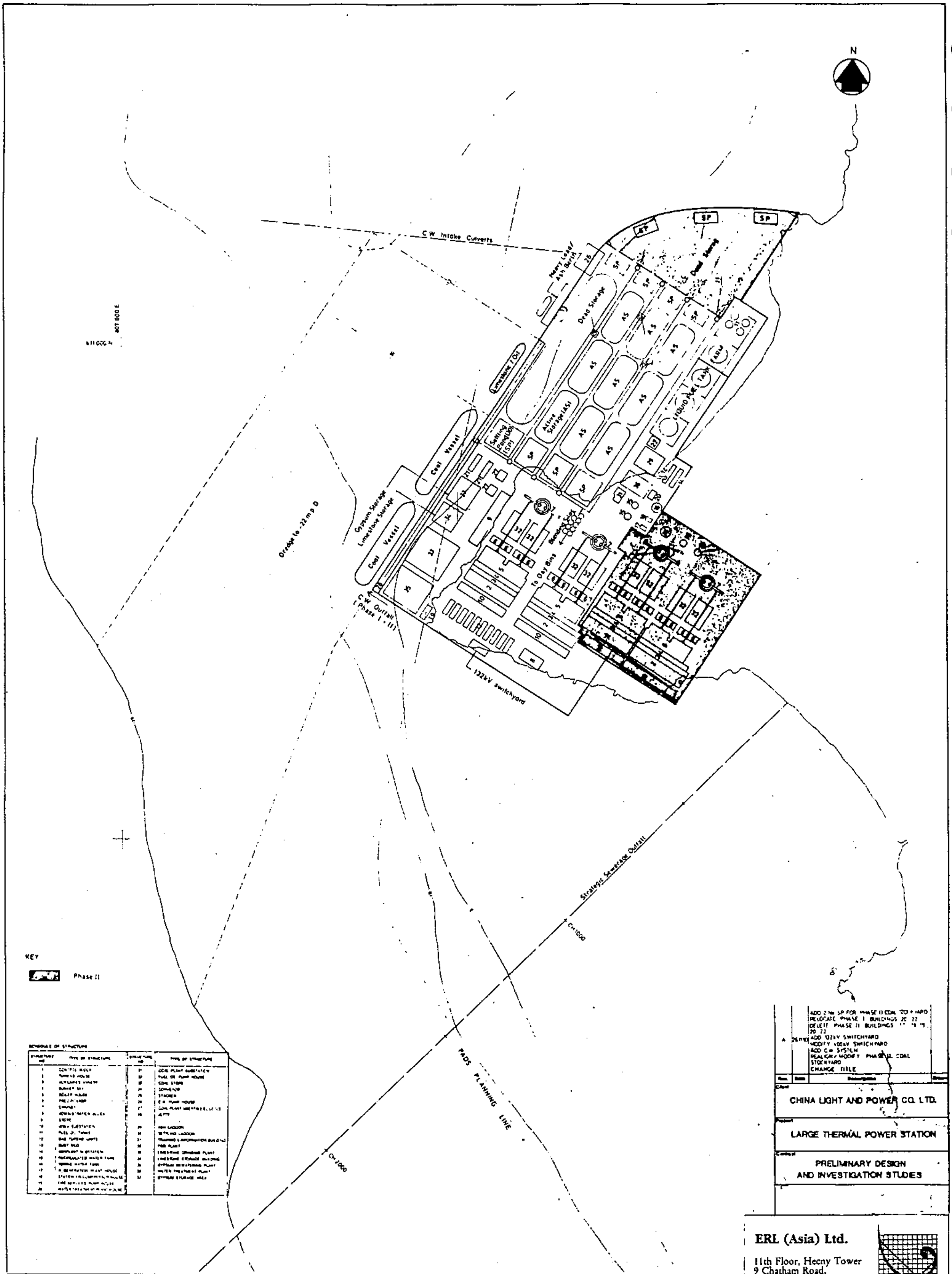

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Figure V3/A10 LTPS at Black Point: Stage 2, Scenario I Option 5

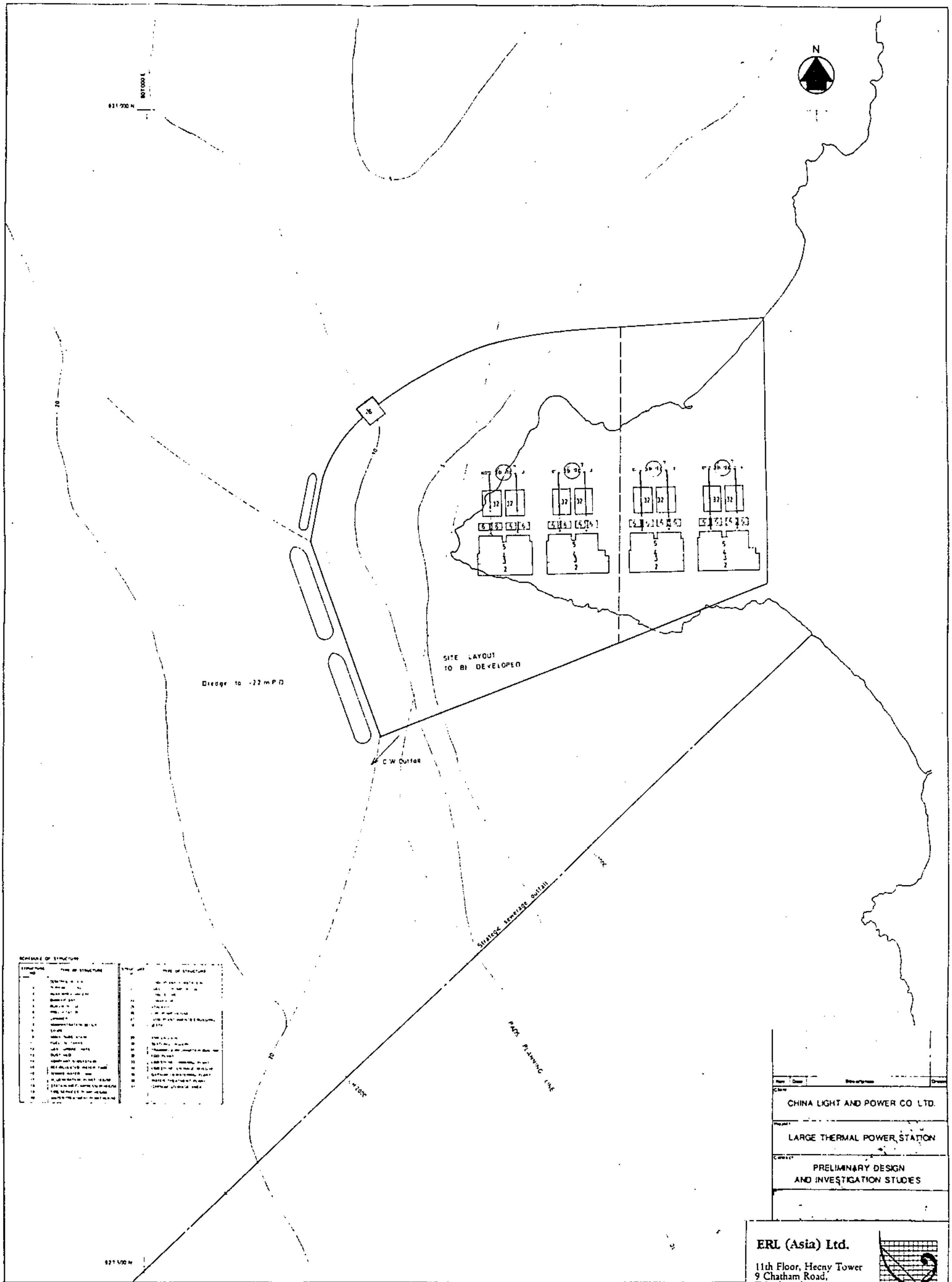

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Figure V3/A11 LTPS at Black Point: Stage 2, Scenario I Option 6

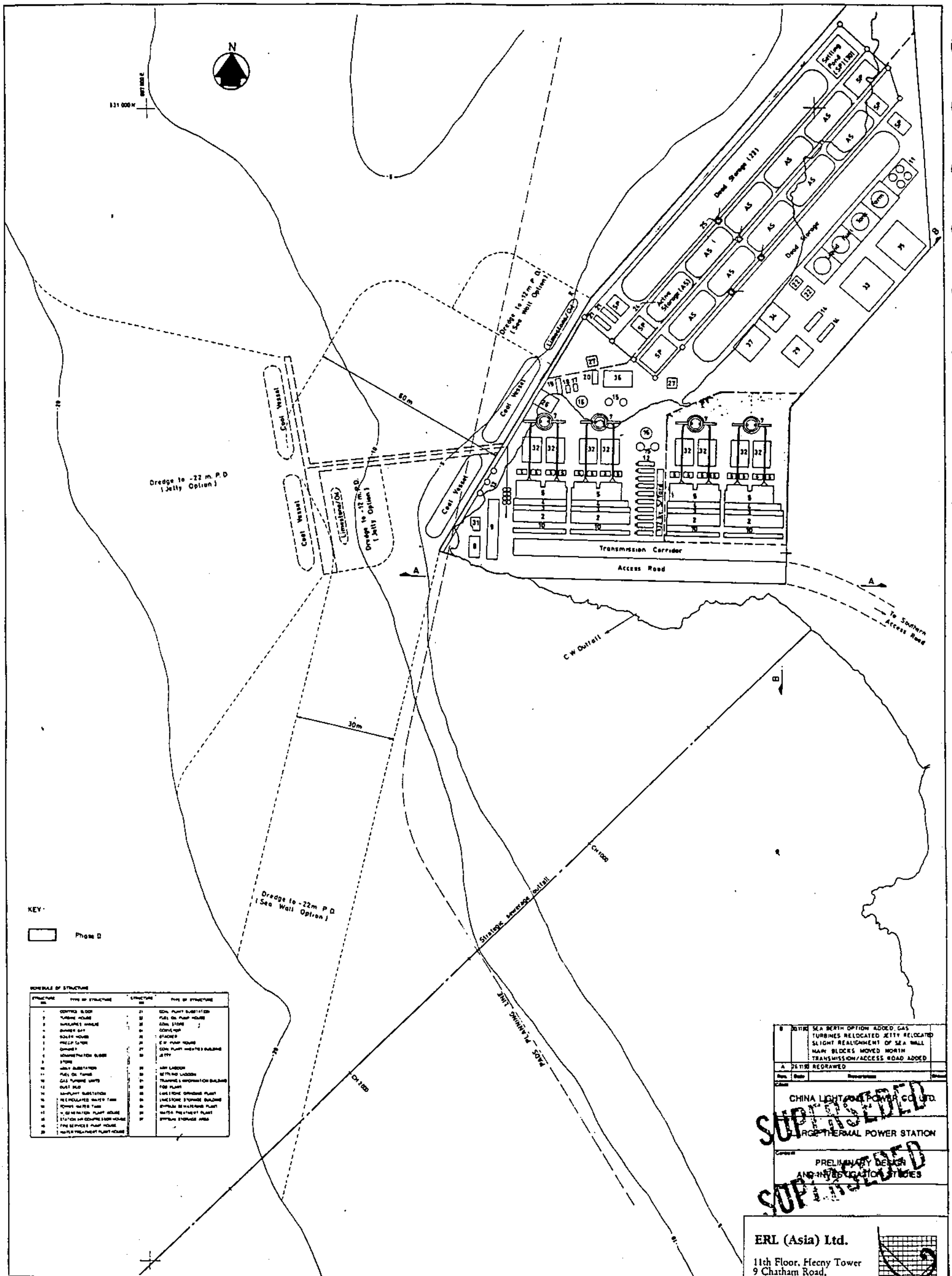

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Figure V3/A12 LTPS at Black Point: Stage 3, Scenario I Option 4

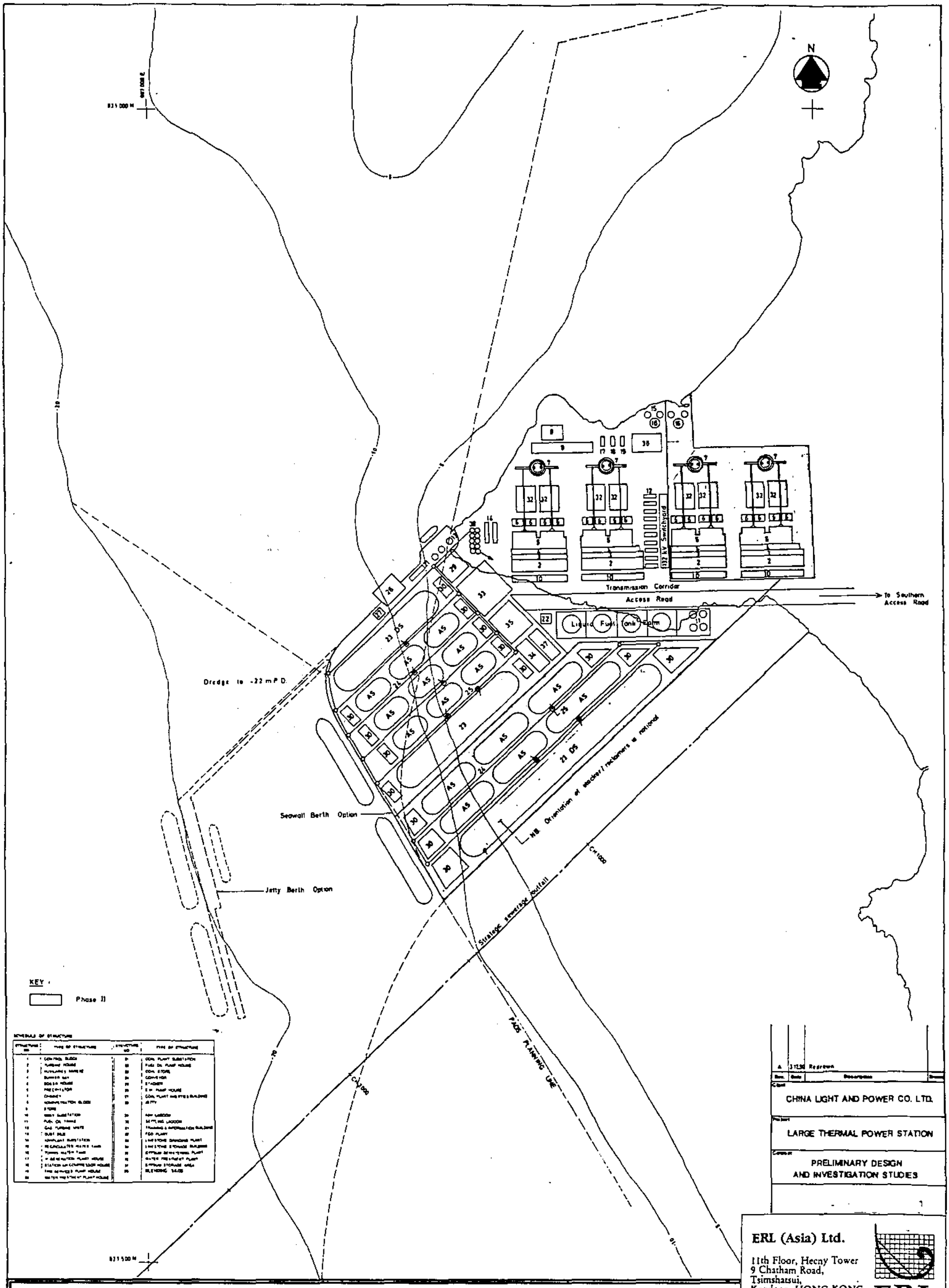

Figure V3/A13 LTPS at Black Point: Stage 3, Scenario I Option 6

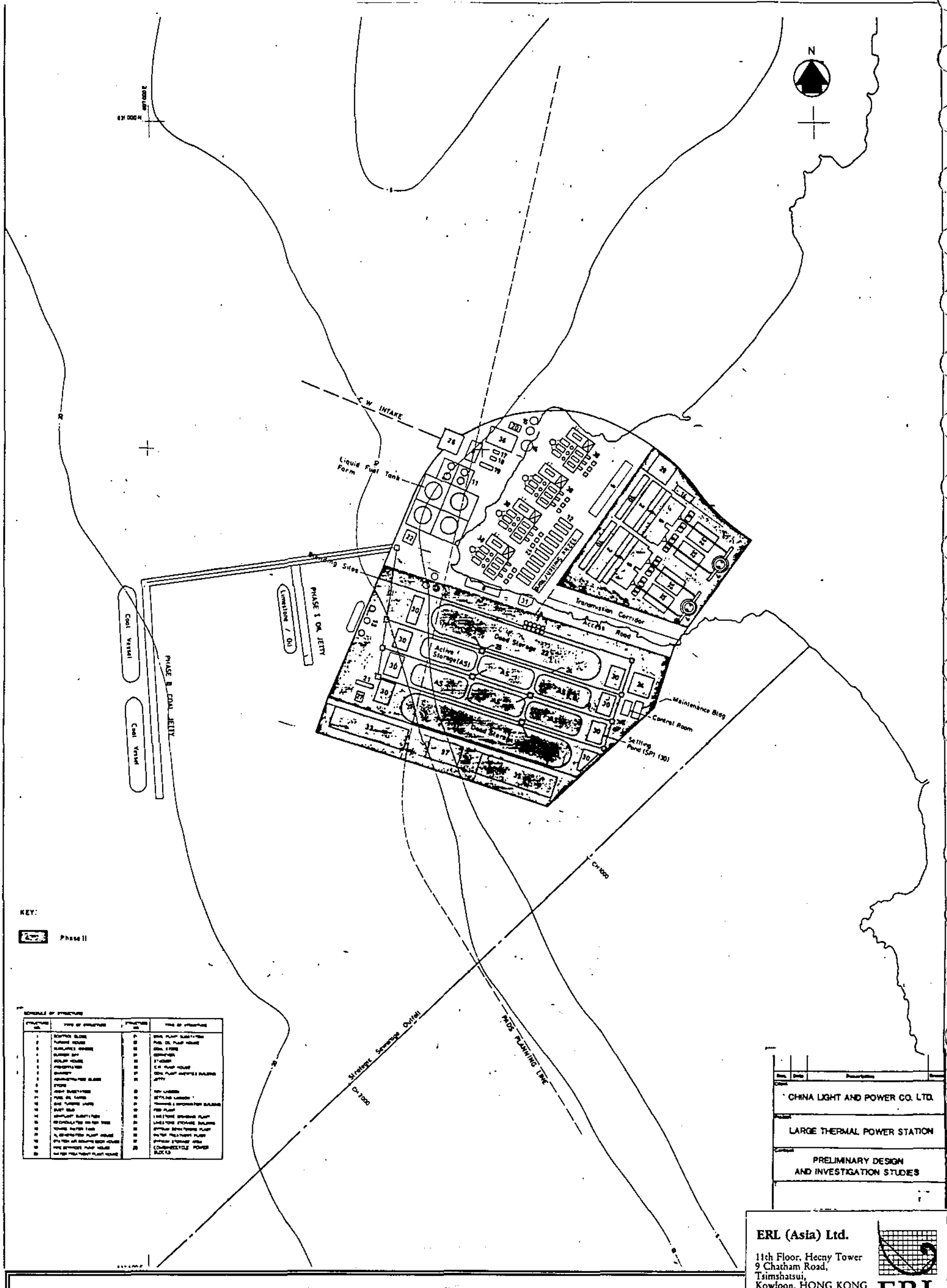

Figure V3/A14 LTPS at Black Point: Stage 4, Scenario II Option 7

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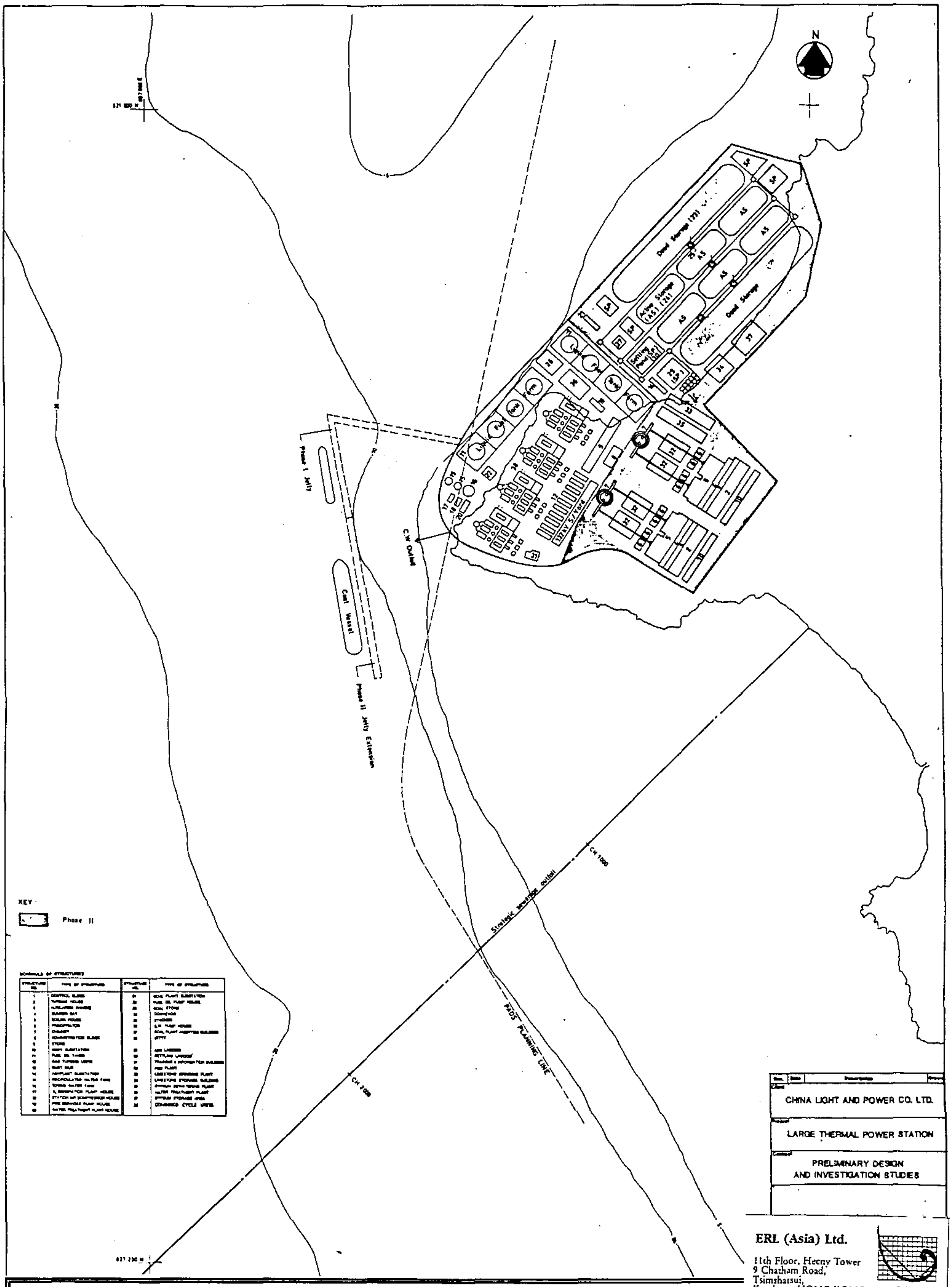


Figure V3/A15 LTPS at Black Point: Stage 4, Scenario II Option 8

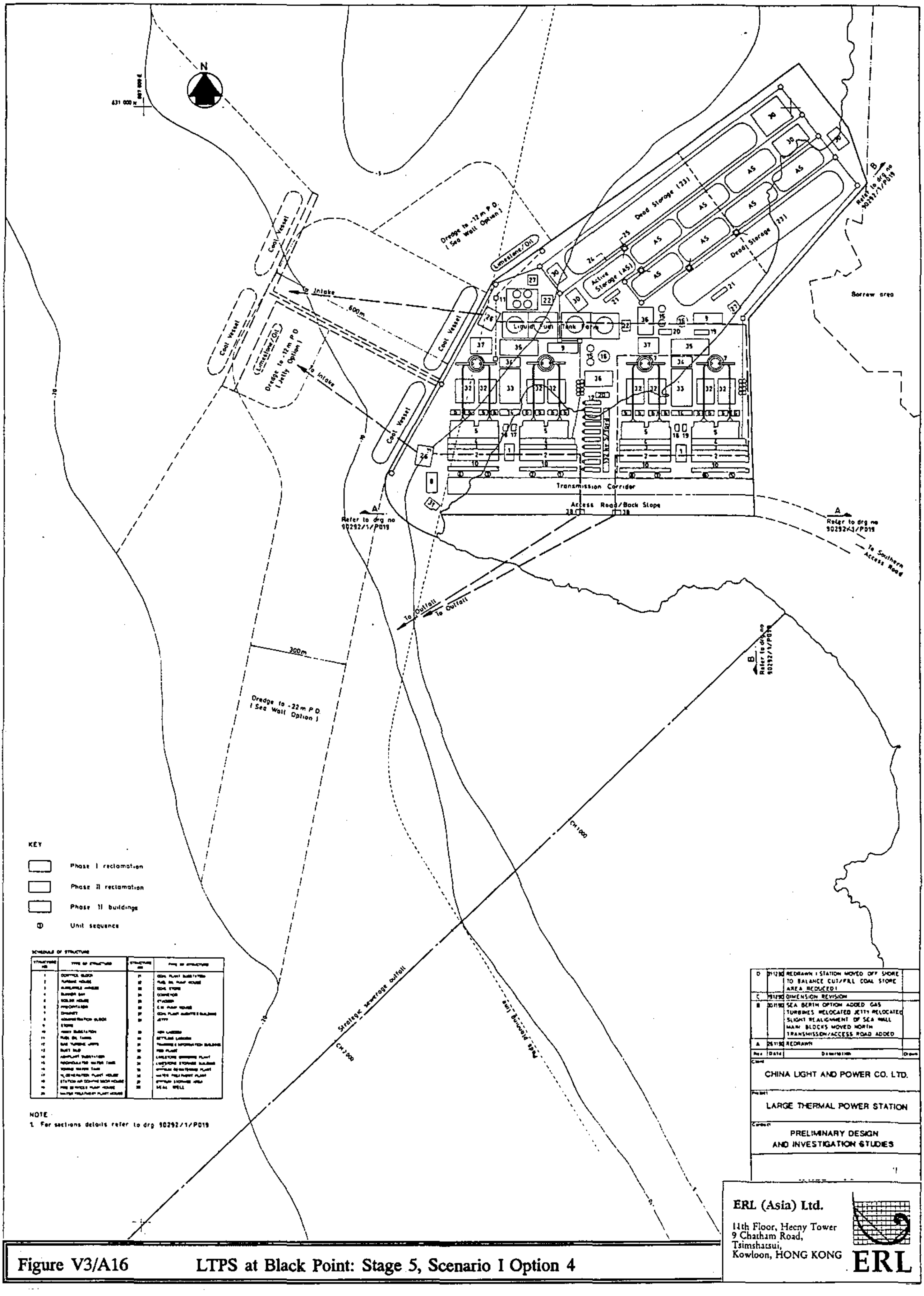


Figure V3/A16 LTPS at Black Point: Stage 5, Scenario I Option 4

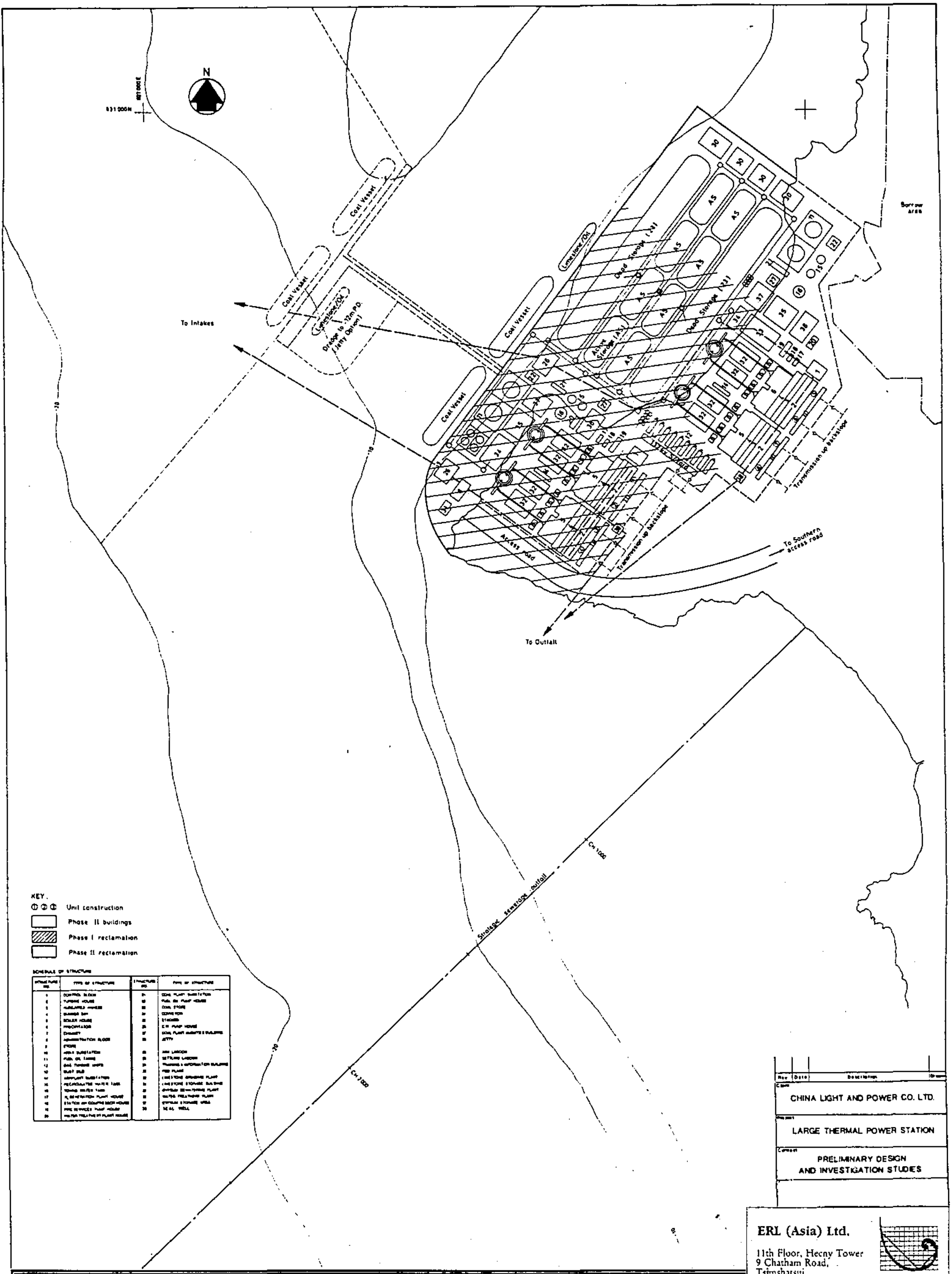
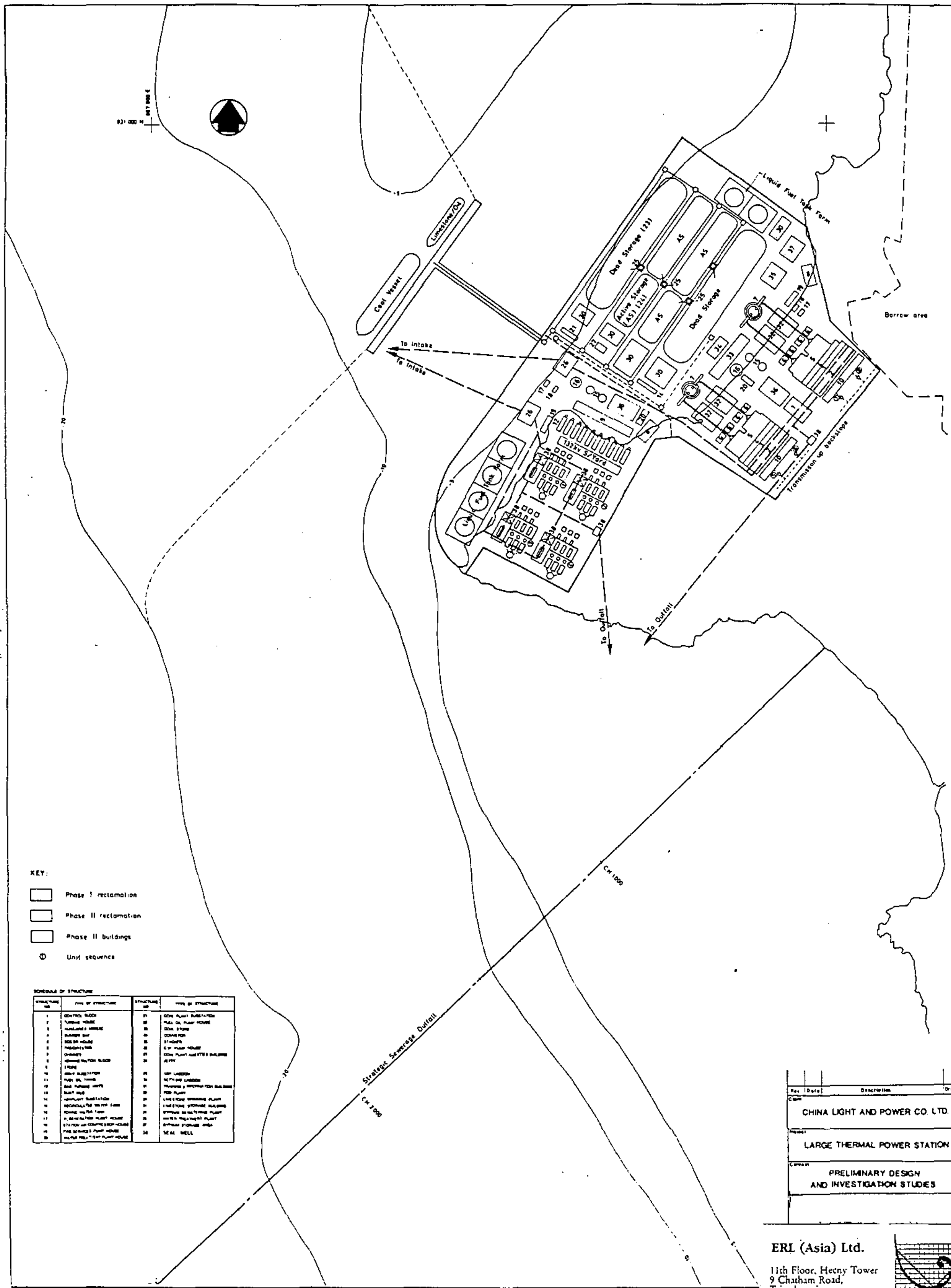


Figure V3/A17 LTPS at Black Point: Stage 5, Scenario I Option 9



Rev	Date	Description	Drawn

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Figure V3/A18 LTPS at Black Point: Stage 5, Scenario II Option 10

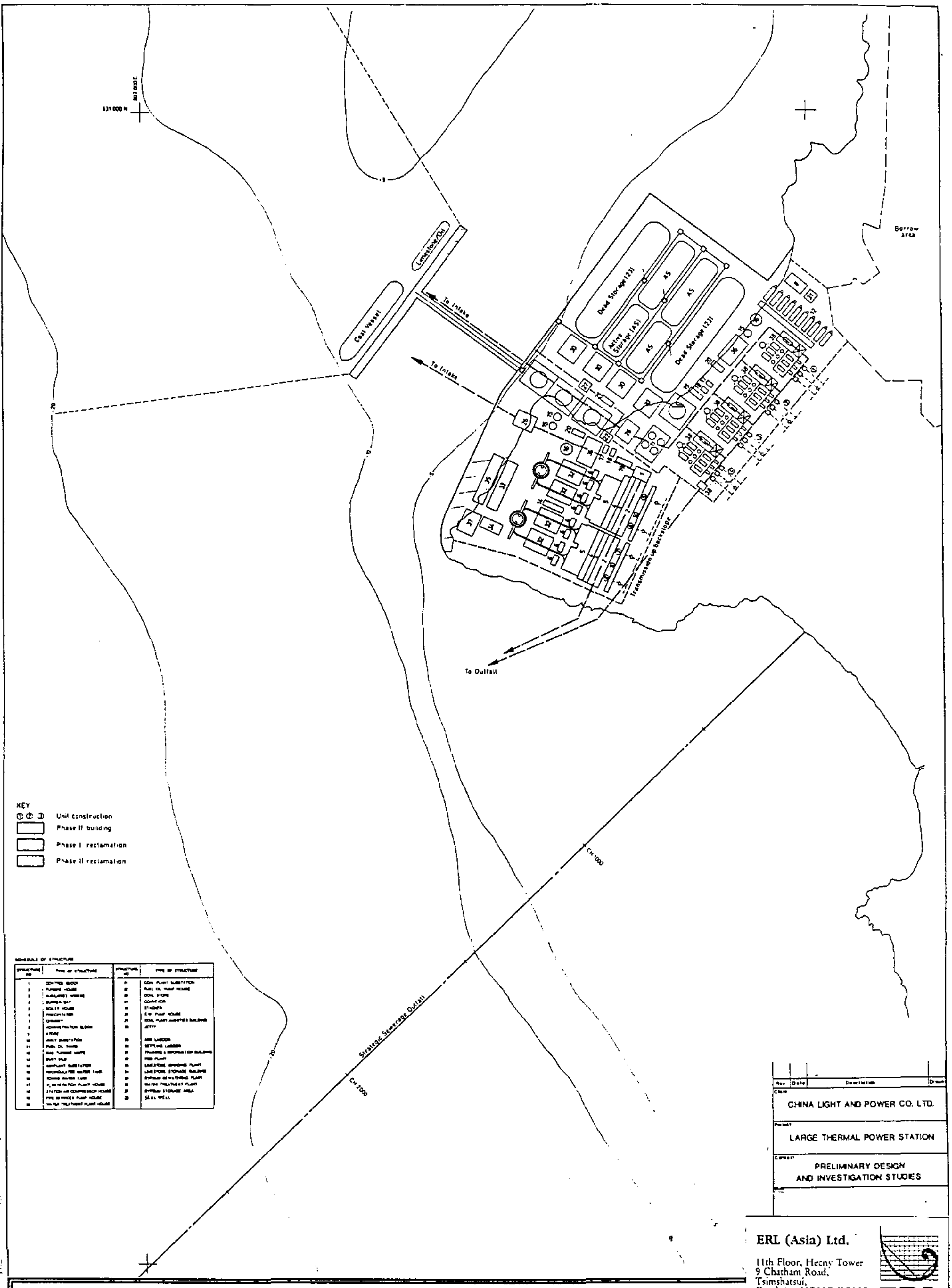

Figure V3/A19 LTPS at Black Point: Stage 5, Scenario II Option 11

ANNEX V3/B

NOISE PROPAGATION ALGORITHM

B. NOISE PROPAGATION ALGORITHM

Factors governing the propagation of noise through long transmission path from plant sources have been studied quite extensively by CONCAWE[3], and the fundemental findings of the study report have been expressed for each octave band in the following equation:

$$SPL = \log \Sigma (SWL + DI - K_1 - K_2 - K_3 - K_4 - K_5 - K_6 - K_7)$$

And, in application of the above equation to this report, the followings are observed:

- DI Directivity Index, taken as 3 dB for point sources, and 6 dB for vertical plane source;

- K_1 Geometric Spreading, for point source is 10 log ($4\pi r^2$);

- K_2 Atmospheric Absorption, is expressed in tables for the relevant values of temperature and relative humidity, and in the report typical meteorological condition, at 25°C and 85% R.H., giving lower attenuaton value will be used;

- K_3 Ground Effect Attenuation, is caused by the reflecting and absorbing properties of the ground, the value depends in a complex manner on frequency, source and receiver height, and acoustic impedance of ground coverings, and is not considered in the study;

- K_4 Meteorological Attenuation, takes into account the effect of wind and vertical temperature gradient on the noise propagation, formulation of the exact contribution is diverse and uncertain and hence not employed;

- K_5 Source Height Correction, is applied to adjust the ground effect attenuation and hence not taken in here;

- K_6 Barrier Attenuation, is based on Maekawa's empirical chart that relate with the path difference between the direct and screened path, and the frequency;

- K_7 In-plant Screening, may be observed in practice for a large complex site but this cannot be predicted with certainty.

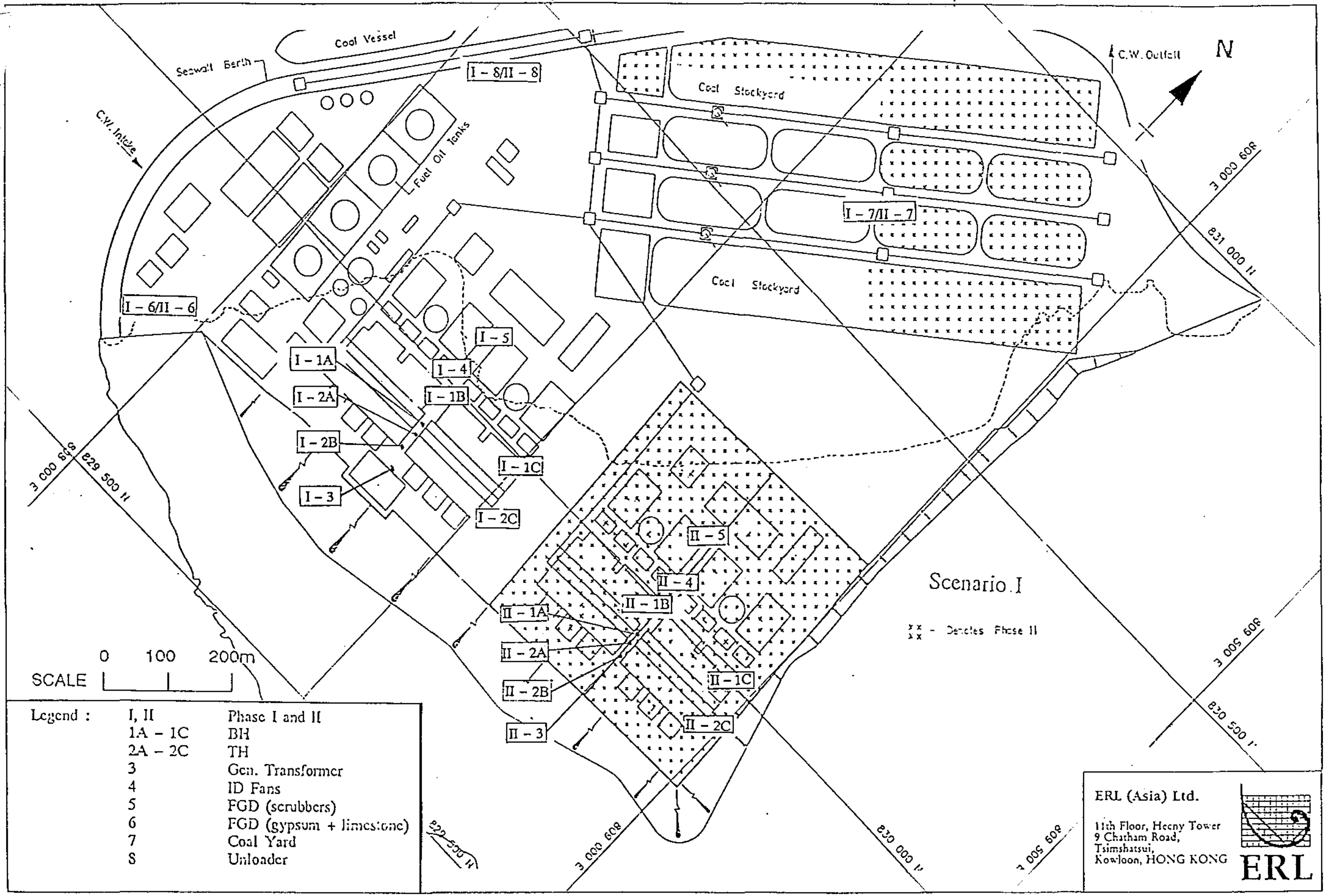

Figure V3/B1 INVENTORY OF NOISE SOURCE MODEL – SCENARIO I

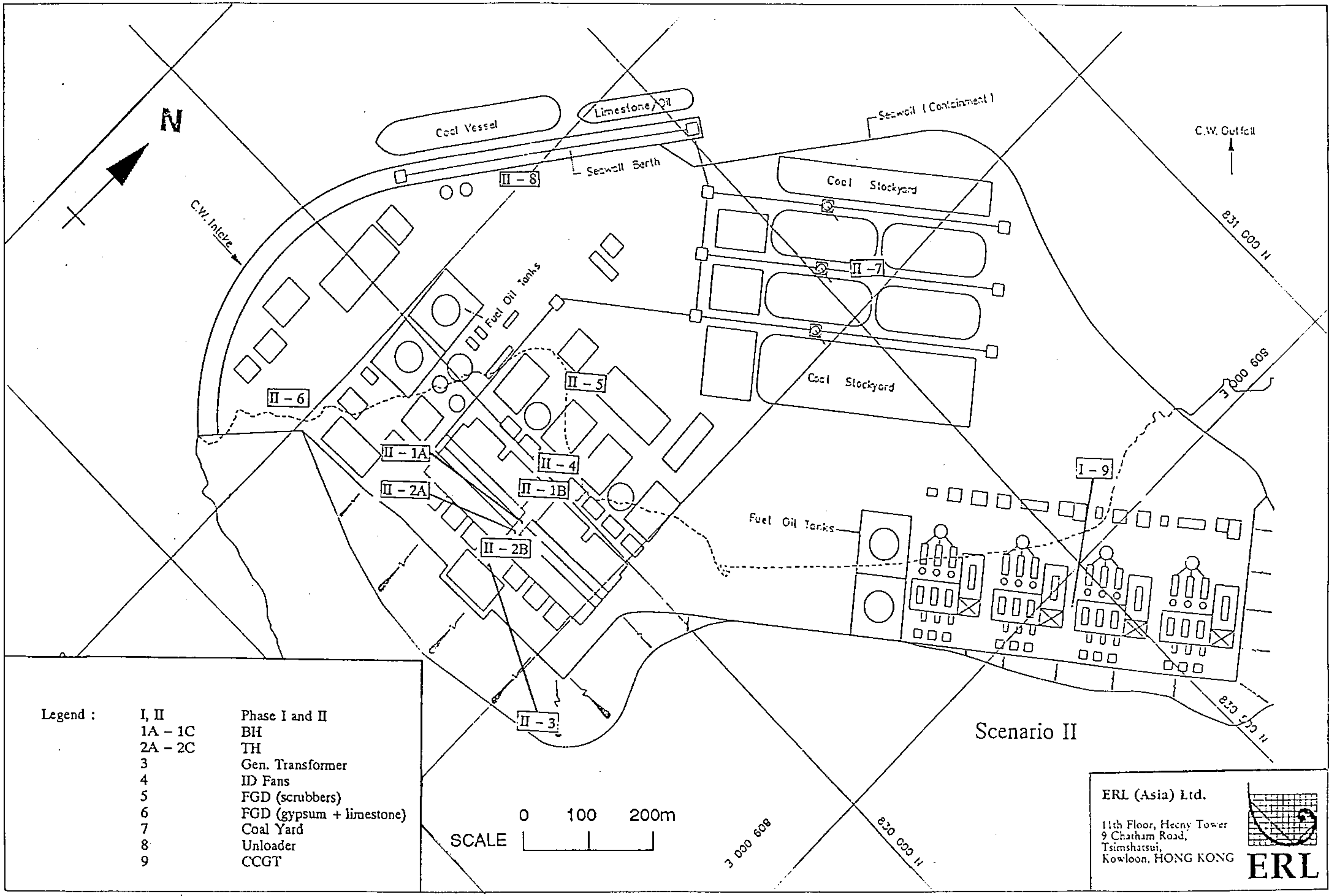

Figure V3/B2 INVENTORY OF NOISE SOURCE MODEL – SCENARIO II

Scenario I S1NA
LTPS Operational Noise
NSR 1 - Lung Kwu Tan

DES 1	Des 2	SWLi	S(m)	F(hz)	DI(DBA)	K1(DBA)	K2(DBA)	K6(DBA)	SPLi(DBA)	
Phase I										
I - 1A) BH	South Facade (*)	127.0	2560.0	500.0	6.0	79.2	6.7	24.6	22.6	
I - 1C) BH	East Facade	120.0	2410.0	500.0	6.0	78.6	6.3	24.7	16.4	
I - 2A) TH	Top Facade	107.0	2440.0	250.0	3.0	78.7	2.0	17.1	12.2	
I - 2B) TH	South Facade	105.0	2440.0	250.0	6.0	78.7	2.0	22.6	7.7	
I - 2C) TH	East Facade	97.0	2360.0	250.0	6.0	78.5	1.9	22.7	0.0	
I - 3) Gen. Transformer		116.0	2420.0	125.0	6.0	78.7	0.5	20.7	22.1	
I - 4) ID Fans		114.0	2560.0	250.0	3.0	79.2	2.0	22.9	12.9	
I - 5) FGD (scrubbers)		121.0	2600.0	500.0	3.0	79.3	6.8	25.3	12.7	
I - 6) FGD (gypsum + limestone)		115.0	2650.0	250.0	3.0	79.5	2.1	18.4	18.0	SPL (Phase 1)
I - 7) Coal Yard		129.0	1410.0	1000.0	3.0	74.0	9.2	25.0	23.9	28.8 dB(A)
Phase II										
II - 1A) BH	South Facade (*)	127.0	2320.0	500.0	6.0	78.3	6.0	19.6	29.1	
II - 1C) BH	East Facade	120.0	2180.0	500.0	6.0	77.8	5.7	25.0	17.6	
II - 2A) TH	Top Facade	107.0	2180.0	250.0	6.0	77.8	1.7	21.5	12.0	
II - 2B) TH	South Facade	105.0	2180.0	250.0	6.0	77.8	1.7	21.5	10.0	
II - 2C) TH	East Facade	97.0	2130.0	250.0	6.0	77.6	1.7	20.9	2.8	
II - 3) Gen. Transformers		116.0	2150.0	125.0	6.0	77.6	0.4	20.8	23.2	
II - 4) ID Fans		114.0	2320.0	250.0	3.0	78.3	1.9	21.4	15.5	
II - 5) FGD (scrubbers)		121.0	2350.0	500.0	3.0	78.4	6.1	22.2	17.3	
II - 6) FGD (gypsum + limestone)		115.0	2650.0	250.0	3.0	79.5	2.1	22.7	13.7	SPL (Phase 2)
II - 7) Coal Yard		129.0	1410.0	1000.0	3.0	74.0	9.2	25.0	23.9	31.7 dB(A)

SPL (overall)
33.5 dB(A)

* - Layout revised with BH opening facing south

Table V3/B1

NOISE PROPAGATION COMPUTATION SPREADSHEETS 1

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11th Floor, Hecny Tower
9 Chatham Road,
Tsimshatsui,
Kowloon, HONG KONG

ERL

Scenario I S2NA
LTPS Operational Noise
NSR 1 - Lung Kwu Tan

DES 1	Des 2	SWLi	S(m)	F(hz)	DI(DBA)	K1(DBA)	K2(DBA)	K6(DBA)	SPLi(DBA)	
Phase I										
I - 9) CCGT		116.0	2570.0	500.0	3.0	79.2	6.7	25.0	8.2	SPL (Phase 1) 8.2 dB(A)
Phase II										
II - 1A) BH	South Facade (*)	127.0	2560.0	500.0	6.0	79.2	6.7	24.6	22.6	
II - 1C) BH	East Facade	120.0	2410.0	500.0	6.0	78.6	6.3	24.7	16.4	
II - 2A) TH	Top Facade	107.0	2440.0	250.0	3.0	78.7	2.0	17.1	12.2	
II - 2B) TH	South Facade	105.0	2440.0	250.0	6.0	78.7	2.0	22.6	7.7	
II - 2C) TH	East Facade	97.0	2360.0	250.0	6.0	78.5	1.9	22.7	0.0	
II - 3) Gen. Transformer		116.0	2420.0	125.0	6.0	78.7	0.5	20.7	22.1	
II - 4) ID Fans		114.0	2560.0	250.0	3.0	79.2	2.0	22.9	12.9	
II - 5) FGD (scrubbers)		121.0	2600.0	500.0	3.0	79.3	6.8	25.3	12.7	
II - 6) FGD (gypsum + limestone)		115.0	2650.0	250.0	3.0	79.5	2.1	18.4	18.0	SPL (Phase 2)
II - 7) Coal Yard		129.0	1410.0	1000.0	3.0	74.0	9.2	25.0	23.9	28.8 dB(A)

SPL (overall)
28.8 dB(A)

* - Layout revised with BH opening facing south.

Table V3/B2

NOISE PROPAGATION COMPUTATION SPREADSHEETS 2

ERL (Asia) Ltd.

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9 Chatham Road,
Tsimshatsui,
Kowloon, HONG KONG

ERL

Scenario I S1N0
LTPS Operational Noise
NSR 2 - Tsang Tsui

DES 1	Des 2	SWLi	S(m)	F(hz)	DI(DBA)	K1(DBA)	K2(DBA)	K6(DBA)	SPLi(DBA)	
Phase I										
I - 1B) BH	North Facade (*)	104.0	2170.0	500.0	6.0	77.7	5.6	25.0	1.6	
I - 1C) BH	East Facade	120.0	2080.0	500.0	6.0	77.4	5.4	25.0	18.2	
I - 2C) TH	East Facade	97.0	2080.0	250.0	6.0	77.4	1.7	24.1	0.0	
I - 3) Gen. Transformer		116.0	2250.0	125.0	6.0	78.0	0.5	21.3	22.2	
I - 4) ID Fans		114.0	2160.0	250.0	3.0	77.7	1.7	24.5	13.1	
I - 5) FGD (scrubbers)		121.0	2140.0	500.0	3.0	77.6	5.6	25.0	15.8	
I - 6) FGD (gypsum + limestone)		115.0	2600.0	250.0	3.0	79.3	2.1	19.6	17.0	SPL (Phase 1)
I - 7) Coal Yard		129.0	1650.0	1000.0	3.0	75.3	10.7	25.0	20.9	26.7 dB(A)
Phase II										
II - 1B) BH	North Facade (*)	104.0	1790.0	500.0	6.0	76.0	4.7	25.0	4.3	
II - 1C) BH	East Facade	120.0	1680.0	500.0	6.0	75.5	4.4	25.0	21.1	
II - 2C) TH	East Facade	97.0	1710.0	250.0	6.0	75.7	1.4	25.0	1.0	
II - 3) Gen. Transformers		116.0	1860.0	125.0	6.0	76.4	0.4	22.9	22.4	
II - 4) ID Fans		114.0	1770.0	250.0	3.0	76.0	1.4	25.5	14.2	
II - 5) FGD (scrubbers)		121.0	1740.0	500.0	3.0	75.8	4.5	25.0	18.7	
II - 6) FGD (gypsum + limestone)		115.0	2600.0	250.0	3.0	79.3	2.1	19.6	17.0	SPL (Phase 2)
II - 7) Coal Yard		129.0	1650.0	1000.0	3.0	75.3	10.7	25.0	20.9	27.6 dB(A)

SPL (overall)
30.2 dB(A)

* - Layout revised with BH cladding facing north.

Table V3/B3

NOISE PROPAGATION COMPUTATION SPREADSHEETS 3

ERL (Asia) Ltd.
11th Floor, Hecny Tower
9 Chatham Road,
Tsimshatsui,
Kowloon, HONG KONG

ERL

Scenario I S2ND
LTPS Operational Noise
NSR 2 - Tsang Tsui

DES 1	Des 2	SWLi	S(m)	F(hz)	DI(DBA)	K1(DBA)	K2(DBA)	K6(DBA)	SPLi(DBA)	
Phase I										
I - 9) CCGT		116.0	1380.0	500.0	3.0	73.8	3.6	25.0	16.6	SPL (Phase 1) 16.6 dB(A)
Phase II										
II - 1B) BH	North Facade (*)	104.0	2170.0	500.0	6.0	77.7	5.6	25.0	1.6	
II - 1C) BH	East Facade	120.0	2080.0	500.0	6.0	77.4	5.4	25.0	18.2	
II - 2C) TH	East Facade	97.0	2080.0	250.0	6.0	77.4	1.7	24.1	0.0	
II - 3) Gen. Transformer		116.0	2250.0	125.0	6.0	78.0	0.5	21.3	22.2	
II - 4) ID Fans		114.0	2160.0	250.0	3.0	77.7	1.7	24.5	13.1	
II - 5) FGD (scrubbers)		121.0	2140.0	500.0	3.0	77.6	5.6	25.0	15.8	
II - 6) FGD (gypsum + limestone)		115.0	2600.0	250.0	3.0	79.3	2.1	19.6	17.0	SPL (Phase 2)
II - 7) Coal Yard		129.0	1650.0	1000.0	3.0	75.3	10.7	25.0	20.9	26.7 dB(A)

SPL (overall)
27.1 dB(A)

* - Layout revised with BH cladding facing north.

Table V3/B4

NOISE PROPAGATION COMPUTATION SPREADSHEETS 4

ERL (Asia) Ltd.

11th Floor, Hecny Tower
9 Chatham Road,
Tsimshatsui,
Kowloon, HONG KONG

Scenario I S1N8
LTPS Operational Noise
NSR 3 - Lung Kwu Sheung Tan

DES 1	Des 2	SWLi	S(m)	F(hz)	DI(DBA)	K1(DBA)	K2(DBA)	K6(DBA)	SPLi(DBA)	
Phase I										
I - 1A) BH	South Facade (*)	127.0	1175.0	500.0	6.0	72.4	3.1	23.2	34.4	
I - 1C) BH	East Facade	120.0	1000.0	500.0	6.0	71.0	2.6	23.1	29.3	
I - 2A) TH	Top Facade	107.0	1100.0	250.0	3.0	71.8	0.9	20.6	16.7	
I - 2B) TH	South Facade	105.0	1100.0	250.0	6.0	71.8	0.9	25.0	13.3	
I - 2C) TH	East Facade	97.0	970.0	250.0	6.0	70.7	0.8	25.0	6.5	
I - 3) Gen. Transformer		116.0	1085.0	125.0	6.0	71.7	0.2	19.2	30.9	
I - 4) ID Fans		114.0	1175.0	250.0	3.0	72.4	0.9	21.4	22.3	
I - 5) FGD (scrubbers)		121.0	1200.0	500.0	3.0	72.6	3.1	23.5	24.8	
I - 6) FGD (gypsum + limestone)		115.0	1430.0	250.0	3.0	74.1	1.1	24.6	18.2	SPL (Phase 1)
I - 7) Coal Yard		129.0	1410.0	1000.0	3.0	74.0	9.2	25.0	23.9	37.6 dB(A)
Phase II										
II - 1A) BH	South Facade (*)	129.0	840.0	500.0	6.0	69.5	2.2	24.2	37.1	
II - 1C) BH	East Facade	123.0	680.0	500.0	6.0	67.6	1.8	25.0	31.6	
II - 2A) TH	Top Facade	110.0	720.0	250.0	6.0	68.1	0.6	22.3	21.9	
II - 2B) TH	South Facade	109.0	720.0	250.0	6.0	68.1	0.6	22.8	19.5	
II - 2C) TH	East Facade	100.0	635.0	250.0	6.0	67.0	0.5	25.0	10.4	
II - 3) Gen. Transformers		116.0	700.0	125.0	6.0	67.9	0.1	20.7	33.3	
II - 4) ID Fans		114.0	840.0	250.0	3.0	69.5	0.7	23.0	23.9	
II - 5) FGD (scrubbers)		121.0	870.0	500.0	3.0	69.8	2.3	25.0	27.0	
II - 6) FGD (gypsum + limestone)		115.0	1430.0	250.0	3.0	74.1	1.1	25.0	17.8	SPL (Phase 2)
II - 7) Coal Yard		129.0	1410.0	1000.0	3.0	74.0	9.2	25.0	23.9	40.0 dB(A)

SPL (overall)
42.0 dB(A)

* - Layout revised with BH opening facing south.

Table V3/B5

NOISE PROPAGATION COMPUTATION SPREADSHEETS 5

ERL (Asia) Ltd.

11th Floor, Hecny Tower
9 Chatham Road,
Tsimshatsui,
Kowloon, HONG KONG

ERL

Scenario II S2N8
LTPS Operational Noise
NSR - 3 - Lung Kwu Sheung Tan

DES 1	Des 2	SWLi	S(m)	F(hz)	DI(DBA)	K1(DBA)	K2(DBA)	K6(DBA)	SPLi(DBA)	
Phase I										
I - 9) CCGT		116.0	1000.0	500.0	3.0	71.0	2.6	25.0	20.4	SPL (Phase 1) 20.4 dB(A)
Phase II										
II - 1A) BH	South Facade *	127.0	1175.0	500.0	6.0	72.4	3.1	23.2	34.4	
II - 1C) BH	East Facade	120.0	1000.0	500.0	6.0	71.0	2.6	23.1	29.3	
II - 2A) TH	Top Facade	107.0	1100.0	250.0	3.0	71.8	0.9	20.6	17.7	
II - 2B) TH	South Facade	105.0	1100.0	250.0	6.0	71.8	0.9	25.0	13.3	
II - 2C) TH	East Facade	97.0	970.0	250.0	6.0	70.7	0.8	25.0	6.5	
II - 3) Gen. Transformer		116.0	1085.0	125.0	6.0	71.7	0.2	19.2	30.9	
II - 4) ID Fans		114.0	1175.0	250.0	3.0	72.4	0.9	21.4	22.3	
II - 5) FGD (scrubbers)		121.0	1200.0	500.0	3.0	72.6	3.1	23.5	24.8	
II - 6) FGD (gypsum + limestone)		115.0	1430.0	250.0	3.0	74.1	1.1	24.6	18.2	SPL (Phase 2)
II - 7) Coal Yard		129.0	1410.0	1000.0	3.0	74.0	9.2	25.0	23.9	37.6 dB(A)

* - Layout revised with BH opening facing south.

SPL (overall)
37.7 dB(A)

Table V3/B6

NOISE PROPAGATION COMPUTATION SPREADSHEETS 6

ERL (Asia) Ltd.
11th Floor, Hecny Tower
9 Chatham Road,
Tsimshatsui,
Kowloon, HONG KONG

ERL

ANNEX V3/C

OPERATIONAL ASPECTS OF THE COAL CONVEYOR

V3/C1 INTRODUCTION

The background to the routing of the coal conveyor and its notional specification is given in Annex V2/C.

V3/C2 LIKELY IMPACTS AND THEIR SIGNIFICANCE

V3/C2.1 Air Quality

As the conveyor would be totally enclosed, including at transfer points, there would be little scope for dust emissions. There would be no other source of emission such as vapours or odour.

V3/C2.2 Water Quality

Again, the enclosure would prevent rainfall from percolating through the coal on the conveyor, so no contaminated run-off would be produced. It is likely that drainage measures would be provided beneath the line of the conveyor and small quantities of run-off may arise. However any contamination from the external surfaces of the enclosure would be very slight and would not constitute a significant disposal problem.

V3/C2.3 Noise

This is a potential source of significant impact, as cases have arisen in which conveyors have become a noise nuisance due to squeaking or whining from the moving parts. The noise is not generally loud but can be a nuisance, particularly if the conveyor operates at night.

This potential problem can be overcome by initial design features, and, more importantly, by regular maintenance.

V3/C2.4 Visual Impact

The presence of a linear feature about 2.5m high by 2.5 wide running along the beach-front road will be noticable, but would not prejudice any especially important views or landscapes; in addition, development under PADS will result in the industrialisation of the visual context of the area. Given that it is impractical to conceal the conveyor, it would be necessary to design and colour it in such a way as to minimize its impact.

V3/C2.5 Severance

The conveyor will preclude access to the beach unless provision is made at intervals for crossing points. These can be over or under the conveyor, depending on the local conditions and engineering limitations. The location of these should be determined by detailed investigations into local needs, although it should be noted that the beaches between CPPS and Black Point will be lost to the Tuen Mun Port Development under PADS.

C.3 CONCLUSION

Overall the consultants consider that if the mitigation principles identified above are adopted, the operational impacts of the conveyor will be acceptable.

ANNEX V3/D

PATHWAYS OF TRACE ELEMENTS THROUGH COAL-FIRED UNITS AND FGD SYSTEMS

D1. INTRODUCTION

The Governments Best Practicable Means programme (BPM) stipulates 90% reduction of sulphur dioxide emissions from new coal-fired generating plant. At the proposed LTPS at Black Point it is intended to fit each coal-fired unit with a flue gas desulphurisation (FGD) system in order that BPM and Air Quality Objectives (AQOs) are met.

The choice of FGD system has not yet been confirmed as economic, technical and environmental concerns associated with each option have yet to be fully evaluated. All commercially available FGD systems have been evaluated with regard to their suitability for the proposed LTPS. The following FGD options have been carried forward for detailed evaluation:

- o **Option 1** – **The Wet Limestone/Gypsum Process:**
  - (a) – Commercial grade gypsum product
  - (b) – Gypsum dissolved in seawater cooling
- o **Option 2** – **The Seawater Process**

In view of the generation of liquid effluent, solid by-product and retained gaseous emissions it is necessary that the environmental effects of the disposal of each are assessed and that any necessary treatment is affected prior to discharge/disposal. The environmental assessment and mitigation measures that may be necessary are discussed in the relevant sections of the IAR Air-Section V3/3, Water - Section V3/5, Waste Disposal - Section V3/6.

This section examines the pathways of environmentally sensitive trace elements through the coal-fired units and FGD system.

D2. THE FGD PROCESSES

The three FGD options all operate on the same basic principal; SO_2 and other acidic species are `scrubbed' from the flue gas by an alkaline absorbent, but there are differences in the absorbents and reagents used:

- o **The Wet Limestone/Gypsum Process:** This FGD system uses a limestone slurry to absorb flue gas SO_2 in a wet scrubber. The system can be configured to produce various grades of gypsum (calcium sulphate dihydrate) or, alternatively, the gypsum could be dissolved with the seawater cooling and discharged from the seawater outfall provided no adverse impacts result (however the technical feasibility of the latter option has yet to be determined);

- o **The Seawater Process:** This also uses a wet scrubber to absorb SO_2, but the absorbent is the alkaline seawater used for cooling supplimented by quantities of lime. Sulphur dioxide is removed from the system as gypsum (calcium sulphate) in solution with the cooling water return. Both calcium and sulphate ions are major natural constituents of seawater. Two processes are currently being considered.

It is possible that each of the above processes will require a prescrubber to be fitted before the SO_2 absorber in order to remove quantities of toxic metals and/or chlorides present in the flue gases that would otherwise adversely affect process chemistry or, in the case of the Limestone/Gypsum FGD system, contaminate an otherwise marketable gypsum by-product. (An alternative for the latter system is to incorporate a chloride purge stream taken from the absorber circuit.)

Prescrubbers (or chloride purges) yield a contaminated effluent water that might require treatment in a wastewater treatment plant prior to discharge via the seawater cooling outfall. Contaminants would be precipitated as their hydroxides or sulphides giving rise to quantities of sludges that require disposal. The quantity of sludge produced will depend upon a number of factors including PFA collection efficiency, coal and lime/limestone specifications, but would consist of about 55-70% by weight calcium sulphate and about 20-35% by weight PFA. The remainder would comprise metal hydroxides and sulphides.

Coal burnt in the furnace gives rise to furnace bottom ash (FBA) and pulverised fuel ash (PFA) in the ratio 1:9. The PFA is carried out of the furnace with the flue gases. Most is collected in the electrostatic precipitator (ESP) (which will be designed to meet the BPM for particulates– currently 50 mg/Nm^3). The remaining PFA particles pass to the FGD plant.

Flue gas and entrained particulates pass to the absorber where SO_2 is scrubbed from the flue gases by an aqueous limestone slurry. Quantities of particulates are captured, but a proportion (dependent on absorber design) will evade capture and pass to the stack. Effluent from the absorber flows to the gypsum plant where a fraction may be bled as a chloride purge.

Alternatively, effluent from the absorber is mixed directly with the seawater cooling where the produced gypsum is dissolved prior to discharge via the CW outfall. If a prescrubber is incorporated a further stream of contaminated liquid effluent will result. If detailed studies show a requirement for wastewater treatment (to reduce levels of heavy metals entering the marine environment) then effluent from the prescrubber or purge will pass to a wastewater treatment plant.

The Limestone/Gypsum FGD process represents the `worst case' in respect of liquid effluent discharge and solid sludge production as it uses greater quantities of solid reagent and incorporates the use of greater amounts of process water (as opposed to direct use of alkaline seawater by option 2. Hence, it is the Limestone/Gypsum system that we have concentrated on here.

D3. SOURCES OF CONTAMINANTS

D3.1 Coal

Coal contains a wide range of trace contaminants the most abundant of which are silicon, iron and aluminium. Other elements include various environmentally sensitive metals; arsenic, cadmium, chromium, copper, mercury, nickel, lead, zinc, selenium and antimony. The worst case concentrations of these elements in coals for the proposed LTPS are shown in Table V3/D3.1(a).

Table V3/D3.1(a)
Worst Case Concentrations of Contaminants in LTPS coal, UK Limestone, Process Water and Deep Bay Seawater

Contaminant	LTPS Max. Coal Conc. mg/kg	Max. UK Limestone Conc. mg/kg	Lime mg/kg	Process Water Conc. mg/kg	Seawater NW Waters mg/kg
As Arsenic	5.0	1.10	2.0	5.1	1.0
Cd Cadmium	1.0	3.70	6.6	0.1	0.05
Cr Chromium	10.0	8.10	14.5	5.0	1.6
Cu Copper	20.0	3.20	5.7	11.0	5.0
Hg Mercury	0.1	0.08	0.14	0.2	0.7
Ni Nickel	20.0	13.00	23.2	10.0	5.00
Pb Lead	10.0	37.00	66.1	10.0	0.90
Zn Zinc	22.0	39.00	69.6	50.0	13.0
Se Selenium	1.0	1.00	1.78	0.5	1.0

The degree to which these metals escape capture in the furnace and ESP is dependent on a number of factors including the level of volatilisation and subsequent condensation. In the FGD absorber (and prescrubber, if fitted) metals are leached from the ash surface at various rates dependent on the pH of the scrubbing medium and the metal concerned.

D3.2 Limestone

A further major source of trace contaminants is the limestone used in the neutralisation process. The purity of limestones used for FGD is typically in the range 90–98 per cent. In addition to the principal contaminant, magnesium carbonate, limestones contain trace amounts of heavy metals and other elements which will be dissolved during limestone slurry preparation and during operation of the FGD process. In view of the acidic conditions in the absorber it may be assumed that dissolution of trace contaminants in the limestone will be essentially complete. Trace metals are normally at levels of mg per kg; concentrations in a typical UK limestone are shown in Table V3/D3.1(a) (it has not yet been determined where limestone for the proposed LTPS would be sourced). Concentrations in lime (used in the seawater process) are higher and have been calculated on the basis of molecular weight from those for limestone.

D3.3 Process Water

Feed water for the FGD system and limestone (lime) slurry preparation plant will normally contain trace concentrations of heavy metals and other substances. Evaporation of water (due to the heat content of the flue gases), and thus concentration of these contaminants, takes place during the FGD process. Concentrations of trace metals in a typical process water are also shown in Table V3/D3.1(a).

D3.4 Seawater

Option 1(b) involves dissolution of produced gypsum in the seawater cooling. The seawater in North Western Waters has been examined for trace metal content[1]. Maximum likely levels are shown in Table V3/D3.1(a).

D4. DEVELOPMENT OF A METHEMATICAL MODEL

The potential quantity and composition of the effluents from a Limestone/Gypsum FGD system depends upon the process conditions; the coal burned; the limestone; and, to a lesser extent, the water used in the scrubbing process. The sources of both the coal and limestone are diverse and variable as therefore are the potential contributions of contaminants.

In order to be able to assess the effects of changes in any of these factors on the potential composition of the process effluent, a mathematical model has been developed, by means of which the quantity and composition of effluents can be calculated for a specified coal composition and combustion rate, limestone and water composition using a series of computations to simulate the processes of fly ash enrichment, leaching and sulphur dioxide neutralisation. The Consultants have developed a model drawing on data, gathered from various sources [2,3,4]. LTPS specific data has been deprived from CLP and preliminary design data for FGD plant at the LTPS (figures supplied by Stone & Webster Engineering (UK) Ltd).

D5. VALIDATION OF THE MODEL

The model has been validated against published measured data from the Steinkohle Power Station (2 x 740 MW) in West Germany[5]. The results show the model to estimate trace contaminants relatively accurately, but conservatively towards water quality, i.e. quantities arising in the gypsum (which would be dissolved in option 1(b) are slightly overestimated and those arising in the wastewater treatment sludge slightly underestimated).

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1 CLP Seawater Monitoring Data reported to EPD

2 Consultants in Environmental Sciences Ltd. in association with Ewbank Preace Ltd. "Evaluation and Treatment of Liquid Discharges from Flue Gas Desulphurisation Processes". Volumes 1 & 2 for CEGB, October 1987.

3 VGB Technische Vereinigung der GrossKraftwerksbetreiber E.V. "Messung der Schwermetallabscheidung einer Rauchgasentsch wefelungsanlage nach dem Kalkwaschverfahren." Kommission der Europaischen Gemeinschaften, Brussel, Marz 1982.

4 ABB Flakt, Norway. A/S Norsk Viftefabrikk "Prescrubber Information" Private Communication

5 VGB Technische Vereinigung der GrossKraftwerksbetreiber E.V. "Messung der Schwermetallabscheidung einer Rauchgasentsch wefelungsanlage nach dem Kalkwaschverfahren." Kommission der Europaischen Gemeinschaften, Brussel, Marz 1982.

D6. LIMESTONE/GYPSUM PROCESS - MODEL OUTPUTS

Tables V3/D6(a) & (b) show the calculated annual loads discharged to the marine environment with the various process options at high merit order for FGD options 1 & 2. These are analysed and assessed in Sections 5 and 6 (Water Quality of Waste Disposal respectively). Table V3/D6(c) shows the relative contributions to the total discharge from the coal, limestone and process water.

Table V3/D6(a)
Annual Loads of Trace Elements Arising From FGD Option - Scenario I

FGD Options	COMMERCIAL GRADE GYPSUM - Option 1(a)						DISSOLVED GYPSUM - Option 1(b)			SEAWATER (FLAKT) - Option 2		
Process Option (ESP Efficiency)	Purge (99.7%)		Prescrubber (99.6%)		Purge & Prescrubber (99.6%)		(99.7%)	Prescrubber (99.6%)		(99.7%)	Prescrubber (99.6%)	
Contaminant	Untreated Effluent kg/yr	Treated Effluent kg/yr	Untreated Effluent kg/yr	Treated Effluent kg/yr	Untreated Effluent kg/yr	Treated Effluent kg/yr	Untreated Effluent kg/yr	Untreated Effluent kg/yr	Treated Effluent kg/yr	Untreated Effluent kg/yr	Untreated Effluent kg/yr	Treated Effluent kg/yr
As Arsenic	415	41.5	580	58.0	839	83.9	982	1178	656	839	1115	593
Cd Cadmium	850	85.0	138	13.8	755	75.5	1497	1561	1437	1474	1539	1414
Cr Chromium	1638	491.3	824	247.1	2246	673.7	3718	4107	3531	3619	4009	3432
Cu Copper	848	84.8	739	73.9	1388	138.8	1879	2236	1572	1720	2078	1413
Hg Mercury	50	20.1	94	37.7	141	56.3	126	201	145	122	198	141
Ni Nickel	4658	1397.4	1630	489.1	3956	1186.8	6227	7001	5861	6029	6803	5662
Pb Lead	6426	642.6	987	98.7	7169	716.8	14790	15263	14376	14473	14946	14058
Zn Zinc	7275	727.5	1701	170.1	8497	849.6	16540	17394	15864	15694	16548	15017
Se Selenium	466	93.2	1132	226.4	1665	333.1	1512	2363	1458	1499	2350	1445

Notes:

1) Untreated effluent from FGD discharged direct to CW outfall.
2) Treated effluent routed via wastewater treatment plant - efficiency of removal based on measured figures at steinkohle the TPS in FRG (not necessarily the maximum reduction achievable).
3) ESP efficiency given for compliance with BPM of 50 mg/Nm^3 for particulates assuming 80% dust capture in a prescrubber and in an absorber.

Table V3/D6(b)
Annual Loads of Trace Elements Arising From FGD Option – Scenario II

FGD Options	COMMERCIAL GRADE GYPSUM – Option 1(a)						DISSOLVED GYPSUM – Option 1(b)			SEAWATER (FLAKT) – Option 2		
Process Option (ESP Efficiency)	**Purge (99.7%)**		**Prescrubber (99.6%)**		**Purge & Prescrubber (99.6%)**		**(99.7%)**	**Prescrubber (99.6%)**		**(99.7%)**	**Prescrubber (99.6%)**	
Contaminant	**Untreated Effluent kg/yr**	**Treated Effluent kg/yr**	**Untreated Effluent kg/yr**	**Treated Effluent kg/yr**	**Untreated Effluent kg/yr**	**Treated Effluent kg/yr**	**Untreated Effluent kg/yr**	**Untreated Effluent kg/yr**	**Treated Effluent kg/yr**	**Untreated Effluent kg/yr**	**Untreated Effluent kg/yr**	**Treated Effluent kg/yr**
As Arsenic	207	20.7	290	29.0	419	41.9	451	589	328.2	419	557	296
Cd Cadmium	424	42.4	69	6.9	377	37.7	748	780	718.7	737	769	707
Cr Chromium	818	245.6	411	123.5	1122	336.8	1859	2053	1765.6	1809	2004	1716
Cu Copper	424	42.4	369	36.9	693	69.3	939	1118	785.7	860	1039	706
Hg Mercury	25	10.0	47	18.8	70	28.1	63	100	72.7	61	99	70
Ni Nickel	2329	698.7	815	244.5	1978	593.4	3113	3500	2930.3	3014	3401	2831
Pb Lead	3212	321.2	493	49.3	3584	358.4	7395	7631	7187.8	7236	7473	7029
Zn Zinc	3637	363.7	850	85.0	4248	424.8	8270	8697	7931.8	7847	8274	7508
Se Selenium	233	46.6	566	113.2	832	166.5	756	1181	729.0	749	1175	722

Notes:

1) Untreated effluent from FGD discharged direct to CW outfall.
2) Treated effluent routed via wastewater treatment plant – efficiency of removal based on measured figures at steinkohle the TPS in FRG (not necessarily the maximum reduction achievable).
3) ESP efficiency given for compliance with BPM of 50 mg/Nm^3 for particulates assuming 80% dust capture in a prescrubber and in an absorber.

Table V3/D6(c)
Relative Contributions to Limestone/Gypsum FGD Trace Element Effluent Discharge from Coal, Limestone and Process Water

Contaminant	COMMERCIAL GRADE GYPSUM WITH PURGE				DISSOLVED GYPSUM WITH PRESCRUBBER			
	Discharge due to FGD	Proportion From			Discharge due to FGD	Proportion From		
		Coal	Limestone	Process Water		Coal	Limestone	Process Water
	g/hr/unit	%	%	%	g/hr/unit	%	%	%
As Arsenic	0.546	46.9	43.2	9.9	13.38	58.2	35.2	6.7
Cd Cadmium	1.732	28.9	71.0	0.1	29.30	10.7	89.2	0.1
Cr Chromium	10.02	16.9	80.7	2.5	71.98	23.8	74.3	1.9
Cu Copper	1.729	28.0	61.5	10.4	32.04	38.5	53.9	7.6
Hg Mercury	0.411	70.9	25.9	3.2	2.965	83.6	14.9	1.5
Ni Nickel	28.49	52.7	45.5	1.7	119.5	27.8	69.9	2.2
Pb Lead	13.10	4.8	93.9	1.2	293.1	7.7	91.3	1.0
Zn Zinc	14.83	7.0	87.5	5.5	323.4	11.1	84.5	4.4
Se Selenium	1.900	64.1	35.0	0.9	29.72	83.7	15.9	0.3

ANNEX V3/E

ENVIRONMENTAL MONITORING DURING THE OPERATION OF THE LTPS

E1. OPERATIONAL AIR QUALITY MONITORING

In order to assess the impacts from the operation of the proposed plant, a monitoring programme is recommended. As defined in Section V3/3.2, two different sources of air pollutants are envisaged, namely, stack emissions and fugitive emissions from ground level sources.

In view of the combined contributions of the LTPS and CPPS to air quality in the area, the opportunity arises to review the overall monitoring programme for air quality impacts.

E1.1 Stack Emissions

The stack emissions will depend on the fuel used and mitigation measures employed. Since the air quality impact to existing or future land uses has yet to be finalised by the Air Quality Key Issue Assessment, it is not possible to rigorously define the monitoring programme for this purpose. However, it is likely that review of the provision of monitoring stations will be required to ensure that any changes in the ambient air quality in the vicinity of the sensitive receptors being affected are adequately recorded.

The stations should be equipped with continuous monitors for SO_2, wind speed and direction, and, where appropriate, NO_x. This setup is essentially similar to CLP's existing air quality monitoring stations. It is recommended that the monitoring stations identified in the KIA be operated a year before the commissioning of the first unit to collect air quality data to establish a realistic background concentration. The data can then be used to assess the impacts resulting from the new units at Black Point.

E1.2 Fugitive Dust Emissions

The principal fugitive dust emissions will arise from handling of coal, pulverised fuel ash (PFA) and quite possibly, FGD reagent/product. With the recommended mitigation measures, it is unlikely that there will be any off–site impacts. However, it is desirable to set up a monitoring programme to confirm this is the case. Periodic samples should be collected at identified sites close to the site boundary.

It is anticipated that the existing monitoring site at Tsang Tsui will also serve the LTPS. One further station is envisaged, to the south of the LTPS site.

E1.3 Stack Gas Monitoring

Apart from the ambient monitoring recommended in the previous section, monitoring of stack gas emissions is also recommended to confirm the efficiency of the pollution control equipment. This applies to the stack emissions from the gas turbines as well as the major units. This will ensure compliance with emissions control regulations and the design and operational criteria laid down in the Specified Process Licence.

E2. OPERATIONAL NOISE MONITORING

The commissioning and operational phase of the proposed LTPS will extend for a long period. As a result of the other planned developments in the vicinity, namely the WENT Landfill and the Tuen Mun Port Development, the area will be subjected to an external change in the background noise environment. To allow for the adjustment of this type of external change in the background noise level, a monitoring programme for the background noise environment is recommended in the following section.

E2.1 Environmental Noise Monitoring

Environmental noise monitoring is considered necessary and should be performed at least once, after the commissioning of each generating unit at the nominal operation load.

(i) Noise Monitoring Criteria

Noise measurements for a period of 24 hours should be carried out at three of the Noise Sensitive Receivers (NSRs) identified in Section V3/4.3 as follows:

NSR1 – Lung Kwu Sheung Tan
NSR2 – Tsang Tsui Village
NSR3 – Lung Kwu Tan

The noise measurements should be corrected and adjusted for the background noise level, in accordance with TM procedures, for compliance checking with statutory noise criteria and the predicted noise level.

(ii) Noise Prediction Validation

A suitable location near the LTPS site boundary, experiencing the minimum of ambient noise variations and other likely influencing factors, should be selected for noise prediction validation. It is recommended that the western boundary of the existing Tsang Tsui Ash Lagoon (site D in baseline noise survey) be selected as the noise reference site. Noise prediction using the initial source model and calculation algorithms is performed and recorded for reference in Section V3/4.5 for the Ash Lagoon noise reference site.

(iii) Recommended Background Noise Monitoring Programme

Environmental noise monitoring should be carried out annually during the operational phase to adjust for changes to the baseline noise conditions that will result from other developments in the area.

A background monitoring scheme of two representative half-hour noise measurements (Leq, L_{90} and L_{max}) taken both during the day/evening and during night-time periods, is recommended at the following locations:

NSR1 – Lung Kwu Sheung Tan
NSR2 – Tsang Tsui Village
Reference Site – Ash Lagoon boundary

Extra noise measurements may be carried out on those occasions when commencement of external development is expected to maintain a specific record such that the causes and effects on the noise baseline can be followed.

E2.2 Measurement Procedure and Requirements

All measurements in the Environmental Noise Monitoring Programme should be performed as follows:

a) All sound level reading should be measured and recorded by suitably experienced staff.

b) Noise measurements should be carried out using approved equipment, which shall be tested at regular intervals in a manner and in a laboratory approved by EPD.

c) The sound level meters used shall comply with the International Electrotechnical Commission Publications 651: 1979 (type 1) and 804: 1985 (type 1), specification, as referred to in the Technical Memorandum to the Noise Control Ordinance.

d) The location of the noise monitoring is to be notified to EPD and recorded for use in subsequent monitoring.

e) Environmental noise levels for criteria checking should be recorded as the average of consecutive Leq (30 min) measurements. L_{90} and L_{10} (30 min) measurements should also be taken for reference, at agreed locations, to the agreed schedule.

f) Calibration and measurement procedures for the noise criteria checking measurements should follow the Annex of the TM.

E3. OPERATIONAL WATER QUALITY MONITORING

Effluent discharges from the planned LTPS, whether into the Deep Bay Water Control Zone or the North Western Waters (declaration as Water Control Zone pending), will be subjected to control standards stipulated in the TM[1], and hence the monitoring and licensing requirements of a discharge consent to be agreed by EPD. Whilst the extent of the water quality impact caused by the discharge from the planned LTPS will be assessed further in the Key Issues Study, an outline of the monitoring programme is proposed in this section. A detailed monitoring programme will be proposed after completion of the detailed assessment in the Key Issues Report.

E3.1 Effluent Monitoring

As stated in section V3/5 liquid effluents from a number of sources will be mixed with the cooling water and discharged via the outfall. Since there is a large variation in effluent characteristics, quality and quantity, individual monitoring of the main effluent streams at source is proposed. A list of proposed sources, monitoring parameters and frequency is shown below:

Sources	Parameter	Frequency
1. Cooling Water	Residual chlorine, oil, TSS, pH, Temp.	monthly
2. Water Treatment Plant	TDS, metal contents, NH_3	monthly
3. Ash Pit	SS, metal contents, pH	monthly
4. Domestic Sewage Effluent	SS, residual chlorine, E. Coli	weekly
5. Run-off from Coal Stockyard	SS, metal contents	monthly
6. FGD Effluent	SS, pH, metal contents	monthly
7. Oil Separator Water	oil, pH	monthly

E3.2 Marine Water Quality Monitoring

To keep track of trends in water quality and to check compliance with the Water Quality Objectives (WQOs) in the vicinity of the discharge, monitoring should be performed on a monthly basis and should include the following:

o **Oyster Marine Buoys**

Marine Buoys B5, located at the boundary of the mariculture zone should be maintained for the trace metal bioavailability monitoring.

o **Far Field Marine Temperature Monitoring Sites**

One to two monitoring sites should be selected at about 1500m from the Cooling Water discharge outfall to provide compliance checking with the water temperature WQO for Deep Bay.

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[1] Technical Memorandum, standards for effluents discharged into drainage and sewerage systems inland and coastal waters.

ANNEX V3/F

ENVIRONMENTAL AUDIT REQUIREMENTS

F1. INTRODUCTION

Annex V3/E identifies monitoring programmes which will serve as indicators of environmental conditions of the LTPS plant when the LTPS is in operation. Auditting of these data is necessary to check that the environmental requirements are being met, that mitigation measures designed for the various systems are in place, and that procedures to reduce environmental impacts are being implemented. The monitoring also provides input to the environmental audit concerning any variances from expected or predicted levels, and whether remedial action is required to counter any unanticipated environmental impacts.

The audit programme will mirror the procedures and recommendations of the environmental impact assessment of the proposed development, and in fact is a continuation of the EIA process for the LTPS.

F2. SCOPE OF THE ENVIRONMENTAL AUDIT

The audit programme for the LTPS should cover the following topics :

- Noise emissions
- Atmospheric emissions
- Effluents discharges
- Solid by-product management

These components of the audit programme should include:

- **Noise Emissions**
  - Identification and characterization of new on site noise generators;
  - Verification of noise monitoring data and assessment against verified prevailing government and company requirements;
  - Identification of new noise sensitive receivers;
  - Review of existing operations and plans which may result in new impacts;
  - Periodic surveying to ensure noise conditions are not unacceptably deteriorating as a result of the LTPS.
- **Atmospheric Emissions**
  - Identification of all direct venting emissions sources and processes;
  - Review of emissions inventory and licence conditions;
  - Verification of emission data and assessment against prevailing government and company requirements;

- Identification and characterization of new emitters (including those in the vicinity not associated with CLP);
- Identification of new receivers sensitive to air quality impacts;
- Review of all air pollution control systems and equipment;
- Evaluation and review when changing or upgrading operations and equipment of mitigation measures employed to minimise impacts on air quality.

o **Water Quality**

- Identification and characterization of new wastewater discharges (including those in the vicinity not associated with CLP);
- Verification of wastewater discharge monitoring data including frequency as recommended;
- Verification of monitoring data on marine water temperature and assessment against prevailing government and company requirements;
- Assessment of efficiencies (including operation & maintenance) of on-site waste water collection, treatment and disposal facilities;
- Evaluation of operations and plans, to ensure continued compliance with existing or forthcoming legislation;
- Review procedures employed to prevent the unnecessary generation of wastewater and pollutants (including spills, leaks etc).

o **Solid By-Product Management**

- Identify all solid by-product produced by and/or stored at the LTPS;
- Evaluate procedures to minimise their generation and discharge;
- Review all on-site containment and storage facilities;
- Assess the disposal practices for solid by-products in the light of any new statutory requirements.

F3. COMPONENTS OF THE AUDIT PROGRAMME

Essential elements of the audit programme strategy will include :

a) Full management commitment

b) Audit team establishment and objectivity

c) Professional competence

d) Well-defined and systematic analytical procedures

e) Reporting procedures

f) Quality Assurance

g) Follow-up

h) Audit Training

The audit programme to be designed after the Key Issue Studies are completed has to be objective and as thorough as practicable. In Hong Kong environmental auditing is not a statutory requirement and it will be necessary to decide whether the audit programme should be carried out by specialised section of CLP, by an internal ad-hoc team from CLP specially assembled for the audit or by external consultants. There are arguments for making the audit independent by using external consultants.

F4. CONCLUSION

The audit programme to be developed for the LTPS will ensure that the appropriate information for effective environmental management is collected, verified and interpreted and reported.

RESPONSE TO GOVERNMENT COMMENTS

CLP LTPS Draft IAR

Response to SMG Comments

Nil Returns

Tuen Mun District Office

Tuen Mun and Yuen Long District Planning Office

Highways Department/NT Region

Security Branch

Building and Lands Department

Economic Services Branch

Fill Management Committee

CLP Large Thermal Power Station at Black Point
Draft Initial Assessment Report

Department	Reference	Comments	Consultants' Response
EAPG/EPD		**Overall comments on DIAR**	
		The coverage is considered comprehensive and adequate. The report is well written and the consultants should be complimented. It would be useful for the final report to include an overall summary of IAR findings and recommendations to cover all three volumes of the report.	Noted and agreed.
		The study recommends further Key Issue Assessments to cover Air Quality, Water Quality and Solid Wastes/By-products Management Strategy. The final report should include a summary listings of the specific issues to be covered under each KIA.	Noted and agreed.
EAPG/EPD	v3/Annex v3/F	We find the environmental audit requirements as set out in this section acceptable. We expect to be reconsulted again on the audit programme to be developed after completion of the Key Issue Studies.	Noted and agreed.
EPD	v3/s.2.4.6 Pg. 31	We note the possible encroachment of the proposed LTPS layout on the Island East Transfer Station jetty and road access to Western New Territories Landfill. SPG/EPD have to be kept informed in order to be able to initiate early discussion with CLP concerning reprovisioning of alternative access to WENT.	Noted.
APG/EPD	v3/s.13.4.2 Pg. 204 Para. 3	The consultants should clarify whether the gas oil to be stored/used is diesel oil. If that is the case, the 6–8 carbon atoms quoted in the report do not match with the specification of diesel oil.	Fuel likely to be used is an industrial diesel oil.

Department	Reference	Comments	Consultants' Responses
WPG/EPD	v3/Annex v3/B3 v2/Annex v2/B1	The proposed water quality monitoring programs are still under review, comments if any will be raised at the SMG meeting.	Noted. (No further comments were raised).
EAPG	Overall comments	There is no specific reference to the environmental impact resulting from decommissioning of the LTPS. The consultants should identify the potential impact and address the issues in the report.	The decommissioning process is very similar to that of construction in terms of impacts and controls. Further comment is difficult due to uncertainties re background environment, legislative controls etc. 50 years hence. However, a broad consideration of decommissioning aspects will be included in the Final Initial Assessment Report.

Department	Reference	Comments	Consultants' Responses
EPD (Air Stream)	Overall comment	1. In the analysis, the emission figures for the Black Point Power Station are lower than the anticipated licensed limits. Although the emission figures of the Castle Peak Power Station are not given in this report, based on the Phase I KIA report, the emission figures of the Castle Peak Power Station are expected to be substantially lower than the licensed limits. As commented on previous occasion, the Consultants are requested to provide justification and the assumptions for adopting lower emission figures and confirm, with the agreement of CLP, that these lower emission figures can be achieved without any technical/operational difficulty. Please note that this information will form the basis for considering conditions in future S.P. licensing.	This point has been raised and discussed as part of the Stack Emissions KIA. CLP are revising the emissions data and will submit them in the Complex Terrain Wind Tunnel Tests Working Paper to EPD.
		2. Some of the air quality modelling results are from the Phase I Report of the KIA. However, the numerical predictions in the report had been found to be unexpectedly low even though the low emission figures have been taken into account and the consultants had been advised to review the calculation and the data files to eliminate the possibility of errors in data manipulation.	Input files used for the modelling runs have been reviewed and found to be valid in respect of emission characteristics and meteorological parameters used to describe the atmospheric boundary layer.

Department	Reference	Comments	Consultants' Responses
		3. The analysis of the meteorological data and background air quality data are considered general and insufficient for evaluating the development potential implications of the projects. Further work including identifying the meteorological conditions for wind tunnel tests, analysing the wind data for the assessment of the frequency of AQO exceedence and determining the background air quality for defining the potential implications are expected.	A Working Paper on Climatology has been submitted to EPD as part of the KIA, Phase II, Part 1. Wind tunnel meteorological scenarios will shortly be proposed to EPD. More detailed background air quality data will be provided by other consultants on PADS project studies.
		4. A general evaluation has been made on the surrounding land use and planning. However, it is not detailed enough for the identification of receptors for the wind tunnel tests. It is expected that separate effort will be made in the KIA to identify the receptors for quantifying the development potential implications of the power plant based on the assessed maximum concentrations and frequency of AQO exceedence. The consultants should note that the receptors for the wind tunnel assessment have to be agreed with us in the design of the tests. 5. Although the hourly AQO objectives are comparatively more likely to be threatened, the development potential constraints may also be affected by long term air quality. As the predictions of the long term air quality are subjected to the same uncertainties due to topography, the daily and annual averages of all relevant pollutants (including SO_2 and NO_2) should also be assessed in the KIA.	Agreed. Proposals will be put to EPD shortly as part of the KIA. The hourly average predictions from the wind-tunnel study will be used to cross-check and confirm the validity of predictions made in the IAR.

Department	Reference	Comments	Consultants' Responses
		6. The Consultants have not established that dry deposition is not a Key Issue as the details of their evaluation such as the predicted contours have not been presented.	The maximum dry deposition rates quoted are taken from the contours, which will be submitted in the Final Initial Assessment Report.
	Volume 1 S.2.3.2	Please note that the reference conditions for the NOx and particulates limits quoted in the last paragraph on Pg. 15 is 12% CO_2, dry and s.t.p..	The reference conditions quoted are standard. Our calculations may not fully take into account the implications of a wet to dry conversion but this should only amount to a 5% deviation in emission rate calculations at most.
	S.2.17	We would like to elaborate that any FGD system with a removal efficiency lower than 90% will be considered only if the by-product problem can be demonstrated to be insurmountable. Also, the removal efficiency must not be unduly sacrificed than is absolutely necessary. The operating life of the Black Point Power Station will go into the next century. At this stage, the Castle Peak Firing Range may appear to the Consultants to remain in military hands long into the future. There can well be changes in its land use in the operating life of the power station. As such, the Range should also be included in the Key Issue Assessment for investigating the implications on its development potential.	Noted. Already discussed as part of the KIA. Agreed with EPD that receptors in Castle Peak Range will be included.
	S.3.1.2 on Pg. 38 S.3.1.3 on Pg. 39	As EPD is now running the monitoring network of ambient air quality, the source of general background air quality data should therefore be EPD not R.O.. There are two Tuen Mun meteorological sites with different grid references. Please clarify.	Noted. Typo: Ref: 49Q KV035812 is Tai Mo Shan, not Tuen Mun

Department	Reference	Comments	Consultants' Responses
	S.3.2 on Pg. 43 – 51	The consultants have only discussed the general meteorological features of the area. Presumably, the consultants will make more specific analysis during the Key Issue Study (Air Quality) Stage for the meteorological conditions to be adopted in the wind tunnel study.	This has been carried out and discussed with EPD.
	S.3.3 on Pg. 52 – 54	In the interpretation of the monitored ambient air quality data for the period from 1985 to 1989, the consultants should take into account the effect on the current air quality of the Fuel Restriction Regulation, which has been in force since last July. To form an updated view on the current ambient air quality, the consultants should make reference to the monitored data after the implementation of the regulation.	No data was available at the time the assessment was made. Any data subsequently available will be used in the Stack Emission KIA.
		The analysis of the ambient air quality data in the report gives a general picture of the background ambient air quality. As specific background ambient air quality is required in the assessment of the development constraint implications of the project, more detailed analysis, which will take into account the monitored resuts of the on-going ambient air quality monitoring conducted by CLP and the findings of the impact assessments of the PADS projects, should be conducted in the KIA stage.	Noted and agreed.
	Volume 2		
	S.3.2 on Pg. 31	If the site formation of the project requires the clearance of existing vegetation, the consultants should submit the methods of clearance for our approval before commencement of the site formation work to ensure they are environmentally acceptable.	Clearance for methods of working is the responsibility of the selected Contractor. Text amended.

Department	Reference	Comments	Consultants' Responses
	S.4.4 on Pg. 43	Please note that stone crushing, grading and batching processes are classified as specified processes under the category of "Mineral Works". Similar to the power station, they are required to implement Best Practicable Means such as maximum enclosure and containment of emissions, dust extraction and collection to meet a particulate emission limit of 50 mg/m^3, use of dust suppression systems and wetting etc to control its emission to acceptable level. The details of the requirements are to be agreed during S.P. Licensing.	Noted and text clarified to reflect this comment. Again this will be the Contractor's responsibility.
	S.4.6 on Pg. 43	As to the modelling assessment of the construction impacts of the project, the following should be provided and addressed in the report: a. The relevant USEPA emission factors as well as the assumed production and loading of the activities in Table V2/4.6 (a). b. The approach that the consultants have adopted to cope with higher emission rates but enhanced diffusion under high wind speed. c. The meteorological conditions used in the study and the rationale of choosing the meteorological conditions. In the predictions of the TSP concentrations, settling has been assumed. The application of the mass fraction of RSP to the TSP predictions to project the RSP concentrations tends to under-estimate the predicted RSP concentrations. The consultants should assess how the RSP predictions would be affected.	The meteorological conditions used equate to a typical worst case (wind speed $2ms^{-1}$, stability D). Not allowing for settling increases TSP's by 3% at site the boundarys, such that RSP's will be less than 4%. Overall, assumption of 50% TSP is considered a reasonable estimate for RSP concentration.

Department	Reference	Comments	Consultants' Responses
		Although the consultants claim that dust emissions can be reduced by 90% by commonly applied control measures, whether such an exceptionally high reduction efficiency can be achieved depends on how the dust control measures are implemented. The consultants should explore how the monitoring results can be made use of for the improvement of the dust mitigation measures in the site and what further mitigation measures are available if dust exceedence still occurs.	90% reduction is figure typically achieved. If monitoring results indicate exceedence, water spray frequencies can be increased and/or the Contractor can provide wind screens.
	S.4.7	The suggested mitigation measures fall short of the BPM requirements for activities such as rock crushing. As commented in S.4.4, additional control requirements will be imposed in S.P. licensing.	Noted.
	Annex V2/B B3	In the period between late 1992 and early 1993, the dust emissions from the project are expected to be at their worst. The proposed measurements are so infrequent that they may not be able to provide feedback for reviewing the adequacy of the dust control measures implemented in the site. The dust measurements should be stepped up in this period to one hour samples every day and 24-hour samples every three days to better monitor the effectiveness of the dust control measures.	The consultants agree that increased monitoring is desirable between late 1992 – early 1993 only and the extent can be discussed with CLP at the appropriate time.
		The measurement method of the hourly TSP should be proposed for endorsement.	Noted.
	Annex V2/C	Although the routing of the conveyor along the shoreline may not cause severe dust impacts during its construction, the routing has not been fixed yet. If the adopted routing differs from the shoreline option, there should be a review on the constructional dust impacts of the conveyor.	Noted and agreed.

Department	Reference	Comments	Consultants' Responses
	Volume 3 S.3.1.1 on Pg. 33	Some of the modelling results in the IAR are based on those in the Stack Emissions KIA Phase I Report, which we understand have not been reviewed inthe light of our comments. As such, our previous comments on the Phase I Report will also apply here. In particular, the following are reiterated:	
		a. The emission figures of the Castle Peak Power Station are substantially lower than the licenses/limits. Similarly the emission figures of the Black Point Power Station are lower than the anticipated licensed limits. the Consultants are requested to provide justification and the assumptions for adopting lower emission figures and confirm, with the agreement of CLP, that these lower emission figures can be achieved without any technical/operational difficulty. Please note that this information will form the basis for considering future S.P. licensing.	Already discussed. Revised figures submitted in the Complex Terrain Wind Tunnel Tests Working Paper.
		b. The numerical predictions appear to be unexpectedly low even though the low emission figures have been taken into account. To eliminate the possibility of errors in data manipulation, the consultatns are advised to review the calculation and the data files.	Reviewed, no errors found.
	S.3.1.2	<u>Table V3/3/1 (b) on Pg. 35</u> The particulates concentration is also expressed as at 12% CO_2, dry condition and s.t.p..	Noted.

Department	Reference	Comments	Consultants' Responses
		The BPM for NOx emission from gas turbine is water/steam injection and other more advanced technology, e.g., SCR. The "75 ppm" NOx limit is applicable only to oil-fired gas turbines. For gas-fired units, the BPM requirement is 85 mg/m^3 (i.e. 42 ppm of 15% O_2)	Reference Conditions for particulate concentrations are noted. [The NOx limit for turbines fired by gas is very stringent 42ppm and CLP believe that they should be consulted in such matters] UK limit is 60 ppm.
	V3/S.3.2	Two 4-flue chimneys, as used in Castle Peak Power Station, are preferred in the context of dispersion to the proposed four 2-flue chimneys. It is advisable to consider adopting this chimney configuration in the design of the plant.	For engineering/development flexibility, 4 flue stacks are not preferred and not base-case. However, this configuration will be considered as mitigation option if necessary.
		The Consultants should note that the exit temperature of the stack being not less than 80°C is a BPM requirement irrespective of their choice of FGD system. Furthermore, the reheating requirement is primarily not for achieving satisfactory thermal buoyancy, but eliminating any visible plume.	Comments noted. 80°C is a sensible minimum temperature in respect of plume rise and also the prevention of immediately visible plumes and in-stack condensation.

Department	Reference	Comments	Consultants' Responses
	S.3.2.1	**Table V3/3.2 (a)** The report only gives the emission figures of the Black Point Power Station, which are lower than the anticipated licensed limits based on the licensed emissions of the Castle Peak 'B' Power Station with adjustment to the BPM limits. Similar observations had also been made for the Castle Peak Power Station and Black Point Power Station while we commented the Phase I Scoping Report. As we had commented before, the Consultants are requested to provide justification for adopting lower emission figures and confirm, with the agreement of CLP, that these lower emission figures can be achieved without any technical/operational difficulty. Please note that these will form the basis of future licencing conditions. It is quite likely that the average emission rates were used by the Consultants. As for an EIA study, it is more appropriate to assess the worst scenario situation and to use the maximum emission data. For reference, the figures appeared in the licences are presented below: Licensed emission Castle Peak 'A' Power Staton NOx emission (per boiler) — 800 g/s SO_2 emission (per boiler) — 722 g/s Particulate emission (per boiler) — 43 g/s	Already discussed in EPD (Air Stream) Overall comment 1, above.

Department	Reference	Comments	Consultants' Responses
		Castle Peak 'B' Power Station Nox emission (per boiler) 1,570 g/s SO_2 emission (per boiler) 1,406 g/s Particulate emission (per boiler) 85 g/s Black Point Power Station (estimated by adjustment of Castle Peak 'B' Power Station with the new BPM requirements) NOx emission (per boiler) 396 g/s SO2 emission (per boiler) 141 g/s Particulate emission (Per boiler) 35 g/s	
		As it is possible for the plant to operate with even higher generation output than the base load rating, it is suggested that an allowance of at least 10% should be made to these emission rates.	This will be covered in the Complex Terrain Wind Tunnel Working Paper.
		Table V3/3.2 (d), Table V3/f.2 (e) and Table V3/3.2 (i) It is noted that the figures presented in Table V3/3.2 (e) and Table V3/3.2 (i) are not directly proportional to those presented in Table V3/3.2 (d). Please clarify how the trace metal emission rates could be derived from the trace metal concentrations in the coal.	Differences are due to losses via volatisation and condensation; see Annex V3/Dii3.1.

Department	Reference	Comments	Consultants' Responses
		Table V3/3.2 (c) and Table V3/3.2 (h)	
		It is noted that the figures presented in these tables are not derived by simple multiplication of the corresponding figures in Tables V3/3.2 (a) and V3/3.2 (f). Please provide also their assumptions in arriving their seasonal estimates.	Assumptions for seasonal estimates are provided in Annex A. Simple multiplication is not sufficient.
		Table V3/3.2 (f)	
		The BPM for NOx emission from gas turbine is water/steam injection and other more advanced technology, e.g. SCR. The "75 ppm" NOx limit is applicable only to oil-fired gas turbines. For gas-fired units, the BPM requirement is 85 mg/m^3 (i.e. 42 ppm).	Noted. See comment above. We would also point and that the UK HM Inspectorate of Pollution do not consider that SCR represents "best available technique not entailing excessive cost".
		The stack height of the combined cycle gas turbine units should be one of the subjects of investigation in the KIA.	Agreed.
		Table V3/3.2 (h)	
		The figures in the table appear to be incorrect as all of the them are less than half of the corresponding figures presented in Table V3/3.2 (c). Could the Consultants please clarify?	These figures have been reviewed for use in the Complex Terrain Wind Tunnel Tests Working Paper.

Department	Reference	Comments	Consultants' Responses
		Table V3/3.2 (j)	
		The NOx emission rate in the table appears to be lower than the figure based on a concentration of 75 ppm. The Consultants are requested to confirm, with the agreement of CLP, that these lower emision figures can be achieved without any technical/operational difficulty. Please note that these will form the basis of the licensing conditions of the plant.	Being revised for submissions in the Complex Terrain Wind Tunnel Modelling Working Paper.
		The stack height of the open cycle gas turbine plant should be one of the subjects of investigation in the KIA.	Agreed.
	S.3.2.3	Apart from the BPM requirements governing the emissions from stack emissions, which have direct implications in the EIA process, there are other BPM requirements needed to be observed in the detailed design of the plant. CLP should discuss with us on those requirements in the detail design stage of the project. Some of the requirements are described below:	
		Ship Unloading Operation (Pg. 46)	
		As grab unloaders will often give rise to spillage of coal particles and may cause short term air pollutant nuisance to the neighbours in the vicinity, the feasibility of using enclosed continuous unloaders for coal unloading should be investigated in the detail design of the plant.	Noted. However, it should be noted that this was attempted at Castle Peak but found to be unsatisfactory.

Department	Reference	Comments	Consultants' Responses
		<u>Active Stockyards (Pg. 47)</u>	
		The dust emissions from the stacker/reclaimer with respect to dust emission should not be worse than those from the one in the Castle Peak Power Station.	Noted.
		The configuration of the stockpiles should be properly designed to avoid the inaccessibility of the water sprays for dust suppression.	Noted.
		<u>Combustion Waste Disposal (Pg. 47)</u>	
		The control of fugitive emissions from handling of materials should meet the BPM requirements. While detailed requirements are to be agreed during he licensing process, the following measures should also be incorporated in addition to those recommended by the Consultants:	
		1. The emissions from fugitive emission sources, including transferring and handling of materials such as limestone, PFA, coal and etc., should be collected and vented to bag filter system to meet 50 mg/m3 limit.	Noted.
		2. Dusty materials, e.g., powdered limestone, PFA and etc, should be stored in fully enclosed silos with dust arrestment plant to meet the above limit value.	Noted.
		3. The total boundary ambient particulate concentration should not exceed 260 μg/m3 (24-hour average).	Noted.

Department	Reference	Comments	Consultants' Responses
	S.3.2.5	Fugitive hydrocarbon emissions	
		To ensure the odour concentration at the boundary will be less than 2 odour units (which is to be one of future licensing conditions), the design of the fuel oil handling equipment should incorporate vapour recovery or vapour return line.	The fuel oils under consideration have low vapour pressures and hence such equipment is not considered appropriate for the grades of oil under consideration.
		The Consultants should also confirm that the heavy fuel oil mentioned in this section will meet the specifications stipulated under the Air Pollution Control (Fuel Restriction) Regs., viz., 0.5% sulphur content and 6 cST viscosity at 40 C.	The heavy fuel oil refered to may not meet this specification as it is considered inappropriate for the LTPS in view of the emissions control equipment to be used; see V3/3.1.2.
		It may also be worthwhile for the Consultants to estimate the rate of fugitive emission of LNG as global warming is also an environmental concern.	It should be noted that the LNG system is pressurised and hence fugitive emissions will be minimal (during coupling–up, valve actuation etc.)
	S.3.4.1	Some of the air quality modelling assessment results are extracted from the Phase I Scoping Report. Our comment on the Scoping Report that the numerical predictions appear to be unexpectedly low even though the low emission figures have been taken into account are applicable here. The consultants are advised to review the calculation and the data files to eliminate the possibility of errors in data manipulation and unrealistic modelling parameters such as mixing height for the study.	Review has revealed no significant errors. We would appreciate seeing EPD's results and assumptions.
		It is noted that detailed assessment of air quality impact to Castle Peak areas as sensitive receptors has not been made. Presumably, this would be addressed in the Key Issue Report.	Receptors along the coast and in the Castle Peak Range will be included in the KIA.

Department	Reference	Comments	Consultants' Responses
	S.3.4.2 on Pg.54 and S.3.4.2 (b) on Pg.57	The methodology of the estimation of the worst daily impacts of the plant is not clearly presented. The consultants should also provide the following in the report:	
		a. Instead of using the actual meteorological data of a certain number of years or of a typical year for the predictions of the daily impacts, the consultants have adopted the standard deviations of wind directions and wind speed of a typical summer's day. The consultants should provide justifications for this approach and explain how the worst daily impacts for different wind directions can be predicted.	a. Given the dispersion models available, the way in which meteorological data is collected and archived, and the behaviour of the atmosphere, it is difficult to construct meaningful estimates of daily average pollutant concentrations. The approach taken represents the most pragmatic possible in the circumstances. The biggest single influence on the daily average concentration experienced by a particular receptor is the persistence of wind direction.
		b. Furthermore, the local topography is likely to have significant influence on the predictions. The consultants should explain how this has been catered for in the predictions.	b. As the worst case has been taken to be unstable, convective conditions, the influence of topography is secondary to that of the convective updraughts and downdraughts. In principle, the influence of topography can be incorporated as for the one-hour averages, by using RTDM; however this is not considered appropriate in view of the detailed modelling to be carried out in the wind tunnel.

Department	Reference	Comments	Consultants' Responses
	S.3.4.2 (i) (a) on Pg. 57	c. The consultants should explain how the variations of emission have been accounted for in the predictions.The prediction of the worst daily impacts is subject to the same uncertainties associated with those of hourly impacts. The predictions should be reviewed in the light of the findings of the wind tunnel tests during KIA.	c. Over a period of 24 hrs, i.e. one day, the emission were assumed to be constant and maximum.
		The Consultants should provide technical basis for the estimated 60% conversion of NO to NO_2.	The NO to NO_2 convertion rate of 60% is based on the work of Janssen et al (Atmos. Environment, Vol. 22, pp 43-58, 1988) who measured NO and NO_2 concentration in power plant plumes using aircraft borne instrumentation. Their measurements showed conversion rates of between 20% and 80% depending on O_3 concentrations and windspeed. 60% was chosen in this instance on the grounds of known high episodic O_3 concentrations in Hong Kong.
	S.3.4.2(c)	Similar to the prediction of daily impacts, the methodology of the prediction of the annual impacts is not clearly presented. The consultants should provide the following in the report:	
		a. the meteorological data used in the predictions (If actual meteorological data are not used, justifications of the adequacy of the approach should be provided.);	a. Annual average meteorological data provided in Annex B (for Lau Fau Shan).
		b. the assumed variations of emissions in the predictions;	b. Emissions were varied from season to season according to the anticipated demand. (provided by CLP).

Department	Reference	Comments	Consultants' Responses
		c. the approach to cater the effect of the local terrain on the predictions.	c. Long term modelling has assumed level terrain, (at stack base height) except where specifically stated. It is neither meaningful or desirable to put terrain heights at each of the 6561 grid points. ISC does not permit the terrain height to be greater than the stack height and does not adequately deal with plume behaviour over and around steep, high obstacles.
		The prediction of the annual averaged impacts is also subject to the same uncertainties associated with those of hourly impacts. The predictions should be reviewed in the light of the findings of the wind tunnel tests during KIA.	Conclusions will be reviewed in the light of the wind tunnel test results.
		<u>Figure V3/3.4 (c) – (l)</u>	
		Please explain the term "Partial Operational Load" in the title of Figure V3/3.4 (c). If the predictions are based on limited operation scenario of the plant, further assessment should be made to evaluate the impacts under full operation scenario.	The term 'partial operaitonal load' means a mixture of operating conditions chosen to reflect the likely loads experienced by the power station. Therefore, the units will be operating at full load for much of the time, partial load for a smaller fraction of the total and will be shut down for limited periods.

Department	Reference	Comments	Consultants' Responses
		We are surprised that the predictions in Figure V3/3.4 (1) are based on the assumption of non–flat terrain. Please clarify whether all the predictions have catered for the effect of terrain. Figure V3/3.4 (m) There is a shoulder in the curves at about 1–2 km distance. It is likely that this is contributed by the emission of the combined cycle gas turbines at low level. If this being the case, it would be quite surprising that the both scenarios (viz. 4 coal–fired plants + 4 CCGTs and 8 coal–fired plants) would give rise to similar results. The consultants should make a review.	This was a security run. The non–flat terrain referred to is simply an idealised plateau at stack height for those areas of Hong Kong which are greater than 250m amsl. The 'shoulder referred to by EPD is an initial peak due to the CCGT's produced by the model. The main peak, due to the CCGT's, in fact occurs at 4–5 km for stability categories B and C, with the maximum being 120 $\mu g\ m^{-3}$. Addition of these curves to those of 4 coal–fired units at Black Point therefore produces similar concentrations as 8 coal–fired units for Categories B and C. (The lower emissions rates from the CCGT's are balanced by lower stack heights for NOx.)
	S.3.5	While it is likely that background concentrations at most of the area of concern are low, the Consultants should also note that there are some substantial industrial developments in the northwest N.T. and their emissions may also contribute to the background level, when wind blows westerly. As mentioned in our comments on S.3.3 of Volume 1, more detailed analysis in the Key Issue Report are expected.	Noted.

Department	Reference	Comments	Consultants' Responses
	S.3.6 (c) on Pg. 73	The predictions on the impacts of particulates and toxic metals are based on the predictions of SO_2 and NO_2. If the predictions are found to be inadequate in the light of the above comments, the predictions of particulate and toxic metals impacts should be revised.	Having reviewed the predictions, the consultants do not believe this to be the case.
	S.3.6.1 (i) (c)	Some of the trace metals (arsenic, cadmium, chromium and nickel) are carcinogenic and no known safe threshold has been established. It is considered appropriate that in assessing whether or not the impacts of these pollutants are acceptable, the carcinogenic risk should be estimated with the unit risk factors developed by the W.H. O., U.S.E.P.A. or California Air Resources Board. It is a common practice to accept a carcinogenic risk of less than 1 x 10^{-6}.	Predicted levels are so low, this is not considered necessary. Levels will be well within known rural levels and negligible with respect to urban levels.
	S.3.6.2 (i) (b) on Pg. 78	The dry deposition is assumed to be proportional to the ambient concentration of the acidic gas. The proportional relationship should be given in the report.	Noted and agreed.
		Figure 3.6 (a) and (b) are not presented in the report. As such, meaningful comments cannot be made.	These will be included in the Final Report Annex C.
	Annex V3/E	It is considered more appropriate to agree on the details of the monitoring requirements after the completion of the Key Issue Report.	Noted.

Department	Reference	Comments	Consultants' Responses
-		However, it is expected that the following would be the minimum:	
		1. Ambient monitoring of both SO_2 and NOx at appropriate locations agreeable to EPD.	This can be reviewed in conjunction with existing monitoring work at a later date.
		2. Ambient particulate monitoring at various locations at the boundary of the premises;	
		3. Continuous monitoring of particulates (opacity), SO_2, NOx, CO and on-line transmission of the monitoring signals by telemetry to EPD.	CLP do not consider that a telemetry link is necessary.
	Others	a. The report has not included the assessment of air impact on the northwest N.T., e.g., Castle Peak, Tuen Mun, Tsang Tsui and etc. It is expected that detailed assessment would be made in the KIR.	Agreed.
		b. The consultants should advise if the emissions from both Power Stations may cause odour nuisance to the air passengers when the proposed Chek Lap Kok airport is in use.	Emissions will not cause odour nuisance to air passengers.

Department	Reference	Comments	Consultants' Responses
EPD (NPG)	V1/2.3.5	Please incorporate the adopted "Daytime General Construction Noise" criteria for completeness in this section although it is given in Section V2/5.4.1.	Agreed.
	V2/5.2	The "worst case" approach of construction noise assessment is supported.	Noted.
	V2/5.7	The 3 mitigation measures suggested are generally acceptable. It is important that they would be translated into construction contract documents. To permit 24-hr operation, the effectiveness of quietest dredgers and silencing fitments applied to diesel power plant have to be given to enable the consideration of Construction Noise Permit. Early preparation work should be made unless night-time dredging could be re-scheduled to daytime period as recommended in Section V2/14.2.	Noted and agreed.
	V2/8.1	The preference of sea transportation of material and equipment is supported.	Noted.
	V2/8.6.1	The mitigation measures suggested to reduce the impact from road transportation of plant, materials and staff are supported.	Noted.
	V3/4.2.1	For completeness, please indicate the meanings of a, l and x in eq. 4.2.	a = distance between source + receptor l = length of source k = angle of view at receptor (in radians)
	Table V3/4.4 (a)	Typo found at Phase II NSR1 under L_{90} + 10 during day and evening.	Should be >55. Text amended.

Department	Reference	Comments	Consultants' Responses
	Table V3/B1 - B6	The noise reduction effectiveness of K6 (Barrier Attenuation) has contributed significantly to the low levels predicted. It is therefore important that the surrounding terrain acting as barrier must be retained.	Agreed, but retention depends on Government or other projects taking this into account.
	Annex V3/E2	It is considered prudent to indicate clearly that it is the responsibility of the operator to conduct operational noise monitoring and submit for the information of the Government.	Agreed.
	Annex V3/E2.1	a. Please add "and thereafter at least 2 times a year" to the end of para. 1.	Suggest "and thereafter once per year".
		b. following a, it is convenient to obtain background noise measurements simultaneously. Please therefore amend "annually" in the first line under para. (iii) to "at every 6-month interval".	Amendment is not applicable, in view of above.
	Vol 3 5.2.1	In order to reduce the opportunity for residual chlorine to react with organic material present from Pearl River sources and NWNT effluent, which will tend to form chlorinated compounds, disinfection methods other than chlorine should be investigated.	Noted, but other methods are not commonly used and may be less reliable. Alternatives will be discussed in the Water Quality Key Issue Assessment.
WPG/EPD	5.4.2 5.8.1	The WQO for temperature for North Western Waters when declared is unlikely to be greater than 2 degrees celsius.	Noted.
	5.4.3	Reference is made to Table V3/5.4 (e), which is a reproduction from the Technical Memorandum. One parameter listed as prohibited is: 'wastes liable to form scum, deposits or discoloration. From experience at other power stations this will need to be considered for the cooling water discharge.	Noted and agreed. However, at Castle Peak this depends on EPD approval of the proposed treatment method.

Department	Reference	Comments	Consultants' Responses
		There is reference to the effect of discharge temperature and decisions on the effects of temperature will be based on the modelling results. Similarly for other parameters discussed.	Agreed.
WPG/LCG	5.6	There seems to be some potential for effluent reuse that would result in the reduction of pollutants discharging into the marine environment. For instance, could the consultant look into the use of PFA lagoon decantrate, ash pit effluent and boiler blowdown for the slurrification of PFA and quenching of furnace bottom ash instead of discharging them into the cooling water outfall?	Agreed. Effluents will be reused wherever this proves practicable. Such options will be discussed in the Water Quality Key Issue Assessment.
	5.6 5.8.2	Despite the comments in the final paragraph of S.5.8.2, it will be necessary to quantify the relevant parameters to ensure that individual and combined effluent streams can comply with the TM or agreed levels based on the TM. Some form of separate or combined pre-treatment may be required. Mere dilution in the cooling water will not be acceptable.	Agreed, assuming dilution in the cooling water "may" not be acceptable. The consultants would point out, however, that this approach does not appear consistent with the practice adopted for the NWNT sewage outfall.
	5.12	Other parameters beside temperature may need to be modelled and at least one conservative parameter should be used to determine general dispersal effects for such a large discharge.	Agreed, this will be addressed in the Water Quality Key Issue Assessment.

Department	Reference	Comments	Consultants' Responses
WMPG/EPD	V3/6	<u>Overall Comments</u> The DIAR onlygives a brief and general coverage on the issue of solid waste/by-product management, such as possible disposal options and possible future reuse and marketing potentials. Chapter 6 is considered adequate as a preliminary study in the DIAR but a Key Issue Report on Solid Waste/By-Product Management must be prepared by ERL immediately such that WMPG/EPD can comment/agree on any detailed waste management options for the LTPS. More specific and quantitative assesment of the problems, requirement and solutions for the solid waste/by-product management should be included in the KIR in order to develop a practical and environmentally acceptable management strategy and programme for the waste generated from LTPS. The KIR for Solid Waste/By-Product Management should address at least the following: I. <u>PFA</u> The proposed PFA management strategy should include study and solution for different situation, including the worst case scenario. The worst situations to be considered include: i. Government policy on usage of PFA on land reclamation and general fill remains unchanged. (Retrict to use above sea level)	Noted. The scope for the Solid By-Products KIA has subsequently been agreed with EPD.

Department	Reference	Comments	Consultants' Responses
		ii. Use of PFA in concrete does not increase substantially due to attitude of PFA in concrete usage remains unchanged. iii. Other unfavourable conditions. II. <u>FGD wastes</u> We note the FGD processes under consideration for adoption at the LTPS. If a decision is taken for an option that generates FGD solid wastes for disposal as gypsum, this will need to be addressed in details with a view to develop a practical and environmentally acceptable management strategy based on a realistic projection of gypsum wastes arisings. <u>Specific comments</u>	
	V2/7.4.1	Presumably the construction wastes from the LTPS to be disposed of at the WENT landfill do not include construction debris which is suitable for reclamation, such as soft fill and crush rockfill. Suitable filling material should be sorted and disposed of at public dump for reclamation to ensure good use of the material and to avoid unduly overloading the WENT landfill.	Agreed. All suitable rock wastes are intended for use in the reclamation.
	Table V3/2.2 (b) on Pg.21	The gypsum production appears to be over-estimated. Not only that the estimation is inconsistent with ash production estimation by the fact that the maximum sulphur content has been used, the figures are inconsistent with those presented in Table V3/6.2 (c).	Agreed, these figures have been revised in line with those provided in section V3/6.2.2.

Department	Reference	Comments	Consultants' Responses
		Could the Consultants provide the definition of "Lower Merit Ranking" and "Higher Merit Ranking" coal?	Please see Final Site Search Report p. 20, point 3.5.2.
	V3/6.3 (i) on Para. 138	If the excess FBA, not being absorbed by the commercial market, is disposed at the existing Tsang Tsui lagoon and mixed with the PFA, it will contaminate the PFA in the lagoon and render both the PFA and FBA no market value in the future. It will probably cause permanent disposal problem for the PFA and FBA. Consideration should be given for separate storage of FBA & PFA with market value from those having no market value.	The admixture of FBA with PFA is not considered to be deleterious to the potential value or subsequent utilisation of the lagooned material.
	V3/6.3.1 (i) on Pg. 139 Para. 2	At present, PFA is not allowed to be used as fill material below the high water mark. The tremendous volume of fill required from 1996 to 2003 includes majority underwater fill material. If the present policy remains unchanged, the quantity of PFA utilization on this aspect will not be significant and it cannot solve the PFA disposal problem. The trace metal content in PFA is an issue of concern for use below the water line.	Noted. However, PFA has already been used successfully below high water e.g. Area 47S, Cross Harbour Tunnel without significant environmental impacts.
	V3/6.3.1 (i) Pg. 141	Please quantify PFA utilization as general fill material if this disposal method is considered viable in the future.	Agreed, this will be considered in the Solid Byproducts KIA.

Department	Reference	Comments	Consultants' Responses
WMG & SCG/EPD	V3/S.6	Despite the possibility of alternative utilization of PFA, FBA and gypsum, it appears that a large amount of these materials may have to be temporarily stored at the Tsang Tsui ash lagoons. It is questionable whether the materials from both stations could be accomodated at the existing lagoons up to at least the year 2000, taking into account that the lagoons were designed only to accomodate PFA from CPPS over a ten year period of operation (which started on 5.3.87). In this respect, the study should include future projections of waste arisings from both plants in connection with the capacity of the existing lagoons.	Agreed. But "extra" capacity will be available from sales of PFA. The contents of the lagoon are themselves intended for reuse.
WMG/EPD	V3/P. 142	Consideration should be given for restoring the land borrow area in the vicinity of Tsang Tsui Lagoon by PFA as part of the LTPS waste disposal strategy.	Agreed, this will be considered within the Solid By-Products KIA.
	V3/6.3.1 (i) Pg. 143	Disposal options should be studied and identified at the present moment assuming the worst situation rather than deferring the study to end 1990s. The possible options should be submitted to WMPG for comments/agreement.	Ibid.
		If additional ash disposal facilities is needed, the type location and other characteristics of the facilities should be studied by CLP and then commented/agreed by WMPG/EPD as aprt of the EIA study. The siting and layout of the LTPS will pose certain constraints on the type and lcoation of the PFA disposal facilities.	Ibid.
	V3/S6.3.2 (i) Pg. 144	On the disposal of gypsum, the option of requesting the vendor of the FGD system to buy back the gypsum produced may be viable and may worth consideration (i.e. exporting outside of Hong Kong).	Ibid.

Department	Reference	Comments	Consultants' Responses
	V3/S.6.3.3 (i) Pg. 153	Since the chemical composition of the FGD sludge from wastewater treatment is very similar to FGD gypsum, the possibility of combined handling and disposal of the two wastes streams should be considered. Such possibility must be fully explored before consideration is given to separate disposal of FGD sludge.	This option is identified in the second bullet point under FGD By-products on page 153.
SCG/EPD	V3 Table 6.2 (g) item 12 Pg. 134	It is against EMSD's policy to accept kitchen grease (grease trap waste) at sewage treatment plant. The waste should be disposed of at landfill or recycling plant if available.	Noted.
EAPG/EPD	V3/S.12	We note that Scenario 2 is found to be less visually intrusive than Scenario I.	Agreed.
	S.12.6.2	We support the recommendation for planting and terracing of the north facing out slope but suggest that all cut slopes on site should be recontoured and at least hydroseeded.	Noted. Recontouring/hydroseeding will be carried out where practicable.
	S.12.4	As the coal-fired chimneys are considered the principal visual intrusive elements from various view points, we consider the 2 x 4-flue configuration more aesthetically acceptable than the proposed 4 x 2-flue configuration. It should be noted that such a configuration would be more beneficial on air quality grounds as well. The consultants and CLP should further consider whether site layout constraints could be overcome to allow for such a configuration.	Aesthetically agreed, but limited by the need for development flexibility.

Department	Reference	Comments	Consultants' Responses
		It has been noticed for a long time that yellowish plumes have been emitted from the Castle Peak Power Stations. The consultants should, perhaps, advise whether the emissions are visually acceptable and whether there are any possible mitigation measures. Would similar emissions be produced by the LTPS, and if so, their visual impact and possible mitigation measures should also be addressed.	Such emission characteristics are not expected from the LTPS.
Tuen Mun and Yuen Long District Planning Office		<u>Volume 1 : The Surrounding Environment</u>	
		– Regarding para. 2.2.2, please be noted that nine initial development options have been formulated under the NWNT Development Strategy Review, there may be additional population growth along the Tuen Mun – Yuen Long corridor. The resultant proposed population distribution pattern is very much depending on the outcome of the Review, which is scheduled to be completed by the end of this year. Therefore, the above development might have to be taken into account of.	Noted.
		– Regarding para. 2.9 (Marine traffic), please note that in the Ma Wan Channel Improvement Study, the levels of estimated marine traffic only include ocean going vessels and the forecast has not been taken into account of dangerous goods traffic.	Noted.

Department	Reference	Comments	Consultants' Responses
		<u>Volume 3 : Operation Phase EIA</u>	
		– Regarding Chapter 6 : Waste Disposal, solid waste is a significant potential problem particularly with regard to disposal of PFA and FGD wastes. Also related to FGD – from where is it proposed to obtain raw materials for this process and have increased traffic number been taken into account in the EIA?	i. Noted and agreed. ii. Vessels importing/exporting FGD related materials have been included in the traffic estimates provided in the DIAR.
		– Regarding Chapter 9 : Civil Aviation, what sort of effect in this likely to have on dispersion of the flume in adverse weather condition and will adequate dispersion be achieved in all conditions?	Adequate plume dispersion is being investigated within the Stack Emissions Key Issue Assessment.
Provisional Airport Authority		It appears that the actual height of the power plant stacks is not specified in the Report provided, however earlier discussions have indicated a planning figure of 250m should be used. This height would clearly penetrate the preliminary obstacle limitation surface height of 155m established for this area and needs further review in liaison with CAD/PAA.	Agreed. The need to gain agreement from the PAA (ex-CAD) for the stacks to exceed the obstacle limitation surface height restrictions is acknowledged on p. 147, section 10.3.1 of the Final Site Search Report (September 1990). This agreement has now been obtained see Annex D in this volume. (see Annex D)
		For your information the finalised obstacle limitation surfaces for the new airport together with restrictions relating to telecommunication systems etc., which leads to the formation of a comprehensive safeguarding chart, will be available at the end of Phase III of Airport Master Plan Study in September 1991.	Noted. (see Annex D)

Department	Reference	Comments	Consultants' Responses
		Our Consultants have expressed concerns about the temperature of exhaust emissions and its effect on aircraft performance and the potential for fog and/or cloud formation as discussed under Section 9.3.1 Particulate Effects of DIAR Vol 3. Both factors appear to have been evaluated and the conclusions indicate that no substantial effect is anticipated. I would be grateful if sufficient data is available to support these conclusions.	Modelling data will be provided as appropriate. (Please see Annex D)
District Lands Office, Tuen Mun - Building & Lands Department	2.14.3 Vol. 1	It is suggested that investigation of overall 'Fung Shui' by CLP in conjuction with local expert should include the large no. of graves in the area.	Agreed.
	3.3.4 Vol. 1 3.8.1	Local people are very concerned about the combined effect on water and air quality to be generated by existing power station at Tap Shek Kok and the proposed LTPS. Suggest to attend to this problem in the Key Issue Studies.	Noted.
	13.2 Vol.2	The height of exhaust stacks is a potential 'Fung Shui' problem.	Noted.
	General	As a general comment, I would suggest that an assessment be made on the sentiment of and possible objection from the local people to the siting of the proposed LTPS in close proximity to the power station at Tap Shek Kok. The cumulative effects on the environment by the two stations should also be addresed inseparably.	Noted. The cumulative effect of emissions to air and water from both stations will be addressed in the Stack Emission and Water Quality KIA's.

Department	Reference	Comments	Consultants' Responses
TD Transport Department	Vol. 2, Chapter 8 Vol. 3, Chapter 7	Transportation of equipment and materials primarily by sea to site to reduce the impact on road system is encouraging and should be supplied.	Noted.
		Since all land transport to the site has to pass through the junction of Lung Mun Road and Wu Chui Road which is already very busy at the moment, the consultant should be requested to carry out a detailed assessment on the traffic impact to this junction.	Section V3/7.5.2 points out that planned road improvements associated with Area 38 and PADS will alleviate traffic impacts on Lung Mun Road, to which LTPS traffic would have been only a very small contribution (<5%) in any event. Further investigation of this issue is therefore not considered appropriate. (Please see Annex E of this volume). (Please see Annex E)
		In addition to the proposed busing system for employees, the consultant should be requested to investigate on the necessity and feasibility to operate ferry transportation for workers and employees between the site and, say, public landing stages in Tuen Mun to alleviate further the traffic burden on road system.	Considered, but weather and length of travel time/loading logistics (Kadoorie pier) render this option impractical.
		Generally speaking, no adverse comment on the mitigation measures proposed by the consultant.	

Department	Reference	Comments	Consultants' Responses
PELB	(32) in PELB (E) 55/10/44 (90) x 1	While I have no specific comment on the content of the report, I would like to remind you that it is Government's policy that private sector companies required to undertake EIA studies should issue an Executive Summary of the Final EIA to the public, and the Executive Summary must be issued well before irrevocable development decision are taken on the project. For a project of such a sizeable scale like the captioned one, I would strongly advise that the full Final EIA report be issued to the public.	An Executive Summary of Stage 1 (Site Search Study) of the EIA process for the LTPS was issued in September 1990. It is intended that an equivalent Executive Summary be produced dealing with the site specific Stage 2 work, as required under Section 5.2 of the Study Brief. Release of the full Final EIA to the public may in part depend upon any precedent set by the release of EIA's for similar projects, such as PADS, or would itself create a precedent.
Electrical & Mechanical Services Department	Vol. 1 Pg. 33 Section 2.15.3	The average metal concentration from Yuen Long & Shek Wu Hui Sewage Treatment Works had been used to estimate that for Pillar Point discharges. Because of different sewerage catchment characteristics, it appears to be more appropriate and essential to take samples and analyses from Pillar Point discharges.	Whilst it is agreed in principle that sampling and analysis at Pillar Point discharges for metal concentrations may be appropriate, it should be noted that the time-frame of the study would only have permitted sampling over a short period of the year. Any seasonal variations would not have been made apparent. The data on which our estimates are based are year-round and a composite from two discharges. We consider this adequate to achieve the aim of providing an indication of the potential for metal pollution. It should be noted that the report highlights the indicative nature of the results. Data for metal levels of Pillar Point were requested from DSD but none were available.

Department	Reference	Comments	Consultants' Responses
	Vol. 3 Pg. 96 Section 5.2.4	The data in table V3/5.2 (d) showed the poor performance of the biological wastewater system at Castle Peak Power Station and this should be improved at LTPS.	Operational modifications are currently improving the wastewater treatment system at CPPS. This will also be improved at LTPS.
	Vol. 3 Pg. 99 Section 5.2.7	The metal content of the ash decantrate return would invariably increase as loading accumulates on the ash lagoon and it should be monitored before discharge with the cooling water.	Ash decantrate return is dealt with under the Castle Peak licensing condition.
	Vol. 3 Pg. 193 – 206 Section 13	The contents of this Section are generally agreed. The Conclusions & Mitigation (Section 13.5) are agreed and supported.	Noted.
	Vol. 1 Pg. 60 Section 3.5.3	Adequate precautions should be taken to ensure that any well likely to be used for human consumption will not be polluted or fouled.	Agreed.
RSD	Table V2/7.3a (a) on Pg. 77 of Vol. 2	To add under Public Health and Municipal Services Ordinance the following: Public Cleansing and Prevention of Nuisances (Regional Council) By–laws Cap. 132. Carrying of mud onto street. Littering from specified vehicles.	Text amended accordingly.
TMDev. O	V1, Pg. 27 Section 2.7.2	It is dangerous to assume that the proposed PADS reclamation from Tap Shek Kok to Black Point will take care of the resettlement issue of Lung Kwu Tan and Lung Kwu Sheung Tan. The consultants should be aware that there is no firm programme, at least in the time being, for the PADS development in that area. If the consultants consider that resettlement of Lung Kwu Tan and Lung Kwu Sheung Tan are not required due to the presence of the LTPS, they should explicitly say so without linking to the possible PADS development.	This has not been assumed, and line 8 of Section 2.7.2 explicitly points out that the resettlement of Lung Kwu Tan and Lung Kwu Sheung Tan will not be required for the LTPS.

Department	Reference	Comments	Consultants' Responses
T.M. Dev. O	V1, Pg. 27 Section 2.8.2	The proposed dual 3–lane carriageway is identified under PADS, not Area 38 development study.	Text amended.
	V2, Pg 15 Section 2.3.1 and V3, Pg. 138 Section 6.3.1	Since CLP is the main PFA producer in HK, the use of PFA in site formation/reclamation works of the LTPS, both above and below high water level, should be seriously considered by the consultants in order to encourage and promulgate the use of PFA in other reclamation projects.	This option for PFA utilisation is being actively pursued by CLP, along with the opportunities for the use of PFA in other site formation/reclamation activities in Hong Kong.
		A. <u>Volume 1</u>	
Marine		1. Para. 1.1.2, pg. 3	
		Clarification on passage rules for the Ma Wan Channel is necessary. At present, large bulk carriers up to 272m length, 16.5m draft and approximately 120,000 dwt (individual ones up to 140,000 dwt) delivering coal to Tap Shek Kok make transit under pilotage between 1 hour after to 1½ hours after highwater at Quarry Bay in daylight with a Marine Department launch in escort to clear local traffic. Traffic lights, that is the leading sector and traffic lights at Ma Wan, are operated for the transit inbound and outbound. Otherwise, Marine Department has not laid down criteria for passage around Ma Wan. The pilots are employing unofficial guidelines of their own which are currently under the consideration of the Pilotage Advisory Committee. These guidelines are not based on rules recommended by BMT.	Text amended. These matters will be dealt with in a separate Marine Impact Assessment.

Department	Reference	Comments	Consultants' Responses
		The recommendations made by BMT for the various classes of vessels have not been implemented and further decisions on implementation have not been taken. A current meter is expected to be installed in the area to widen the transit window for the largest vessels;	
	Marine	2. Para. 2.3.4	
		A reference needs to be made to the requirement under MARPOL Annex IV and V to install waste reception facilities at the berth.	Waste reception is understood to be the responsibility of the HK Port Authority.
		3. Para. 2.9	
		It must be noted the forecast level and capacity estimated in the Ma Wan Channel Improvement Study were made based on a number of assumptions regarding the growth in traffic which needs to be kept under review and the capacity calculation assumed two-way passing of vessels, which is not presently carried out, would be allowed.	Noted.
		The statement in the paragraph is therefore too wide sweeping. The term capacity needs definition (number, sizes, delays, risks etc.). It must be noted that when estimated capacity is laid against forecast traffic levels, the whole approach in this respect is purely theoretical rather than practical. In this respect the uncertainty of the situation would result in the vessels proceeding to the LTPS not being given priority over others. Delays may therefore arise at times.	This subject is indeed largely theoretical but the analysis is hindered by Government's inability to release studies such as the Ma Wan Channel Improvements study.

Department	Reference	Comments	Consultants' Responses
		4. Para 2.22	
		The removal, reprovisioning and associated costs of the VTS will need to be funded by the development of the LTPS.	Request to be considered by CLP.
		B. <u>Volume 2</u>	
		1. Para. 1.1.2, page 3 same remarks as para. 1.1.2, page 3 in Volume 1.	Noted.
		2. Paras. 2.3.2, 3.3	
		A seawall berth in this location has merit over that of a jetty berth from a port planning, operation and shipping safety point of view because of the PADS developments as well as the massive port developments at Shekou, Ma Wan and Chiwan resulting in very busy marine traffic off Black Point.	Noted. This is one option under consideration for the detailed engineering design.
		It is given to understand that the developer has the intention to leave vessels alongside the berths during typhoons. This will have a substantial impact on design and loading criteria. This aspect should be referred to where appropriate in paragraphs up to para. 3.6.2.	Text amended, see V2/2.3.2.

Department	Reference	Comments	Consultants' Responses
		3. Paras. 2.1, P.p 13 2.3.2 P.p 24 2.4.2 P.p 26 3.3.3 P.p 34 6.2.1 P.p 58	
		The references made regarding draft and channel depths appear confusing. The figure of 20m has been quoted at times for the draft of vessels and at other times for the depth of the channel whilst in Annex V2/A, the channels were shown to be -22mPD. (Note: these above discrepancies are repeated in the relevant parts of the volume 3).	Drafts and channel depths will be developed over time as larger vessels are handled. Final channel depths are anticipated to be about -20mPD. The Figures in Annex V2/A illustrate the evolution of the project design and hence do not reflect current information. Text clarified.
		4. Para. 8.3.2	
		Marine Department does not have a system to record the number of vessel movements through the Ma Wan Channel. The record of 2000 ocean-going vessel movements in 1988 was a one off set exercise.	Noted.
		C. <u>Volume 3</u>	
		1. Para. 1.1.2, page 3	
		Same remark as para. 1.1.2, page 3 in Volume 1.	Noted.

Department	Reference	Comments	Consultants' Responses
		2. Para. 5.2.11	
		It is noted that the potential of oil spill is based on 64 recorded and documented incidents between 1977–1986, it may be underestimated as there may be un–recorded or undocumented cases and more uptodate figures.	See Item 4 below.
		The consequences of an oil spill need to be addressed.	
		3. Para. 5.5	
		No mention has been made of the possibility of leaving vessels alongside during typhoons and which would be the preferred layout to accomplish this.	Text Amended. See Item B(2) (P.39). Above.
		4. Paras. 5.10, 5.11	
		The matter of oil spill risk and potential damage should be quantified. An oil spill contingency plan must be produced by the LTPS to meet that risk.	Agreed. Spill frequency is given in V3/5.2.11. An oil spill contingency plan will be produced by CLP.
		5. Paras. 6.1, 6.2.5	
		Facilities to meet MARPOL Annex 5 requirements should be incorporated into the design criteria and addressed in the report.	Text amended. See Item A2 (P.39) above.

Department	Reference	Comments	Consultants' Responses
Marine		6. Para. 7.3.3	
		The wording is too loose. Please see comment (3) in Volume 1.	Text amended.
		7. Para. 7.5.3	
		What is meant by will require increased controls of maritime movement? Have the consequences of costs, funding and responsibility arising from the 'increased controls' been taken into account?	This has been pointed out as being necessary at site search stage (SSR) section 6.2.1, page 113. Funding is assumed to be the responsibility of HKG.
		8. Para. 8.3.1	
		Add 'the toxic effect of oil spill'.	This aspect is addressed in V3/5.10 of the DIAR.
		9. Para. 13.1	
		An oil spill contingency plan will be needed for the on-site oil storage facilities for up to 250,000 tonnes of oil.	Text amended. The oil storage tanks will be bunded so as to contain 110% of the tank's capacity. See also V3 Section 5.11.
		10. Para. 13.3.1 (ii) page 197	
		It is unlikely that anchoring will be prohibited near the pipeline. Burial depth must take this into account. Direct impact of the anchor of the largest vessel likely to transit/use the area should be anticipated as the minimum to plan for.	Noted. We remain of the opinion that it is inadvisable to permit vessels to anchor in the immediate vicinity of pipelines.

Department	Reference	Comments	Consultants' Responses
Marine		11. Para. 13.4.2 It is noted that the study addresses hazards to life by fire or suffocation, presumably the pollution impact on the environment and water intakes has assessed.	The oil spill contingency plan takes account of such potential impacts.
Agriculture	Annex V1/F and Vol. 2 Para. 9.2	Prior approval is required for the destruction of wild plants, wild animals and their nests and eggs protected under current legislation.	Noted. However, it should be noted that the Yung Long area has been recently cleared of vegetation, and presumably, wildlife, for the purposes of crop cultivation.
	Vol. 2 Para. 9.2.2	Apart from protecting the plants in the protected list from large scale harvesting for commercial purposes, the Forests and Countryside Ordinance also protects forests, plantations and rare species against human damages. Moreover, the Wild Animals Protection Ordinance prohibits hunting of any wild animals territory-wide. The Animals and Plants (Protection of Endangered Species) Ordinance restricts local possession of endangered species as well.	See comment above.
	Vol. 2 Para. 9.2.4	The proposed mitigation measure of introducing the protected plants to be affected into the LTPS landscaping areas or to the restoration of cut slopes is supported.	Noted.
	Vol. 2 Para. 9.3.4	Can the consultant provide more details of habitat improvement for the compensation of losses of habitats?	Possible methods of habitat improvement applicable to the Black Point area include enhancement of habitat diversity and the productivity of habitats. As indicated on P.98 of Vol 2.
	Vol. 3 Para. 8.3.1	When will the Water Quality Key Issue Report be ready for comment?	Currently scheduled for July 1992.
	Vol. 3 Para. 8.3.2	Can the consultant supply more information to elaborate their statement that "it is believed that Lung Kwu Tan and Lung Kwu Sheung Tan to the south of Black Point are the only known breeding areas for the king crab in Hong Kong?	This statement is derived from consultation with Professor Brian Morton of the University of Hong Kong.

Department	Reference	Comments	Consultants' Responses
	Vol. 3 Para. 8.3.5	Since it is stated that "discharge of cooling water may cause major changes in the ecology surrounding the outfalls and perhaps as far away as 500m", the consultant should assess the ecological impacts of each discharge model with a view to adopting the one with the least ecological impact.	Ecological effects arising from cooling water discharges will be considered in the Water Quality Key Issue Assessment.
	Vol. 1, Pg. 29, S.2.12, Last Para., 1st sentence	"Deep Bay" should be amended to "Deep Bay Water Control Zone" to avoid confusion.	Agreed.
	2nd sentence	"mariculture areas" should be replaced by "fish culture zone"	Agreed.
	Vol. 2, Pg 63, S.6.3.3, Para. 2	"mariculture zone" should be amended to "mariculture subzone" for consistency.	Agreed.
	Vol. 3, Pg. 103, S.5.3.2 Mariculture 2nd Para., 1st sentence	The correct spelling of the nearest Fish Culture Zone is "Tung Chung".	Text amended.
	2nd Last sentence	I suggest to add " ... of Deep Bay Water Control Zone" after "mariculture subzone" for consistency.	Text amended.

Department	Reference	Comments	Consultants' Responses
Antiquities and Monuments Office	Vol. 1 2.14	For the site of Yung Long, no mention is made of the rescue excavation financed by the China Light and Power Company Ltd up to $0.4 million. The excavation which was conducted from December, 1985 to April 1986 by Mr Brian Peacock succeeded in confirming the site's exceptional potential.	Noted and text amended.
		For the site of Lung Kwu Sheung Tan, part of it was affected by the construction of a sewage tunnel which resulted in a rescue excavation funded by the project vote in 1989 – 90.	Noted and text amended.
	Vol. 2 12.2.1	The statement: "Once clearing an soft ground excavations are complete, ... not significantly affect any cultural resources" is not necessarily true as blasting can affect neighboring areas.	Blasting will be properly controlled, and is therefore not expected to significantly affect adjacent areas.
		We do not share the view contained in the statement "Notwithstanding the above ... have remained unknown" as we see archaeological remains as a finite and non–renewable resource the preservation in situ of which is always preferred. If physical preservation is not feasible, an archaeological excavation for the purposes of 'preservation by record' is only regarded as a second best option. It is because excavation means the total destruction of evidence from which future techniques could almost certainly extract more information than is currently possible.	Noted, text amended. However it remains the case that any excavations resulting from the development of the site will add to the body of knowledge of the subject.
	12.3	For the Yung Long site, its outstanding archaeological significance has been established beyond doubt by previous excavations.	Noted. See Vol. 1 s.2.14.1.

Department	Reference	Comments	Consultants' Responses
	12.4.1	The distribution of archaeological remains within the site is not uniform. There is bound to be a much higher concentration of are attracts at the main deposit area. The estimated resources which could be affected in different parts of the project area need substantiation.	Agreed. Such substantiation is considered part of the initial stage of any archeological investigation of the site; the figures in the IAR are intended to merely provide an indication of the possible concentration of deposits across the site.
	12.6.2	For site inspections, trial trench of 1m x 1m or 1m x 2m is usually preferred to small (10 cm wide) shallow trenches.	Noted.
		For the section under: Full Resource Protection and Recovery, some sites might in fact require full excavation. However, archaeological excavation is a tedious scientific recovery process which requires patient trawling, recording and section drawings. The size of the excavation square may vary and a round-the-clock excavation involving 300 workers is not feasible.	Noted and reference to excavation and workforce size deleted.
		The archaeological investigations at Penny's Bay mentioned under "Conservation and Storage" was carried out by the Antiquities and Monuments Office with the assistance of CLP.	Noted and text amended.
	14.2	Apart from devising a full mitigation plan to the satisfaction of AMO, Funds and time should be made available under the project for the mitigation measures. CLP is requested to provide assistance and support as far as possible.	Request to be considered by CLP.

Department	Reference	Comments	Consultants' Responses
North West New Territories Development Office, TDD	i. Air Quality Analysis of Climatological Data	It is noted that neither Tin Shui Wai nor Yuen Long has been the subject of consideration in assessing the effects of the plume fallout. On many occasions, smoke of yellow in colour was observed at Tin Shui Wai and Yuen Long, which was similar in colour to the stack emissions from the Castle Peak Power Station. Grateful if the effects of stack emissions from the Black Point Power Station on the environment of the above two areas could assessed in greater detail.	Both Tin Shui Wai and Yuen Long will be included as receptors in the complex terrain wind tunnel tests.
	ii. Water Quality	As you are aware, a submarine outfall at Urmston Road for the NWNT Sewerage Scheme will be commissioned by end 1992. It appears that the report has not been able to indicate adequately at this stage that the construction and operation of the Power Station would not adversely affect the submarine outfall and its operation. In view of this, a further look specifically into the likely impact on the submarine outfall is a requirement of this office.	Potential interaction of the NWNT discharge with those from the LTPS cooling water system will be considered in the Water Quality Key Issue Assessment.

FURTHER RESPONSES TO COMMENTS

Department	Reference	Comments	Responses
Transport Dept		I wish to reiterate that the proposed Large Thermal Power Station (LTPS) would induce traffic impact to the junction of Lung Mun Road and Wu Chi Road and detailed traffic impact study should be carried out by the Consultant.	Issue Resolved. Please see Annex E of this volume.
		I would further point out that the road improvements works associated with Area 38 and PADs are still under planning at this stage. The proposed LTPS may not match with these road improvement works, therefore, interim measures should be planned by the Consultant to alleviate the traffic problems of Lung Mun Road.	Issue resolved. Please see Annex E of this volume.
Geotechnical Engineering Office	Pg 23, Para 5 and 6	I support the Consultants' intention to use vertical drains to accelerate consolidation of marine mud in reclamation as this will reduce the fill requirement and the volume of mud to be disposed. Please note that the Fill Management Committee (FMC) now require sufficient design details be given to justify the need for mud disposal when project engineers seek approval from FMC to use a mud disposal site. Although the EIA report states that marine mud above a thickness of 10m will have to be removed, this figure should be reviewed at the detailed design stage. The consolidation time of a drained reclamation is mostly dependent on the vertical drain spacing rather than the mud thickness. For example, one quadrant of the test embankment at Chek Lap Kok has vertical drains installed into both marine mud and lower alluvial layers, with a total thickness of drained soil greater than 20m. The monitoring data indicate that the consolidation process progressed well.	Noted, marine mud removal requirements will be reviewed at the detailed design stage.
	Pg 139, Para 3	As the sources of the PFA for the LTPS are likely to be the nearby power station and ash lagoon, the quoted average cost of HK$30/m^3 may represent an overestimation. This will make the use of PFA more attractive.	Noted, this aspect of PFA use will be reviewed in the Solid Byproducts KIA.

Department	Reference	Comments	Responses
	Pg 139	PFA as Reclamation Fill: At present some project offices have reservations on the engineering and environmental aspects of PFA fill below water. An instrumented trial utilising PFA as fill below water is currently planned as part of the site formation for a submarine outfall to be constructed near the proposed LTPS. If the trial is successful, this should remove any reservations against the use of PFA as fill for the LTPS.	Noted. Any further information concerning this trial will be considered in the Solid Byproducts KIA.
	Pg 145	(FGD Gypsum as) Reclamation Fill: The properties of FGD gypsum are dependent on the raw materials and the chemical processes of power generation. The properties of PFA/FGD gypsum presented in Table V3/6.3(a) may not be representative of the PFA/FGD gypsum to be produced at the LTPS. The use of FGD gypsum (mixed with PFA) as fill needs to be investigated and its feasibility demonstrated by field tests under Hong Kong conditions. While the use of PFA as fill below water is still in dispute, it is premature to consider the use of FGD gypsum. I suggest that attention should be concentrated on gaining wider acceptance of the use of PFA before introducing the FGD component.	Agreed. Whilst the PFA/FGD gypsum data presented in the DIAR are only indicative, they are considered representative of the material to be produced. The issue of the beneficial use of FGD gypsum will be considered further in the Solid Byproducts KIA, however, we concur with the view that wider acceptance of PFA utilisation should take priority.
PM/NWNT		I have no comment on your enclosed Consultants' responses to comments. However, I would like the Consultants to further address on my concerns when they have completed the Complex Terrain Wind Tunnel Tests and Water Quality Key Issue Assessment as suggested in their responses.	Noted, PM/NWNT's concerns re air quality impacts to Tin Shui Wai and Yuen Long, and interaction of the LTPS cooling water discharge with that from the NWNT sewer will be addressed in the respective KIA reports
APG/ACG		*Numerical Modelling in the IAR* We have noted that the long term predictions in the IAR will be reviewed based on the wind tunnel results. The uncertainties associated with the numerical modelling will therefore eventually be sorted out. Any further comments on this aspect have become unnecessary.	Noted and agreed.

Department	Reference	Comments	Responses
	Vol 1, S.2.3.2 (Pg 6 of the Response to Comments)	The typical moisture content of the flue gas is 10%. The Consultants' assumption of 5% at most is a bit too optimistic.	Noted. This aspect will be reviewed and discussed further where appropriate in the course of the Stack Emissions KIA.
	Vol 2, S.3.2 on Pg 31 (Pg 7 of the Response to Comments)	Any clearance of existing vegetation for forming the site is part of the construction work of the project. Its impacts should be assessed along with any other constructional impacts. We appreciate that the Consultants may not have the details of the clearance arrangement. However, this lack of information should not stop the consultants from assessing whether the scale of the clearance is likely to cause unacceptable air pollution impacts, recommending preferable clearance methods and warning against unacceptable practice. This information should be the basis for the Contractor to propose his clearance method.	Air quality impacts from construction activities and the creation of cleared open areas, susceptible to dust blow, were modelled and reported in Vol.2 p.40–47 of the IAR, and methods to control air quality impacts to acceptable levels applicable to all stages of the construction process, were recommended. The text has been expanded to clarify this issue. It should be noted that the majority of the existing vegetation on the site other than rock scrub, has already been cleared by others for the purposes of cultivation.
	S.4.4 on Pg 43 (Pg 8 of the Responses to Comments)	Our comment was intended to highlight to CLP our BPM and S.P. Licence requirements for some of construction processes of the plant. Would CLP please confirm that the requirements mentioned will be incorporated in the contracts with their Contractors.	CLP have indicated that the BPM for "Mineral Works" will be incorporated within the Construction Contract documentation.
	Vol 3, S.3.1.2 (2nd para) and Table V3/3.2(f) (Pg 11 and 14 of the Responses to Comments)	Due to the rapid development of the NO_x control technology, it has been shown that the 42 ppm limit can be met by water/steam injection or low NO_x combustors. The proposed 60 ppm limit can only be accepted if the achievement of lower emission is demonstrated to be both technically and economically infeasible.	Noted. CLP have reservations regarding the feasibility of using water/steam injection to control NO_x, but CLP have indicated that the Tender Document for the CCGT plant will specify a NO_x level of 42 ppm.

Department	Reference	Comments	Responses
	S.3.2.3 Ship Unloading Operation on Pg 46 (Pg 15 of the Responses to Comments)	The use of a continuous unloader has been successfully applied in other power stations, including the Lamma Power Station. Unless CLP has convincing arguments to support the infeasibility of this technology; it will be regarded as a BPM requirement during the licensing.	As noted previously, CLP have encountered severe operating difficulties with continuous unloading equipment in the past. However, CLP intend to carefully examine the options for this type of equipment at the detailed design stage.
	S.3.2.5 (2nd para) (Pg 17 of the Responses to Comments)	It is inappropriate to assume that heavy fuel oil (which does not meet the requirement of the Air Pollution Control (Fuel Restriction) Regs will be allowed in the LTPS as no exemption from the operation of these regulations will be granted.	Noted. This issue will be explored further in the Stack Emissions KIA.
	Annex V3/E, item 3 (Pg 23 of the Responses to Comments)	The telemetry link for transmitting on-line monitoring data to EPD is the most effective both technically and economically means for checking compliance. It is to be applicable for all major specified processes and hence, we would not accept the waiving of this requirement in granting the licence.	Noted. We understand that this issue is under discussion between CLP and EPD.
WMPG	Vol 3, S.6.3 on Pg 138 (Pg 29 of the Responses to Comments)	Although the admixture of PFA and FBA may not rule out all the beneficial use of PFA such as use as fill, it will restrict some of the beneficial use such as use in the concrete industry. Separate storage should be considered.	Separate storage for the two materials will be considered in the Solid Byproducts KIA.
Marine Dept		I wish to point out that the consultants' responses to my comments made under Volume 1, para 2.3.4 (Page 39 of DIAR) and Volume 3, para 5.5 (Page 42 of DIAR) is based on a misconception. According to the Convention, the Government of each Party to the Convention undertakes to ensure the provision of facilities at ports and terminals for the reception of wastes. Therefore it would be in order for the reception facilities to be incorporated into the design criteria of the berths.	We understand that CLP are prepared to install facilities for the reception of waste at their berth for the LTPS at Black Point at the appropriate time. Text amended.

ANNEX A

Seasonal Emission Rate Calculations

Calculation of Seasonal Emission Rates
(Reference : Table V3/3.2 (c) and Table V3/3.2 (h))

Calculation of seasonal emission rates:

- The volume emission rate (Nm^3s^{-1}) and fuel use (kg s^{-1}) for 50, 75 and 100% load were supplied by CLP.
- For each season the % load was calculated from the average mega wattage.
- Assuming a linear relationship between % load and volume emission rate, and % load and fuel use, these two emission characteristics were calculated for each average seasonal load.
- Using the calculated seasonal volume emission rate, the NO_x emission rate was calculated assuming a NO_x emission concentration of 842 ppmv for Castle Peak A and B and 300 ppmv for Black Point.
- Using the calculated seasonal volume emission rate, the particulate emission rate was calculated assuming a particulate concentration of 0.115 g Nm^{-3} for Castle Peak A and B, and 0.050 g Nm^{-3} for Black Point.
- Using the calculated seasonal volume emission rate, the SO_2 emission rate was calculated assuming a percentage composition of SO_2 in the exhaust gas of 0.056% for Castle Peak A and B, and 0.006% for Black Point.

ANNEX B

Lau Fan Shan Meteorological Data

Table

Lau Fau Shan Meteorological Data Used for the Long Term Modelling (% Frequency)

	Wind Speed	Wind Direction																
	m/s	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
Stability A	0.5	0.0084	0.0076	0.0026	0.0058	0.0111	0.0081	0.0061	0.0010	0.0025	0.0016	0.0038	0.0007	0.0060	0.0231	0.0270	0.0156	0.13
	1.0	0.0302	0.0145	0.0140	0.0215	0.0163	0.0212	0.0146	0.0152	0.0010	0.0009	0.0082	0.0224	0.0635	0.0973	0.1088	0.0574	0.51
	2.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00
	4.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00
	7.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00
	15.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00
Stability B	0.5	0.1174	0.0736	0.0366	0.0432	0.0544	0.0585	0.0490	0.0404	0.0091	0.0038	0.0206	0.0383	0.0651	0.0956	0.1352	0.0994	0.94
	1.0	0.2836	0.2039	0.0916	0.2138	0.1099	0.0907	0.0774	0.0321	0.0182	0.0141	0.0397	0.1450	0.2053	0.2317	0.2187	0.2334	2.21
	2.5	0.3463	0.2608	0.2424	0.3026	0.1887	0.1580	0.1236	0.0713	0.0321	0.0174	0.0901	0.3493	0.3794	0.2625	0.2644	0.2046	3.29
	4.5	0.3197	0.2571	0.1879	0.2787	0.1774	0.1017	0.0970	0.1408	0.0741	0.0317	0.1237	0.8621	0.3090	0.0827	0.0522	0.0701	3.17
	7.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00
	15.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00
Stability C	0.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00
	1.0	0.0189	0.0208	0.0225	0.0108	0.0089	0.0105	0.0117	0.0035	0.0023	0.0048	0.0011	0.0096	0.0057	0.0015	0.0040	0.0078	0.14
	2.5	0.1477	0.2439	0.2356	0.2630	0.1332	0.1012	0.0745	0.0627	0.0143	0.0192	0.0541	0.1350	0.1017	0.0659	0.0324	0.0546	1.74
	4.5	0.6140	0.8613	0.9295	1.3031	0.6073	0.3020	0.6839	0.6582	0.2636	0.1665	0.5993	1.8576	0.4993	0.1487	0.1334	0.1357	9.76
	7.0	0.0656	0.0561	0.0243	0.0580	0.0643	0.0273	0.0847	0.0610	0.0106	0.0642	0.1478	0.3275	0.0374	0.0206	0.0102	0.0349	1.09
	15.0	0.0285	0.0080	0.0071	0.0134	0.0084	0.0105	0.0118	0.0084	0.0063	0.0424	0.0239	0.0155	0.0000	0.0000	0.0046	0.0227	0.21
Stability D	0.5	0.0979	0.1038	0.1093	0.1647	0.1462	0.1201	0.1078	0.0602	0.0212	0.0204	0.0137	0.0401	0.0557	0.0308	0.0532	0.0703	1.22
	1.0	0.1025	0.1824	0.3442	0.3559	0.3099	0.2418	0.1030	0.0797	0.0231	0.0176	0.0584	0.0424	0.0321	0.0463	0.0397	0.0220	2.00
	2.5	0.1369	0.3322	0.8777	0.8946	0.4981	0.3787	0.3219	0.1621	0.0613	0.0557	0.1163	0.1313	0.0759	0.0388	0.0675	0.0543	4.20
	4.5	1.2022	2.0382	5.0313	4.7008	2.8389	2.0819	2.8696	1.2984	0.5811	0.5541	0.6739	0.8735	0.1999	0.3481	0.4458	0.4765	26.21
	7.0	0.6847	0.5214	1.1748	0.9100	0.6393	0.3572	0.7947	0.3018	0.2080	0.3516	0.2589	0.2528	0.0379	0.1523	0.2921	0.2136	7.15
	15.0	0.3637	0.1049	0.1946	0.1883	0.2401	0.0802	0.1598	0.0620	0.1244	0.1512	0.1001	0.0301	0.0174	0.0941	0.1249	0.1164	2.15
Stability E	0.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00
	1.0	0.0098	0.0288	0.0478	0.1357	0.1209	0.1150	0.0751	0.0228	0.0064	0.0030	0.0043	0.0123	0.0043	0.0127	0.0144	0.0081	0.62
	2.5	0.1092	0.3775	0.8454	1.3101	1.0063	0.9608	0.7949	0.3124	0.1234	0.1074	0.0836	0.0717	0.0436	0.0606	0.0767	0.0484	6.33
	4.5	0.1898	0.3177	1.0301	1.4757	0.8500	1.0832	1.5744	0.3310	0.2034	0.2478	0.1279	0.0874	0.0356	0.0582	0.0646	0.0721	7.75
	7.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00
	15.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00
Stability F	0.5	0.1765	0.2678	0.3562	0.5386	0.6891	0.6090	0.5576	0.3147	0.1332	0.1241	0.1457	0.1114	0.1058	0.0867	0.1068	0.1354	4.46
	1.0	0.1422	0.2951	0.6404	1.3430	1.6338	1.6676	1.4305	0.6229	0.2245	0.1933	0.1116	0.1109	0.0726	0.0639	0.1166	0.0837	8.75
	2.5	0.0225	0.1253	0.4173	0.9961	1.0858	1.2196	1.1229	0.3853	0.1653	0.1518	0.0944	0.0510	0.0198	0.0193	0.0374	0.0356	5.95
	4.5	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00
	7.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00
	15.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00
All Stabilitie	0.5	0.4001	0.4528	0.5047	0.7522	0.9007	0.7956	0.7206	0.4162	0.1660	0.1499	0.1838	0.1906	0.2326	0.2363	0.3221	0.3207	6.74
	1.0	0.5873	0.7454	1.1604	2.0807	2.1998	2.1468	1.7123	0.7762	0.2755	0.2337	0.2232	0.3426	0.3835	0.4534	0.5022	0.4123	14.24
	2.5	0.7627	1.3397	2.6185	3.7664	2.9121	2.8183	2.4377	0.9937	0.3963	0.3516	0.4385	0.7383	0.6204	0.4471	0.4784	0.3977	21.52
	4.5	2.3255	3.4743	7.1789	7.7583	4.4737	3.5688	5.2251	2.4284	1.1222	1.0001	1.5249	3.6805	1.0440	0.6377	0.6960	0.7544	46.89
	7.0	0.7504	0.5775	1.1991	0.9680	0.7035	0.3845	0.8795	0.3628	0.2186	0.4158	0.4067	0.5803	0.0752	0.1730	0.3023	0.2485	8.25
	15.0	0.3923	0.1129	0.2018	0.2017	0.2485	0.0907	0.1716	0.0704	0.1307	0.1936	0.1240	0.0456	0.0174	0.0941	0.1295	0.1391	2.36
Total		5.22	6.70	12.86	15.53	11.44	9.80	11.15	5.05	2.31	2.34	2.90	5.58	2.37	2.04	2.43	2.27	100.00

ANNEX C

Annual Average Dry SO_2 and NO_x Deposition Contours

Figure V3/3.6(a)
Annual Average Dry Deposition of SO_2 for Scenario I (keq km^{-2} yr^{-1})

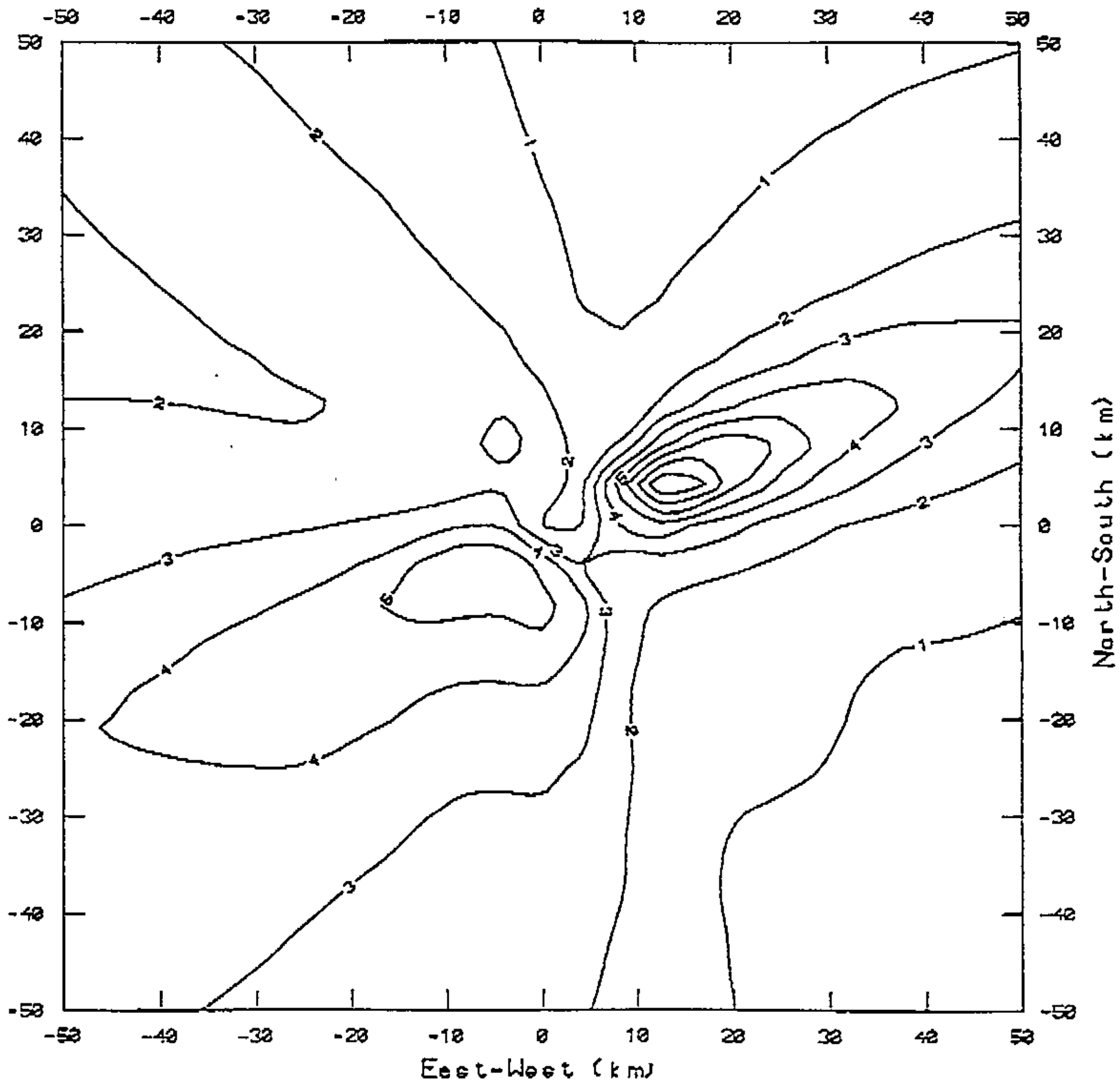
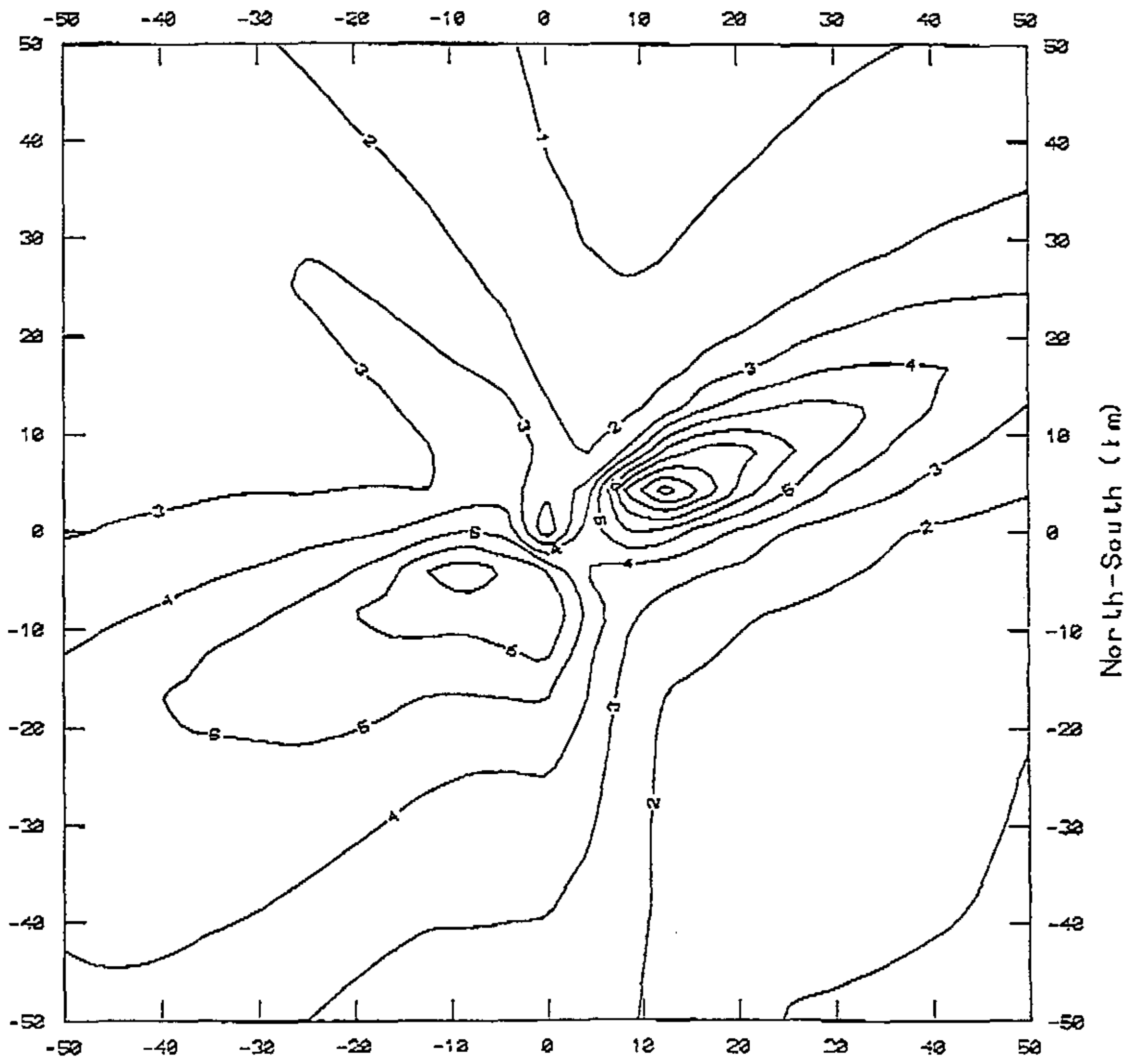


Figure V3/3.6(b)
Annual Average Dry Deposition of NO_x for Scenario I (keq km^{-2} yr^{-1})



ANNEX D

Aviation Aspects

PROVISIONAL AIRPORT AUTHORITY

7 July, 1992

Your Ref: C1013/WP51/SL/sl
Our Ref: (0015) ATS/5000

ERL (Asia) Limited
11/F Hecny Tower
9 Chatham Road
Tsimshatsui
Kowloon

Attn: Mr. Steve Laister
LTPS EIA Project Manager

Dear Sir,

Large Thermal Power Station - Aviation Aspects

Thank you for your letter on the 8 June 1992. We confirm that the issue concerning particle emission has been adequately covered.

Yours faithfully,

J. P. Wright
Engineering Director

JPW/RM/dc

9 JUL 1992

臨時機場管理局
25TH FL. CENTRAL PLAZA, 18 HARBOUR RD, WANCHAI
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香港灣仔港灣道十八號中環廣場二十五樓
電話：(852) 824 7111 圖文傳真：

ERL (Asia) Limited

An associate of
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Limited

11th Floor, Hecny Tower
9 Chatham Road,
Tsimshatsui,
Kowloon, HONG KONG.
Telephone : 722 0292
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ERL

C1013./WP51/SL/sl

Provisional Airport Authority
25/F Central Plaza
18 Harbour Road
Wanchai
Hong Kong

Attention: Mr J Peter Wright

8th June, 1992

Dear Mr Wright,

Large Thermal Power Station - Avaition Aspects

Thankyou for your letter of 13th May, your ref.ATS/5000 responding to our fax of 23 March,1992.

With regard to your second point, concerning particle emissions, we should point out that this issue was addressed in the Initial Assessment Report for the LTPS and referred to in subsequent correspondence with the PAA ; we enclose copies of the relevant section of the IAR and the correspondence for your reference. We believe that the issue has been adequately covered and would appreciate your confirmation that the PAA's concerns have been met.

Yours sincerely,
For ERL (Asia) Ltd

Steve Laister

STEVE LAISTER
LTPS EIA Project Manager

PROVISIONAL AIRPORT AUTHORITY

13 May, 1992

Our Ref: ATS/5000

ERL (Asia) Limited
11th Floor, Hecny Tower
9 Chatham Road
Tsimshatsui
Kowloon

Dear Sir

Large Thermal Power Station - Thermal Effects on Aircraft

We are responding to your fax of the 23 March, 1992 regarding the report entitled "Plume Dispersal Calculation for Large Thermal Power Stations".

The information regarding the temperature of the stack gasses indicates that we would not anticipate any engine problems with aircraft flying in the vicinity of the proposed plant due to the temperature of the gasses.

The referenced report does not address particle emission or the use of high-quality scrubbers to reduce the release of hygroscopic nuclei into the atmosphere, so we are unable to comment on that aspect, which is of particular interest to aviation planners. However, we would urge that the installation of high-quality scrubbers are planned for use at Black Point.

Yours faithfully,

J Peter Wright
Engineering Director

(Asia) Limited.
11/F
18 MAY 1992

JPW/RM/rl

臨時機場管理局
25TH FL. CENTRAL PLAZA 18 HARBOUR RD. WANCHAI
HONG KONG TEL: (852) 824 7111 FAX: (852) 824
香港灣仔港灣道十八號中環廣場二十五樓
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民 航 處
安全監察部
辦事處：香港國際機場停機坪大廈 261 室

CIVIL AVIATION DEPARTMENT
SAFETY REGULATION DIVISION
Room 261 APRON SERVICES COMPLEX
HONG KONG INTERNATIONAL AIRPORT
HONG KONG

本處檔號 OUR REF: (84) in AS/OPS/7/1 IV

28 February 1992

來函檔號 YOUR REF:

電　話 TEL. NO.: 769 7710

電報掛號 CABLES: AVSTANDARD HONGKONG
TELEX : 39524 CFSHK HX
AFTN : VHHHYAYC
FAX NO: 362 4257

Mr. Steve Laister
LTPS EIA Project Manager
ERL (Asia) Ltd.
11th Floor, Hency Tower
9 Chatham Road
Kowloon

Dear Sir,

LTPS at Black Point - Stack Heights

Thank you for clarification of the latest position on the proposed CLP stacks at Black Point. I have no objection to the erection of the stacks to the proposed height of 257 mPD provided that they are marked and lighted in accordance with ICAO Annex 14 specifications. Low-intensity obstacle lights should be used which should be fixed red lights having an intensity sufficient to ensure conspicuity. Please keep us informed of your proposed marking and lighting scheme.

Yours faithfully,

(T T TO)
for Director of Civil Aviation

c.c. PAA (Attn.: Mr. R. Maggs)
EPD (Attn.: Mr. K.H. Yeung)

FACSIMILE

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Total no. of pages including this page: 1

Environmental Protection Department
E(EA) 14
環境保護署

TO:	PM/PAA (Attn.: Mr Robin Maggs/Mr K Tobin)	FROM:	Yeung Kai Hoi, EAPG
		OUR REF.:	( ) in EP 2/G/39 IX
		TEL NO.:	835 1843
YOUR REF.:	( ) in NAPT/FAC/412 'WG' 4	DATE:	03 Feb 1992
YOUR FAX NO.:	824 0717	OUR FAX NO.:	591 0558

EIA for the LTPS at Black Point
<u>Stack Height & Safeguarding Chart</u>

In the 1st Study Management Group (SMG) Meeting for the above mentioned study in May 1991, you were requested to resolve the stack height issue with CLP/ERL. You informed the SMG that the safeguarding charts for the CLK Airport would be available by September 1991 and only by then you could comment on the acceptability of the stack height. In October 1991, you wrote to inform us that the safeguarding charts would not be available until end of October. We called your office in November 1991 but was only informed that the charts should be available by end of December 1991 when your AMPS consultancy agreement would expire. We called in January 1992 again. Your Miss Cheung Yee Wah informed us that you were finalising the charts and you <u>might be able</u> to finalise the charts by end of February 1992. In short, you have delayed to resolve the stack height issue with CLP/ERL <u>since May 1991</u> and yet to give a clear indication as to when you could do so.

2. CLP/ERL have already completed their Complex Terrain Wind Tunnel Tests. A copy of their report was forwarded to you (and CAD) on 21 Jan 1992 for comments. It is high time for you and CAD to resolve the stack height issue with CLP/ERL quickly or else the timing of the LTPS implementation would be compromised. We urge you to provide CLP/ERL with all the necessary information at the earliest possible so that CLP/ERL can commence their discussion with you and CAD to resolve this long outstanding issue. Mr Steven Laister of ERL will be pleased to discuss the matter with you. He can be contacted on 367 0378.

3. We are looking forward to your co-operation in anticipation.

(Yeung Kai Hoi)
Environmental Protection Officer
for Director of Environmental Protection

cc. DAC Attn: Mr Stanley Wong
(Fax: 869 0093)

BY FAX

MEMO

From: Director of Civil Aviation	To: Director of Environmental Protection (Attn : Mr YEUNG Kai-Hoi)
Ref. in WKS/659	
Tel. No. 867 4254	Your Ref. in EP 2/G/39 VIII
Date 26 October 1991	dated 21.10.91

EIA for the LTPS at Black Point
Draft Initial Assessment Report (DIAR)
Response to comments

I refer to your above fax message.

2. The situation is that the CLP consultants need to discuss with the PAA Master Plan consultants regarding the LTPS stack height and other related issues, and the PAA consultants will make recommendation to CAD. Acceptability of the LTPS will not be given unless a positive recommendation is received from the PAA consultants.

(S WONG)
for Director of Civil Aviation

c.c. EM(Technical), PAA (Attn : Mr R P Maggs)

SW/ty

RECEIVED 28 OCT 1991

29 OCT 1991
E.P.D.C.R.

G 73A

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Total no. of pages including this page: 3

Environmental Protection Department

環境保護署

FROM:	Yeung Kai Hoi, EAPG
OUR REF.: ( ) in EP	2/G/39 VIII
TEL NO.:	835 1865
DATE:	21 Oct 1991
OUR FAX NO.:	591 0559

TO: Director of Civil Aviation
(Attn.: Mr Stanley Wong)

YOUR REF.: ( ) in WKS/659

YOUR FAX NO.: 869 0093

EIA for the LTPS at Black Point
Draft Initial Assessment Report (DIAR)
Response to Comments

We refer to the attached copies of memo/letter:

a) PAA's letter ref (60) in NAPT/FAC/412 'WG' 4 IV dated 10 Oct 1991; and
b) your memo ref WKS/659 dated 14 Oct 1991.

2. Thank you for you 'Nil' return to the above. In the light of PAA's indication that you are the authority responsible for assessing the stack heights and their acceptability, we would like to confirm if you have any further comments on the PAA's letter and the stack height, particularly on the acceptability. Your urgent advice by 25 Oct 1991 will be deeply appreciated.

3. PAA has also indicated that the safeguarding charts for CLK Airport will not be available until end of October. By copy of this facsimile message, the consultants are advised to liaise closely with PAA and/or CAD to resolve the requirements on the stack height early.

(Yeung Kai Hoi)
Environmental Protection Officer
for Director of Environmental Protection

By Fax & Post

cc.			
	PM/PAA	Attn: Mr G T Oliver	824 0717
	ERL	Attn: Mr Steven Laister	723 5660
	CLP	Attn: Mr Geoffrey Dunn	455 1020

21 OCT 1991
E.P.D.C.R.

PROVISIONAL AIRPORT AUTHORITY 臨時機場管理局

7/F Shui On Centre, 8 Harbour Road, Hong Kong Tel: (852) 802 3567 Fax: (852) 824 0717

Our Ref.: (60) in NAPT/FAC/412 'WG' 4 IV

Yr Ref. : EP2/G/39 VIII

Tel : 824 2606

Fax : 824 2202

10 October 1991

Director of Environmental Protection
Environmental Protection Department
24-28th Floor
Southern Centre
130 Hennessy Road
Wanchai
Hong Kong

(Attn: Mr. YEUNG Kai-hoi)

Dear Sir,

EIA FOR THE LIPS AT BLACK POINT
DRAFT INITIAL ASSESSMENT REPORT (DIAR)

Thank you for the document outlining the responses to comments regarding the DIAR.

The Consultant's response to the PAA's comments re stack heights (P33) requires some further comment. It should not be presupposed that the act of gaining agreement on stack heights implies that the proposed heights will be acceptable. Further, it should be noted that CAD (Safety Regulation Division) and not the PAA will be the body responsible for assessing the stack heights and their acceptability.

Finally, please note that safeguarding charts for CLK will not be available until approximately the end of October.

Yours faithfully,

G.T. Oliver

G.T. Oliver

GTO/RPM/dh

(D116)

MEMO

From: Director of Civil Aviation	To: Director of Environmental Protection (Attn : Mr YEUNG Kai Hoi)
Ref. in WKS/659	
Tel. No. 867 4254	Your Ref. in EP2/G/39 VIII
Date 14 October 1991	dated 30.9.91

EIA for the LTPS at Black Point
Draft Initial Assessment Report (DIAR)
Responses to comments

Please be advised 'nil' return from CAD.

(S WONG)
for Director of Civil Aviation

SW/ty

G.F. 73A

ERL (Asia) Limited

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Facsimile : 7235660

ERL

C1035/285/WP51/SL/yc

Provisional Airport Authority
7/F Shui On Centre
8 Harbour Road
Wanchai
Hong Kong

Attention : Miss Cheung

6th June, 1991

Dear Miss Cheung,

Large Thermal Power Station Draft Initial Assessment Report

Thankyou your letter of 31st May regarding Sections 9.2 and 9.3 of Volume 3 of the above captioned report. In response to your data requests, please find enclosed the temperature modelling data, which, in conjunction with our consultations with the UK Civil Aviation Authority, their test pilots and a major aero engine manufacturer, led us to the conclusions presented in Section 9.2.

As my colleague, Mr Wenman, explained at the SMG meeting, the conclusions presented in Section 9.3 (Cloud Creation) are based on general meteorological principles rather than project specific data. Should the explanation provided not fully allay your consultants' concerns, perhaps they could provide us with specific details of the scenarios which they believe could lead to cloud formation, so that we can respond further.

Yours sincerely,
For ERL (Asia) Ltd

STEVE LAISTER
Project Manager

c.c. Mr G. Dunn (CLP)
Mr Yeung Kai Hoi (EPD–EAPG)

ANNEX E

Traffic Aspects

URGENT BY FAX (Fax : 591 0558)

MEMO

From TE(NTW) Div., Transport Department
in NR 182/203-37
Tel. No. 399 2425
Date 23 January 1992

To Director of Environmental Protection
(Attn : Mr. Yeung Kai Hoi)
Your Ref. in EP 2/G/39 VIII
dated 17 December 1991

EIA for the LTPS at Black Point
Draft Initial Assessment Report (DIAR)
Further Response to Additional Comments

I refer to your above-quoted memo.

2. Please note that I have no further comment on the draft initial assessment report (DIAR).

(FOK Wai-kit)
for Assistant Commissioner for Transport/NT

FWK/jy

TOTAL P.02

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Total no. of pages including this page: 2

Environmental Protection Department

環境保護署

TO: AC of T/NT	FROM: Yeung Kai Hoi, EAPG
(Attn.: Mr Fok Wai Kit)	OUR REF.: ( ) in EP 2/G/39 VIII
YOUR REF.: ( ) in NR 182/203-37	TEL NO.: 835 1843
YOUR FAX NO.: 381 3799	DATE: 17 Dec 1991
	OUR FAX NO.: 591 0559

EIA for the LTPS at Black Point
Draft Initial Assessment Report (DIAR)

<u>Further Response to Additional Comments</u>

We refer to the telephone conversation (Fok/Yeung) on 17 Dec 1991.

2. It appears that you have not yet received the consultants response to your additional comments. Attached is a copy of our file record of the consultants letter to you dated 5 Dec 1991, which is self-explanatory.

3. We hope that the information provided in the letter are adequate for your purpose. As for the interim measures mentioned in your memo dated 4 Nov 1991, you may find more details in Chapter 8 of Volume 2 and Chapter 7 of Volume 3 of the DIAR in addition to the attached letter.

(Yeung Kai Hoi)
Environmental Protection Officer
for Director of Environmental Protection

ERL (Asia) Limited

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11th Floor, Hecny Tower
9 Chatham Road,
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Telephone : 722 0292
Facsimile : 723 5660

ERL

C1035/908/SML/TD/lc

Transport Department
TE(NT/W) Division
7/F Mongkok Government Offices
30 Luen Wan Street
Kowloon

Attn: Mr. Fok Wai-Kit

5th December 1991

Dear Sir,

EIA for LTPS at Black Point
Draft IAR Response to Comments

Your memo (ref NR182/203-37 to DEP) has been passed to us by DEP for reply.

In response, we acknowledge that the Area 38 and PADS road improvements are still under planning at the present time. However, as your original response to the DIAR points out, the road junction you refer to is "already very busy at the moment", and it is thus overly onerous to require CLP to "alleviate the traffic problems of Lung Mun Road", since these are not of their making.

In particular, we would emphasise that the maximum numbers of vehicle movements during the LTPS construction period, (approximately 260 vehicle movements or (130 ROT's per day) represents a less than 2.5% increase on current (1989) Annual Average Daily Vehicle flows on Lung Mun Road through Tuen Mun.

The combination of LTPS construction and operational traffic, which is anticipated to occur from 1996 to 2008, will at maximum, represent a less than 5% increase on the 1989 flows. This increase is not considered significant, and any impact which may result will be offset by the marked decrease in HGV container traffic using Lung Mun Road which will result from the clearing of container storage activities from Area 38.

CLP's intentions to utilise marine transport of materials where practical and to bus their construction workers to the LTPS site are considered to be adequate mitigation measures and are expected to avoid significant impacts from LTPS derived road traffic in the Tuen Mun Area.

In view of the above, and of the small contribution CLP traffic will make to the future flows through the area, we do not consider that further investigation of the flows at individual traffic junctions within the context of the LTPS study is appropriate.

Yours sincerely
For ERL (Asia) Ltd

SM Laister

STEVE LAISTER
LTPS EIA Project Manager

c.c. Mr. K. H. Yeung (EAPG)