土木工程處
Civil Engineering Office

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Agreement No. CE 45/93

Lantau Port Development - Stage 1

Reclamation for Shipyard at To Kau Wan

North Lantau

EIA for Operational Phase

FINAL ENVIRONMENTAL IMPACT ASSESSMENT REPORT

October 1995

Binnie Consultants Limited
香港賓尼工程顧問有限公司

Agreement No. CE 45/93
Lantau Port Development - Stage 1
Reclamation for Shipyard at To Kau Wan, North Lantau
EIA for Operational Phase
Final EIA Report

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1. INTRODUCTION

1.1 Cheoy Lee Shipyards Limited currently leases land at the head of Penny's Bay on Lantau (Figure 1.1). This shipyard will be affected under Phase I of the Lantau Port and Western Harbour Development.

1.2 A site for the possible reprovisioning of Cheoy Lee Shipyard has been chosen within the Lantau Port and Western Harbour Development area on the north-west shore of Tsing Chau Tsai peninsula in the vicinity of To Kau Wan (Figure 1.1). This is consistent with a principal recommendation of the Port and Airport Development Strategy that the majority of Hong Kong's future port requirements be accommodated at northeast Lantau and in the Western Harbour of the east coast of Lantau Island. The draft North-east Lantau Port Outline Zoning Plan No. S/I - NELP/1 was gazetted on 24th March 1995. To Kau Wan forms the eastern side of the "Boatyard, marine-oriented industrial use and marine services support area".

1.3 The reprovisioning of the Cheoy Lee Shipyard, if approved, will form a very small part of the Lantau Port and Western Harbour (LAPH) Development. A report has been issued by APH Consultants as Addendum C examining the implications and feasibility of the move as part of a Supplementary Study for LAPH developments (APH 1993).

1.4 Design and construction of the new shipyard will be undertaken in two separate stages:

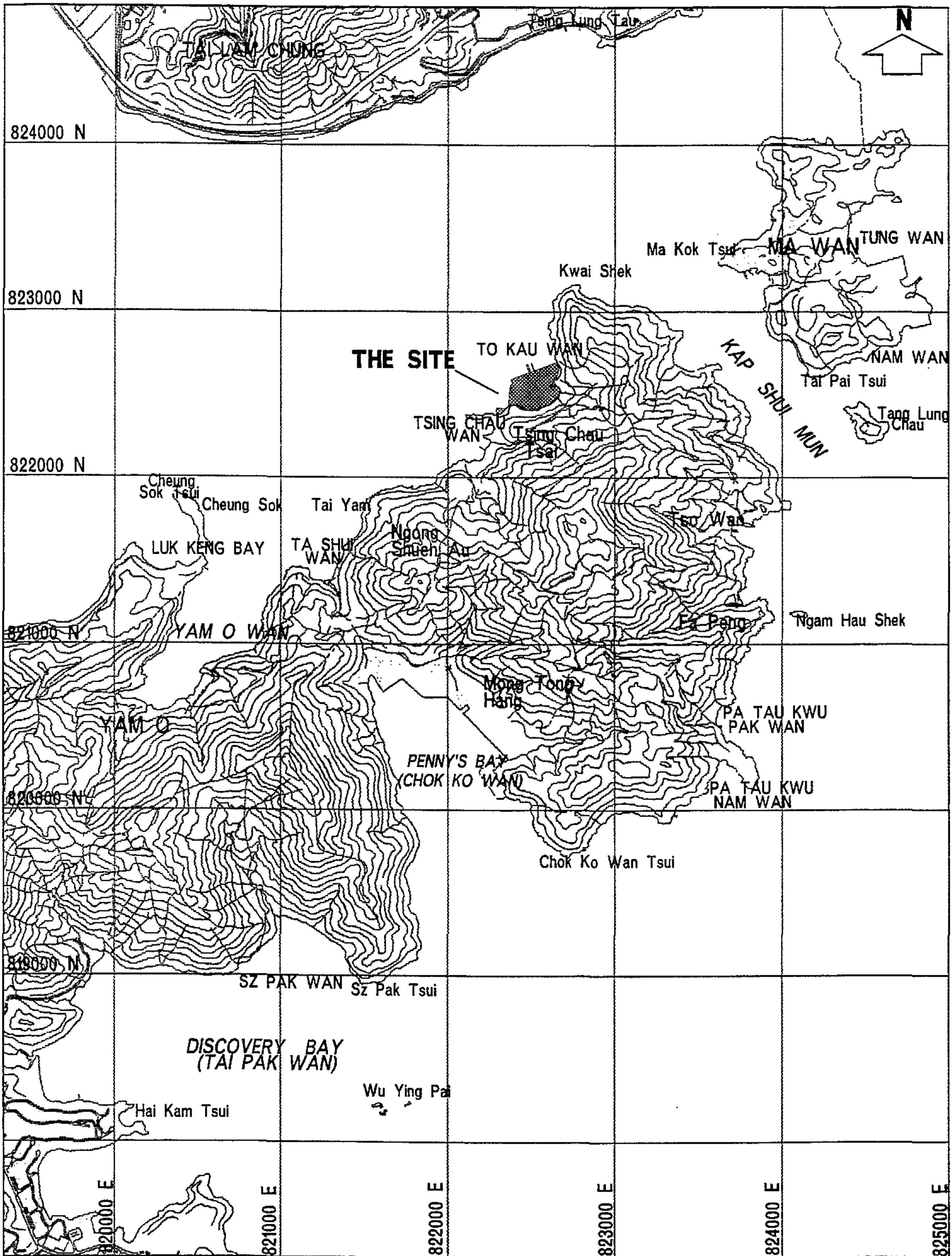
- reclamation and site formation of the 6 ha site; and
- construction of the shipyard facilities.

1.5 An Environmental Impact Assessment (EIA) (BCL 1994a), has been undertaken for the construction of the reclamation. The current EIA, known as the EIA for the Operational Phase or more colloquially the Shipyard EIA, examines the construction of the operational facilities and the operational phase of the shipyard using the existing shipyard as the basis of the EIA study.

1.6 The assistance and courtesy of the owners of Cheoy Lee Shipyards Limited throughout this study was greatly appreciated, particularly their willingness to explain each operation in detail and for providing data for the study. We were provided with transport to and from Penny's Bay, and our visits to the shipyard and our in depth examinations of the site operations were graciously tolerated.

Purpose of the EIA

1.7 The purpose of the EIA study is to provide information on the nature and cumulative extent of environmental impacts arising from the construction of the operational facilities and operation of the proposed shipyard at To Kau Wan, North Lantau.



TO KAU WAN OPERATIONAL EIA	BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 CONSULTING ENGINEERS 賓尼	Date FEB 95	Scale 1 : 30 000
LOCATION OF THE SITE	土木工程署 Civil Engineering Department	Initial WYC	Drawing No. FIGURE 1.1

1.8 This information will contribute to decisions on:

i) the overall acceptability of any adverse environmental effects that are likely to arise as a consequence of the project;

ii) the conditions and requirements for the detailed design, construction and operation of the shipyard; and

iii) the acceptability of any residual impacts after mitigation measures are implemented.

Objectives of the EIA

1.9 The objectives of the assessment are:

i) to describe the proposed project;

ii) to identify and describe other projects which may cause adverse impacts upon the proposed project;

iii) to identify sensitive receivers, sensitive uses or other elements of the community or the environment that may be adversely impacted by the proposed project;

iv) to identify and quantify emission sources and determine the significance of their impact;

v) to identify and quantify any potential losses or damage to flora, fauna and natural habitats;

vi) to identify measures to minimise these adverse impacts;

vii) to identify, assess and specify methods, measures and standards necessary to mitigate adverse impacts and reduce them to acceptable levels;

viii) to design and specify the environmental monitoring and audit requirements necessary to ensure the implementation and effectiveness of the environmental protection and pollution measures adopted;

ix) to investigate the extent of side-effects of proposed mitigation measures recommended in the study; and

x) to identify any additional studies necessary to fulfil the objectives to the requirements of the EIA.

General Approach

1.10 As outlined earlier, an EIA has previously been conducted for the construction of the site at To Kau Wan (BCL 1994a) for which some data on the existing environmental conditions were measured and evaluated. In addition, new and updated information has been collected and evaluated. The combined data has been used as a baseline for comparison with estimated impacts caused by the relocation of the CLS.

1.11 The current processes at the existing Penny's Bay shipyard have been described in this report. Discussions have been held with the owners of Cheoy Lee Shipyard Ltd in order to reach an understanding of the likely processes to be moved to the new site and to determine any changes in volume or activities that may occur as a result of the move.

1.12 At present, final decisions have not been made as to whether certain operations will move from the current Cheoy Lee Shipyards Ltd site at Penny's Bay to To Kau Wan; until the operations are decided the equipment to be moved to To Kau Wan cannot be confirmed.

1.13 In order to undertake quantitative assessments, it has been necessary to define and describe a credible shipyard operation at the To Kau Wan site. The EIA team have taken the worst case approach assuming that virtually all operations and equipment will be moved to the To Kau Wan site. The only activities or equipment omitted are those which the owners of CLS have decided will definitively not move.

1.14 This worst case scenario approach will ensure that CLS management are not restricted from relocating any activity or pieces of equipment. The decision to leave more activities behind will only result in less environmental impact during the operational phase.

1.15 For the worst case scenario, the EIA team have assumed that virtually all current undercover areas will need replacement. This has led to a crowded site. It is likely that in practice a reduction in working area will occur. Again this will lead to a diminuation of impacts.

1.16 To determine the possible impacts of the relocation of the shipyard, the current environmental conditions at the present site at Penny's Bay have been assessed. These impacts have then been modified as appropriate and superimposed on the new site. The principal modifications resulted from a change in the geometry and positioning of the To Kau Wan site as compared to the Penny's Bay site.

Scope of the EIA

1.17 The scope of this EIA includes detailed assessment of the following environmental impacts that could arise from the construction of the operational facilities and the operational phase of the shipyard at To Kau Wan:

- visual impact;
- noise pollution;
- air pollution;
- water pollution; and
- waste disposal.

1.18 For each potential impact, the baseline conditions are established, sensitive uses or users identified and the magnitude and significance of potential impacts assessed. Cost-effective mitigation measures to reduce potential impacts to acceptable levels are recommended as appropriate. This is followed by detailed recommendations for a monitoring and audit programme to ensure compliance with current environmental legislation for parameters which may cause excessive pollution.

Previous Environmental Assessment of the Shipyard Operations at Penny's Bay

1.19 As part of the Lantau Port and Western Harbour Development Addendum C Studies on Cheoy Lee Shipyard, an environmental study was undertaken. The objectives of this small study were to:

- identify potential contamination and the resultant hazards associated with the CLS Penny's Bay area which is to be resumed; and

- assess the potential impacts associated with the TKW site (APH 1993).

1.20 The summary for the TKW site is given in its entirety below (Para 8.2 APH 1993).

"***TKW Site***

The North Shore will be transformed following completion of the LFC, the NLE and LAPH related developments. The impacts of the possible reprovisioning of CLS to TKW site will add to these committed and planned projects. The potential environmental impacts are described in Appendix B and summarised as follows:

Water Quality

Dredging and reclamation will temporarily increase suspended solids, however the extent of the works are limited. The fish culture zone at Ma Wan is the only sensitive area in the immediately vicinity. Control and management of the use of antifouling paints will be required.

Visual Aspects

Given the scale of the developments on the North Shore and the relatively small scale of the CLS site, additional visual impact will be small and there are no sensitive receivers in the immediately vicinity.

Ecology

It is questionable whether the TKW bay area contains any significant marine ecology but this can only be confirmed by a site investigation. Terrestrial areas are not affected by the development.

Noise

There is an absence of Noise Sensitive Receivers beyond adjacent ship building on shore and the floating docks.

Air Quality

Potential air quality impact will result from dust generated during the reclamation and site formation works but this will be limited and temporary.

General

Advantage should be taken of the reprovisioning of the CLS to specify grant/licence terms and conditions which afford a practical but stringent protection of its environment and limits its impacts on adjoining areas."

1.21 Working Paper No. 12A, "Environmental Baseline", part of the "Lantau Port and Western Harbour Development Studies" (APH 1991), only anticipated impacts from the Penny's Bay Shipyard in two categories, namely noise and waste. Impacts on air and water quality were not anticipated. The noise section has the following description:

> *"The shipyards at Penny's Bay carry out luxury boat building, the works are not extensive and it is anticipated that they will be relocated."*

1.22 Noise data from this report is presented in Chapter 5, "Noise Pollution". Twenty four hour monitoring of noise was undertaken on the beach next to the Shipyard, which is close to the squatter huts and right next to docking facilities for CLS.

1.23 The Addendum C Report (APH 1993) gave a site history for CLS Penny's Bay site. This is reproduced below:

> *"The CLS Penny's Bay was built on newly reclaimed land during the early 1960's. A series of aerial photographs of the site reviewed at the Building and Lands Department provided the following potted history.*
>
> *25.1.63 The bay was unreclaimed with the exception of the northern most end.*
>
> *4.4.73 Half the area of the current site was reclaimed and buildings erected.*
>
> *9.12.77 All of the site area was reclaimed although activities were restricted largely to the northern half of the site. A large pit was identifiable between the site and the CL&P power station. This was presumably during the infilling of this area to reclaim it from the bay.*
>
> *22.11.84 Little change from 1977.*
>
> *24.10.91 Close up photographs of the jetty area showed leakage of liquid from the mould storage areas and open storage of drums and metals. A larger area of the site was used for the storage of moulds. The area of land between the power station and CLS was used for open storage, concrete batching, etc.*
>
> *15.7.92 The main changes from the previous year seemed to be the clearing of the site between CLS and the power station. Land-use on the actual site remained the same as 1991.*
>
> *Information on substances and materials used on the site throughout its history is not available, however, it is to be anticipated that activities have remained largely the same throughout. Waste arising on the site has either been burned, recycled or dumped in an open pit."*

1.24 The Addendum C report (APH 1993) also discusses the question of possible contamination of the site. This question was addressed principally in relation to the resumption of the site which does not form any part of this EIA. However, there may be contamination of the marine sediments and waters at Penny's Bay. The operational activities at the shipyard over the previous 30 years will give excellent clues as to the presence or absence of polluting habits. It has of course been remembered that environmental standards and attitudes have changed considerably in the last 30 years.

1.25 The Addendum C report gave a descriptive list of possible sources of contamination, although no chemical testing was undertaken to test for possible contamination. This list was used by the team to supplement their own observations during the first site visit to guard against overlooking possible sources of pollution. In summary, the potential contaminants listed were asbestos, copper, nickel, zinc, lead, arsenic, cadmium, cyanide, solvents and petroleum products.

1.26 The report (APH 1993) also made the following comment of relevance to this EIA:

> *"The mud in Penny's Bay is likely to be contaminated with heavy metals. One sample from the Contaminated Spoil Management Study located in the northern part of the bay indicated that the sediments were contaminated with Mercury and were classified as Class B sediments. The source of the contamination is unknown but it is unlikely that the shipyard activities contributed to this contamination."*

Overview of the Concurrent Development

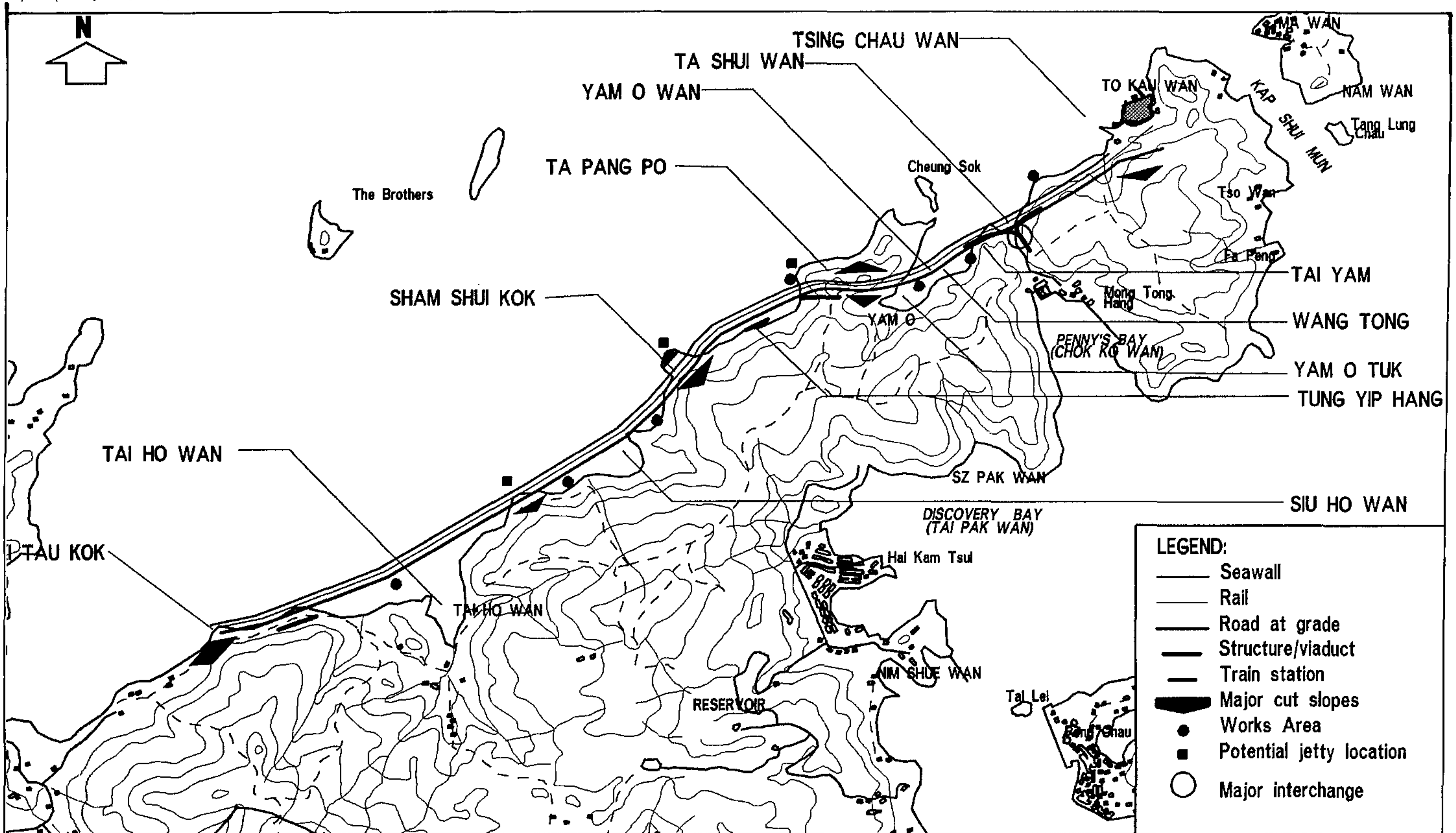
1.27 Lantau is currently experiencing a great deal of construction activity associated with the development of the Chek Lap Kok Airport. A number of the contracts have and will continue to affect the background environmental conditions at To Kau Wan, during both their construction and operational phases.

1.28 The Chek Lap Kok Airport site is over 1,000 hectares in area, ¾ of which is reclaimed land (GM 1991). Dredging for marine fill has taken place at a number of marine borrow areas. Dredging for marine fill has taken place extensively in the *Brothers Marine Borrow Area*, as close as 4 km west of To Kau Wan which has impacted on marine water at To Kau Wan. The To Kau Wan site lies within the 25 NEF noise contour for the year 2030. The New Airport Master Plan (GM 1991) recommended that all new construction of NSRs with the 25 NEF be prohibited.

1.29 The road and rail access to the Airport is currently under construction along the northern coast of Lantau. The major length of road is known as the North Lantau Expressway. This together with the Airport Railway are commonly known as the NLE. The NLE is divided into three sections:

- Chek Lap Kok and Tung Chung to Kei Tau Kok (Tung Chung Section);
- Kei Tau Kok to Sham Shui Kok (Tai Ho Section); and
- Sham Shui Kok to Tsing Chau (Yam O Section).

1.30 The Airport Railway runs to the north of the Expressway and a service road will be constructed to the south. The major features of the Yam O and Tai Ho sections of the project are shown on Figure 1.2.



TO KAU WAN OPERATIONAL EIA

MAJOR FEATURES OF YAM O AND TAI HO SECTIONS OF NLE

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土木工程署 Civil Engineering Department	Initial YPS	Drawing No. FIGURE 1.2

1.31 For the Yam O Section of the NLE approximately:

- 2 million m^3 of marine mud is being removed;
- 6 million m^3 of backfill is required for reclamation;
- 3.5 million m^3 of which is being excavated from Yam O Tuk, and much of the remainder has come from the Toll Plaza excavations;
- about 250,000 m^3 of armour rock will be placed.

There will be major culverts, bridges and viaducts constructed as part of the construction activities (Mott 1991a).

1.32 The construction of the Tai Ho section of the NLE should have little effect on the To Kau Wan area. However, the Tai Ho contracts included the *North of Lantau Borrow Area*. Dredging for marine fill on the eastern side of the Borrow Area was as close as 800 metres to To Kau Wan in 1994.

1.33 The NLE abuts the Lantau Fixed Crossing (LFC). The *Toll Plaza* is being constructed under the LFC contracts. This stretch of road and rail is only about 1 km long and feeds the Kap Shui Mun Bridge between Lantau and the eastern edge of Ma Wan. The Ma Wan Viaducts crosses Ma Wan and the Tsing Ma Bridge spans the Ma Wan Channel to Tsing Yi. The Toll Plaza lies just south of To Kau Wan on the first ridge above the bay.

1.34 Contract 514 of the Lantau and Airport Railway Project comprises the East Lantau tunnels linking the Lantau Fixed Crossing to the Lantau Viaducts. Twin concrete lined tunnels with a horseshoe-shaped bore of 5.2 m internal diameter will run approximately 900 m under the Toll Plaza. The tunnels will be driven through rock by drill and blast methods from the western portal for 24 hours per day, six days per week. There will be up to six explosions per day. The total spoil removed will be about 65,000 m^3. The main construction activities will also include mucking out and provision of shotcrete and concrete (in-situ) tunnel linings. The construction of the East Lantau tunnels and the Toll Plaza, because of their close proximity, will have most direct effect on the To Kau Wan area. This MTRC contract started in mid January 1995. Blasting will begin in late March 1995. The excavation of the MTRC tunnels is programmed for completion in February 1996.

1.35 The *Toll Plaza* contracts commenced in November 1993. The Advanced Earthworks contract, HY/93/02 is nearly complete. It involved approximately:

- 1,600,000 m^3 of soil and rock excavation;
- reclamation at Tsing Chau Wan to 5.5 mPD using 410,000 m^3 of fill material and 250 m of seawall; and
- 1,050,000 m^3 of embankment construction (Mott 1993).

Dredging was completed at Tsing Chau Wan by early March 1994. The extent of the area to be reclaimed under this project and it's relation to To Kau Wan are shown on Figure 1.3.

1.36 The Toll Plaza Roadworks contract, HY/94/04, commenced on 27th March 1995. This contract includes such tasks as road surfacing, subways, underpasses, bridges, the canopy over the Toll Plaza, signs, surface drainage and landscaping. It is due for completion by April 1997.

1.37 There is a possibility that a concrete plant will be erected within the Toll Plaza site. However it seems more likely that concrete would be brought from one of the existing plants at either Kap Shui Mun or Yam O.

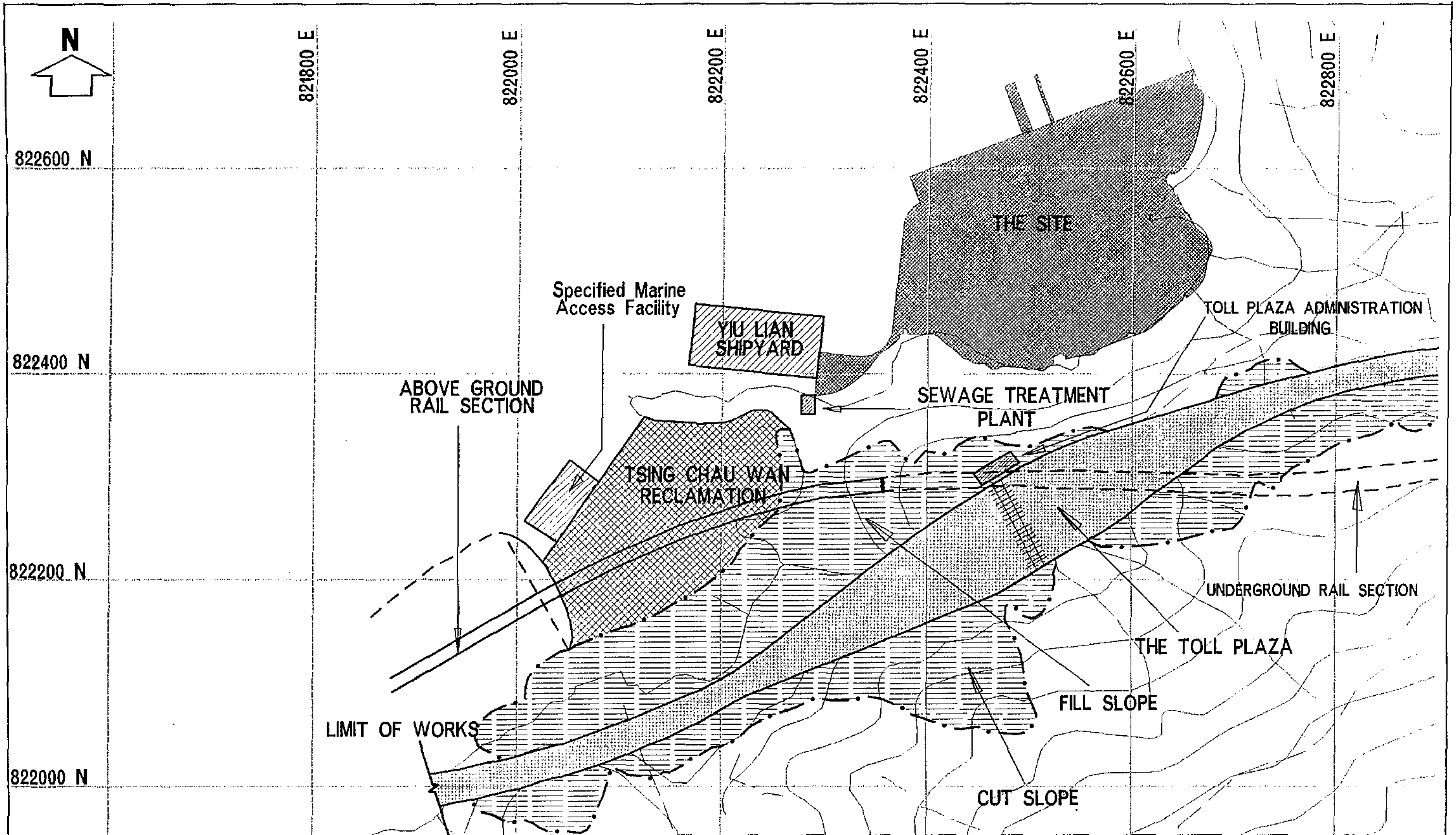
1.38 Construction of the Lantau Administration Building, contract SS C354, commenced on 6th March 1995 and is due for completion in July 1996. The management of the operational Toll Plaza will be from this building. Its siting is shown in Figure 1.3. A sewage treatment plant will be sited near the southern junction of Yiu Lian Shipyard and the TKW site. This package plant has been approved by EPD. Its effluent will be discharged to sea to the south of the Yiu Lian Dockyard. The effluent must meet the requirements of the Technical Memorandum under the Water Pollution Control Ordinance. The treatment plant is programmed for completion in September 1995 initially to provide a treatment facility for the site offices at Tsing Chau Wan and ultimately to serve the Administration Building.

1.39 During the Operational phase of the NLE and the Toll Plaza, noise levels experienced at the To Kau Wan site could be considerable. In addition to noise from the airport, both railway and road noise may be high. The Toll Plaza cutting and the tunnels for the trains will protect part of the expressway and the railway from noise, preventing full exposure of the Site to these sources. Without this effect road noise would definitely exceed 70 dB(A) (L_{10}). The expected rail noise is less intense but the railway line is closer. Without protection rail noise could exceed 60 dB(A) (L_{eq} 30 min).

1.40 Traffic levels are high enough to generate significant amounts of vehicle emissions. Although air quality at the TKW site would definitively lie within the AQO, the current air quality is expected to drop.

1.41 The Yiu Lian Dockyard is shown on Figure 1.4. It has been projected that as many as 76 people could be working at the shipyard. As part of the Yiu Lian Dockyard complex there are Staff Quarters. The main working hours are 8 a.m. to 7 p.m. with occasional overtime continuing no later than 11 p.m. The Yiu Lian Shipyard consists of an area of reclaimed land with five floating docks.

1.42 Currently there can be a strong smell of paint at the To Kau Wan site from the Yiu Lian operation. Large boats are painted in the water at the floating docks. Yiu Lian Shipyard operations would be harmed by excessive quantities of dust from other works.



TO KAU WAN OPERATIONAL EIA

THE TOLL PLAZA WORKS

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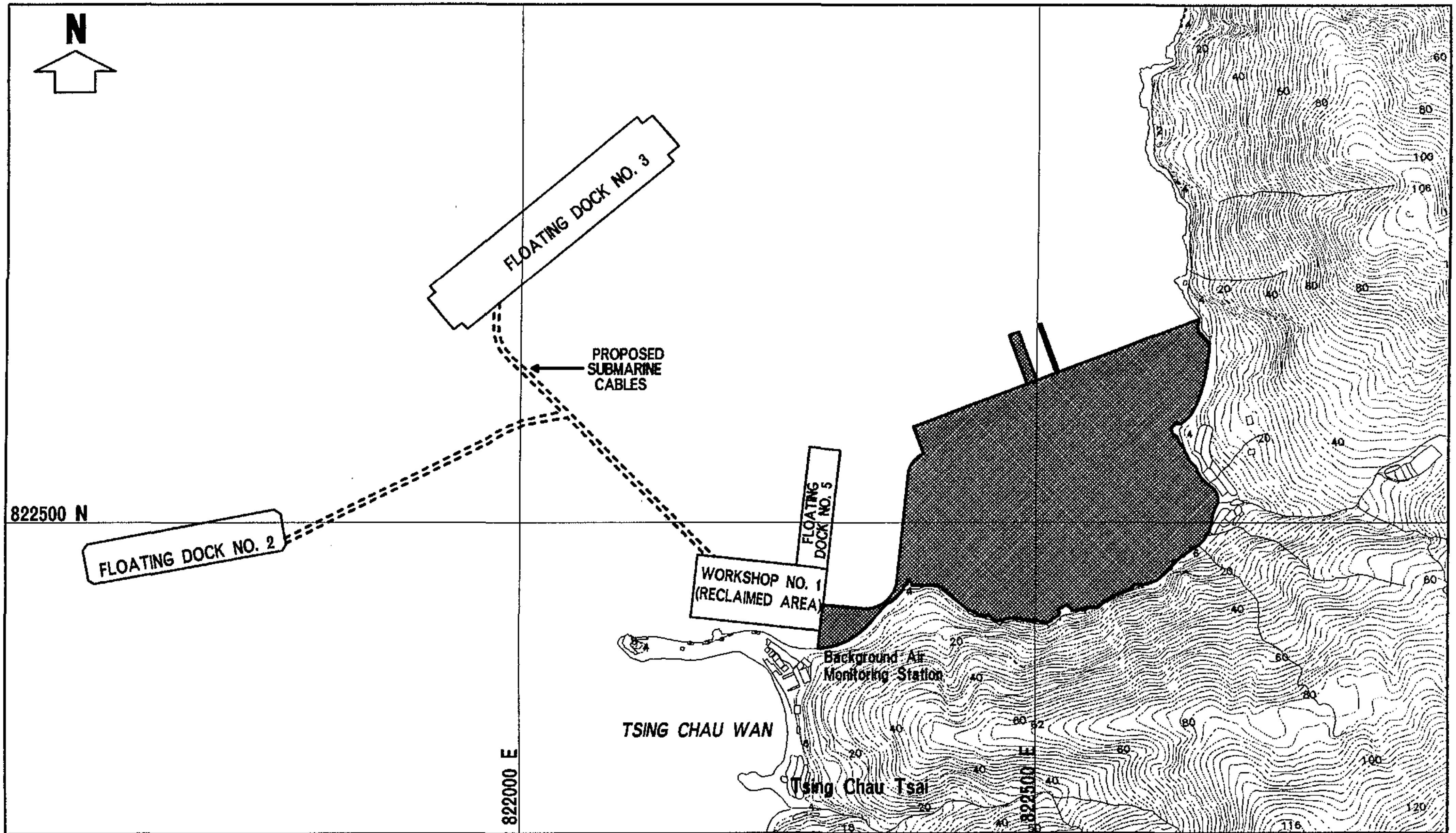

TO KAU WAN OPERATIONAL EIA
YIU LIAN DOCKYARDS

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Environmental Legislation and Guidelines

Construction Noise

1.43 The Noise Control Ordinance (Cap. 400), NCO, was gazetted in 1988 and specific sections relating to general construction work were implemented in 1989. Ordinance No. 2 of 1994 amended the NCO and provided for larger penalties for offences under the Ordinance.

1.44 General construction work using powered mechanical equipment is restricted between the hours of 7 p.m. and 7 a.m. and on Sundays and general holidays.

1.45 The standards and limits for noise emanating from construction sites are set out in Technical Memoranda issued by the Secretary from time to time. The current standards are shown below.

Table 1.1 Area Sensitivity Ratings (ASRs)

Degree to which NSR is affected by IF / Type of Area Containing NSR	Not Affected	Indirectly Affected	Directly Affected
(i) Rural area, including country parks or village type developments	A	B	B
(ii) Low density residential area consisting of low-rise or isolated high-rise developments	A	B	C
(iii) Urban Area	B	C	C
(iv) Area other than those above	B	B	C

Source: Technical Memorandum on Noise from Construction Work other than Percussive Piling

Table 1.2 Basic Noise Levels (BNLs) for Construction Noise from Activities other than Percussive Piling in dB(A)

Time Period / ASR	A	B	C
All days during the evening (1900 to 2300 hours), and general holidays (including Sundays) during the day-time and evening (0700 to 2300 hours)	60	65	70
All days during the night-time (2300 to 0700 hours)	45	50	55

Source: Technical Memorandum on Noise for Construction Work other than Percussive Piling

Operation Noise

1.46 Operational noise limits for ship building is also controlled under Cap. 400. The standards and limits for noise emanating from shipyard operation are set out in "Technical Memorandum for the Assessment of Noise From Places Other Than Domestic Premises, Public Places or Construction Sites" (TM). The current Standards are shown below.

Table 1.3 Acceptable Noise Levels (ANLs) for Noise other than Domestic Premises, Public Places or Construction Sites

<table>
<tr><th>Time Period / ASR</th><th>A</th><th>B</th><th>C</th></tr>
<tr><td>Day (0700 to 1900 hours)</td><td rowspan="2">60</td><td rowspan="2">65</td><td rowspan="2">70</td></tr>
<tr><td>Evening (1900 to 2300 hours)</td></tr>
<tr><td>Night (2300 to 0700 hours)</td><td>50</td><td>55</td><td>60</td></tr>
</table>

Source : Technical Memorandum for the Assessment of Noise from Places other than Domestic Premises, Public Places or Construction Sites

1.47 It is also noted that 10 dB(A) shall be deducted from the above Acceptable Noise Levels if the noise sources and sensitive receivers are within or adjoining the same building.

Air

1.48 The main purposes of the Air Pollution Control Ordinance, APCO, (Cap. 311) is to control the emission of air pollutants (i.e. any solid, particulate, liquid, vapour or gaseous substance emitted into the atmosphere) into the atmosphere of Hong Kong from stationary and mobile sources.

1.49 In subsidiary legislation of Cap. 311, seven widespread pollutant parameters have been identified and limits specified in Hong Kong Air Quality Objectives (AQO). The maximum acceptable concentrations as stipulated in the AQO are shown in the following table.

Table 1.4 Hong Kong Air Quality Objectives

Pollutant	Concentration ($\mu g/m^3$)				
	1 hr$^{(1)}$	8 hrs$^{(2)}$	24 hrs$^{(2)}$	3 mths$^{(3)}$	1 yr$^{(3)}$
Sulphur Dioxide	800		350		80
Total Suspended Particulates$^{(4)}$			260		80
Respirable Suspended Particulars$^{(4)}$			180		55
Nitrogen Dioxide	300		150		80
Carbon Monoxide	30000	10000			
Photochemical Oxidants (as ozone$^{(5)}$)	240				
Lead				1.5	

Notes: Concentration measured at 298K and 101.325 kPa.

(1) Not to be exceeded more than three times per year.
(2) Not to be exceeded more than once per year.
(3) Arithmetic means.
(4) Respirable suspended particulates means suspended particles in air with a nominal aerodynamic diameter of 10 micrometres and smaller.
(5) Photochemical oxidants are determined by measurement of ozone only.

1.50 It is usually recommended by EPD that dust levels be kept under 500 $\mu g/m^3$ over any one hour period. This standard does not form part of the AQO. It is a guideline recommended by EPD.

1.51 A "Technical Memorandum for Issuing Air Pollution Abatement Notices to Control Air Pollution from Stationary Polluting Processes" (TM) was issued in June 1994. This TM details the principles, procedures and standards for the assessment and measurement of air pollution from stationary polluting processes.

1.52 When determining whether the identified air pollutants are in compliance with the TM, the following procedures need to be adopted to determine the:

- sensitive receptor;
- type and quantity of air pollutants emitted from the stationary source;
- concentration levels at sensitive receptors;
- compliance with the AQO.

1.53 Under the Factories and Industrial Undertakings Ordinance (Cap. 59):

> *"It shall be the duty of every proprietor of an industrial undertaking to ensure so far as is reasonably practicable, the health and safety at work of all persons employed by him at the industrial undertaking."*

1.54 The Labour Department has published guidance in the form of occupational exposure limits (OELs) for occupational health and safety practitioners, employers and employees or their representatives to assist them in designing devices or to take appropriate measures in order to protect the workers adequately from particular hazards.

1.55 These Occupational Exposure Limits represent airborne concentrations usually of individual chemical substances. Since OELs are not fine dividing lines between safe and dangerous concentrations, they are used as guidelines to assess the working environment and to indicate whether additional control measures are required.

1.56 An Occupational Exposure Limit is expressed as the time-weighted average (TWA) of the airborne concentration of a substance over an eight hour working day, for a five-day working week. When workers have a work schedule longer than eight hours a day in a 40 hour week pattern, the OEL-TWA may need to be reduced by a suitable factor to ensure adequate worker protection. As a rough guide, the OEL reduction factor (RF) is derived by the Brief and Scala model:

(i) for more than 8 hours per day,

$$RF = \frac{8}{h} \times \frac{24-h}{16}$$

where h = hours worked per day,

(ii) for more than 5-day and 40 hours per week,

$$RF = \frac{40}{H} \times \frac{168-H}{128}$$

where H = hours worked per week

Odour

1.57 The Environmental Protection Department has an unpublished guidance for odour prediction at the receptor:

> *"The predicted odour level at receptor should be less than 5 odour units based on prediction averaging time of 5 seconds. For odour measurement or monitoring, the odour level should not exceed 2 odour units as measured at the site boundary of the plants."*

Water Quality

1.58 The Water Pollution Control Ordinance 1980 (WPCO) (Cap. 358) is the principal legislation governing water quality of marine waters in Hong Kong. Under Sections 4 and 5 of the Ordinance Water Control Zones (WCZs) may be declared and Water Quality Objectives (WQOs) established for each zone or a subzone such as a Fish Culture Subzone.

1.59 The site for the To Kau Wan shipyard lies just within the North Western Water Control Zone (NWWZ) close to the Western Buffer Control Zone. The implementation of the WPCO in NWWZ was declared on 25th February 1992. The NWWZ had been identified as having eight beneficial uses:

- A source of food for human consumption;
- A resource for commercial exploitation;
- A habitat for marine life generally;
- Primary contact recreation - bathing;
- Secondary contact recreation - diving, sailing, windsurfing etc.;
- Domestic and industrial supply;
- Navigation and shipping;
- Aesthetic enjoyment.

1.60 The WQOs for the NWWZ are shown in Table 1.5 below. Table 1.5 also gives the WQO for the Western Buffer Zone relating to dissolved oxygen in Fish Culture Subzones.

1.61 Construction activities at To Kau Wan are included within the definition of Civil Engineering Works (including all building works and reclamation) and are therefore classified as potentially polluting uses by the Hong Kong Planning Standards and Guidelines (HKPSG). As such it is recommended that:

> *"care should be taken in planning and implementation of works to avoid, minimise or ameliorate the occurrence of these adverse effects on water bodies, especially those in .... areas used for commercial fisheries."*

1.62 The relevant WQOs for the NWWZ have been taken into consideration when assessing construction and operation impacts and the requirement for mitigation measures. However, whilst it is an offence under Section 8 of the WPCO to discharge polluting matter into a WCZ, discharges made under a Crown lease granted under the Foreshores and Sea Bed Ordinance (Cap. 127) are excluded.

Table 1.5 Statement of Water Quality Objectives (North Western Water Control Zones) - L.N. 39 of 1992 (Cap. 358)

		Water Quality Objectives	Part or Parts of Zone
A.	**AESTHETIC APPEARANCE**		
	(a)	Waste discharge shall cause no objectionable odours or discolouration of water.	Whole zone
	(b)	Tarry residues, floating wood, articles made of glass, plastic, rubber or of any other substances should be absent.	Whole zone
	(c)	Mineral oil should not be visible on the surface. Surfactants should not give rise to a lasting foam.	Whole zone
	(d)	There should be no recognisable sewage-derived debris.	Whole zone
	(e)	Floating, submerged and semi-submerged objects of a size likely to interfere with the free movement of vessels, or cause damage to vessels, should be absent.	Whole zone
	(f)	Waste discharges shall not cause the water to contain substances which settle to form objectionable deposits.	Whole zone
B.	**BACTERIA**		
	(a)	The level of *Escherichia coli* should not exceed 610 per 100 mL, calculated as the geometric mean of all samples collected in a calender year.	Secondary Contact Recreation Subzones
	(b)	The level of *Escherichia coli* should be less than 1 per 100 mL, calculated as the running median of the most recent 5 consecutive samples taken at intervals of between 7 and 21 days.	Tuen Mun (A) and Tuen Mun (B) Subzones and Water Gathering Ground Subzones
	(c)	The level of *Escherichia coli* should not exceed 1,000 per 100 mL, calculated as the running median of the most recent 5 consecutive samples taken at intervals of between 7 and 21 days.	Tuen Mun (C) Subzone and other inland waters

Table 1.5 Statement of Water Quality Objectives (North Western Water Control Zones) - L.N. 39 of 1992 (Cap. 358) (cont'd)

		Water Quality Objectives	Part or Parts of Zone
	(d)	The level of *Escherichia coli* should not exceed 180 per 100 mL, calculated as the geometric mean of all samples collected from March to October inclusive. Samples should be taken at least 3 times in one calender month at intervals of between 3 and 14 days.	Bathing Beach Subzones
C.	**COLOUR**		
	(a)	Waste discharges shall not cause the colour of water to exceed 30 Hazen units.	Tuen Mun (A) and Tuen Mun (B) Subzones and Water Gathering Ground Subzones
	(b)	Waste discharges shall not cause the colour of water to exceed 50 Hazen units.	Tuen Mun (C) Subzone and other inland waters
D.	**DISSOLVED OXYGEN**		
	(a)	Waste discharges shall not cause the level of dissolved oxygen to fall below 4 mg per litre for 90% of the sampling occasions during the whole year; values should be calculated as water column average (arithmetic mean of at least 3 measurements at 1 m below surface, mid-depth and 1 m above seabed). In addition, the concentration of dissolved oxygen should not be less than 2 mg per litre within 2 m of the seabed for 90% of the sampling occasions during the whole year.	Marine waters
	(b)	The level of dissolved oxygen should not be less than 5 mg per litre for 90% of the sampling occasions during the year; values should be calculated as water column average (arithmetic mean of at least 3 measurements at 1 m below surface, mid-depth and 1 m above seabed). In addition, the concentration of dissolved oxygen should not be less than 2 mg per litre within 2 m of the seabed for 90% of the sampling occasions during the whole year.	Fish Culture Subzones within the Western Buffer Zone
	(c)	Waste discharges shall not cause the level of dissolved oxygen to be less than 4 mg per litre.	Tuen Mun (A), Tuen Mun (B) and Tuen Mun (C) Subzones, Water Gathering Ground Subzones and other inland waters
E.	**pH**		
	(a)	The pH of the water should be within the range of 6.5-8.5 units. In addition, waste discharges shall not cause the natural pH range to be extended by more than 0.2 unit.	Marine water excepting Bathing Beach Subzones
	(b)	Waste discharges shall not cause the pH of the water to exceed the range of 6.5-8.5 units.	Tuen Mun (A), Tuen Mun (B) and Tuen Mun (C) Subzones and Water Gathering Ground Subzones
	(c)	The pH of the water should be within the range of 6.0-9.0 units.	Other inland waters
	(d)	The pH of the water should be within the range of 6.0-9.0 units for 95% of samples collected during the whole year. In addition, waste discharges shall not cause the natural pH range to be extended by more than 0.5 unit.	Bathing Beach Subzones
F.	**TEMPERATURE**		
		Waste discharges shall not cause the natural daily temperature range to change by more than 2.0°C.	Whole Zone
G.	**SALINITY**		
		Waste discharges shall not cause the natural ambient salinity level to change by more than 10%.	Whole zone
H.	**SUSPENDED SOLIDS**		
	(a)	Waste discharges shall neither cause the natural ambient level to be raised by more than 30% nor give rise to accumulation of suspended solids which may adversely affect aquatic communities.	Marine waters

Table 1.5 Statement of Water Quality Objectives (North Western Water Control Zones) - L.N. 39 of 1992 (Cap. 358) (cont'd)

	Water Quality Objectives	Part or Parts of Zone
	(b) Waste discharges shall not cause the annual median of suspended solids to exceed 20 mg per litre.	Tuen Mun (A), Tuen Mun (B) and Tuen Mun (C) Subzones and Water Gathering Ground Subzones
	(c) Waste discharges shall not cause the annual median of suspended solids to exceed 25 mg per litre.	Other inland waters
I.	**AMMONIA**	
	The un-ionized ammoniacal nitrogen level should not be more than 0.021 mg per litre, calculated as the annual average (arithmetic mean).	Whole zone
J.	**NUTRIENTS**	
	(a) Nutrients shall not be present in quantities sufficient to cause excessive or nuisance growth of algae or other aquatic plants.	Marine waters
	(b) Without limiting the generality of objective (a) above, the level of inorganic nitrogen should not exceed 0.3 mg per litre, expressed as annual water column average (arithmetic mean of at least 3 measurement at 1 m below surface, mid-depth and 1 m above seabed).	Castle Peak Bay Subzone
	(c) Without limiting the generality of objective (a) above, the level of inorganic nitrogen should not exceed 0.5 mg per litre, expressed as annual water column average (arithmetic mean of at least 3 measurements at 1 m below surface, mid-depth and 1 m above seabed).	Marine waters excepting Castle Peak Bay Subzone
K.	**5-DAY BIOCHEMICAL OXYGEN DEMAND**	
	(a) Waste discharges shall not cause the 5-day biochemical oxygen demand to exceed 3 mg per litre.	Tuen Mun (A), Tuen Mun (B) and Tuen Mun (C) Subzones and Water Gathering Ground Subzones
	(b) Waste discharges shall not cause the 5-day biochemical oxygen demand to exceed 5 mg per litre.	Other inland waters
L.	**CHEMICAL OXYGEN DEMAND**	
	(a) Waste discharges shall not cause the chemical oxygen demand to exceed 15 mg per litre.	Tuen Mun (A), Tuen Mun (B) and Tuen Mun (C) Subzones and Water Gathering Ground Subzones
	(b) Waste discharges shall not cause the chemical oxygen demand to exceed 30 mg per litre.	Other inland waters
M.	**TOXINS**	
	(a) Waste discharges shall not cause the toxins in water to attain such levels as to produce significant toxic, carcinogenic, mutagenic or teratogenic effects in humans, fish or any other aquatic organisms, with due regard to biologically cumulative effects in food chains and to toxicant interactions with each other.	Whole zone
	(b) Waste discharges shall not cause a risk to any beneficial use of the aquatic environment.	Whole zone
N.	**PHENOL**	
	Phenols shall not be present in such quantities as to produce a specific odour, or in concentration greater than 0.05 mg per litre as C_6H_5OH.	Bathing Beach Subzones
O.	**TURBIDITY**	
	Waste discharges shall not reduce light transmission substantially from the normal level.	Bathing Beach Subzones

1.63 The standards and limits for effluents discharged into the marine waters are set out in the "Technical Memorandum of Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters" was issued in February 1991 (EPD 1991a). The upper limits for effluent discharged into the marine waters within the North Western Water Control Zone are given in Table 1.6 below and for inshore waters in Table 1.7.

Table 1.6 Standards for Effluents discharged into the Marine Waters of North Western Water Control Zone

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)	6-10	6-10	6-10	6-10	6-10	6-10	6-10	6-10	6-10	6-10	6-10	6-10
Temperature (°C)	45	45	45	45	45	45	45	45	45	45	45	45
Colour (lovibond units) (25 mm 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	20
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
Calcium	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/100 ml)	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000

Note: All units in mg/L
All figures are upper limits

Table 1.7 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) (25 mm 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
Calcium	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/100 ml)	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000

Note: All units in mg/L
All figures are upper limits

Ecology

1.64 Legislation on ecology in Hong Kong provides protection of various types to both species and areas.

1.65 The Forests and Countryside Ordinance (Cap. 96) gives general protection to vegetation on all Crown Land, while "Country Parks" and "Special Areas" (which may be inside or outside Country Parks) receive additional protection under the Country Parks Ordinance (Cap. 208). The Wild Animals Protection Ordinance (Cap. 170) provides for the designation of "Restricted Areas" to which access is limited (e.g. Mai Po Marshes). This ordinance also provides for the protection of most mammals, (except wild pigs, the Small Indian Mongoose, rats and shrews), selected reptiles, the Birdwing Butterfly, all wild birds, their nests and eggs in Hong Kong, and prohibits hunting and the possession of hunting appliances. The destruction of animals during land formation works requires a Special Permit issued under Section 15 of the Ordinance. The Director of Agriculture and Fisheries is the Authority under this legislation.

1.66 The revised Town Planning Ordinance (Cap. 131) provides for the designation of "coastal protection areas, Sites of Special Scientific Interests (SSSIs), green belts or other specified uses that promote conservation or protection of the environment". About 50 SSSIs have been designated and Government Departments are required to consult the Agriculture and Fisheries Department when considering a proposal that may affect SSSI. The hillsides to the south and east of To Kau Wan have designated as green belt under the draft Outline Zoning Plan No. S/I - NELP/1.

1.67 The Forestry Regulations (Cap. 96, section 3) prohibit sale and possession of a number of named plant species, including all native orchids, camellias and rhododendrons. The Animals and Plants (Protection of Endangered Species) Ordinance (Cap. 187) prohibits the possession of one additional plant species, *Nepenthes mirabilis*; and also provides for protection of threatened and endangered birds. Import, export and possession of listed species are controlled through a licence system administered by the Director of Agriculture and Fisheries. This legislation enables Hong Kong to meet its obligations under the Convention on International Trade in Endangered Species of Wild Fauna and Flora - the "Washington" Convention.

1.68 Hong Kong is also party to two international conventions which relate directly to conservation of wildlife and wildlife habitat:

(a) The Convention on Wetlands of International Importance Especially as Waterfowl Habitat - the "Ramsar" Convention.

(b) The Convention on the Conservation of Migratory Species of Wild Animals - the "Bonn" Convention.

1.69 The "Ramsar" Convention requires parties to promote wetland conservation and their "wise use". The definition of wetland includes "areas of marine water the depth of which at low tide does not exceed six metres", thus a considerable part of the To Kau Wan reclamation falls within this definition.

1.70 The "Bonn" Convention aims to protect migratory species, including the safeguarding of habitats used by such species. For species which are considered to be both "migratory" and "endangered" the Convention requires parties to make special efforts to counteract factors that are dangerous or potentially dangerous to those species.

1.71 General ecological legislation which applies to marine species includes the Wild Animals Protection Ordinance which protects all cetaceans, and the Animals and Plants (Protection of Endangered Species) Ordinance which provides for protection of threatened and endangered species, and for Hong Kong would include all whales, dolphins and sea turtles.

1.72 In addition, legislation specific to marine ecology includes the Fisheries Protection Ordinance 1987 (Cap. 171) which is designed to promote the conservation of fish and aquatic life and regulates fishing practices. The Marine Fish Culture Ordnance 1983 (Cap. 353) regulates and protects marine fish culture zones designated under the ordinance. Under this legislation it is an offence to deposit any substance which pollutes or is likely to cause pollution of a fish culture zone.

Waste

1.73 The principal legislation governing the management of waste materials in Hong Kong is the Waste Disposal Ordinance (WDO) (Cap. 354) which was enacted in 1980. This ordinance generally encompasses all stages of waste management. The WDO Waste Disposal (Chemical Waste) (General) Regulations (L.N. 20 of 1992) specifically addresses the storage, collection, treatment, transport and disposal of chemical wastes.

1.74 The Building Ordinance (Cap. 123), administered by the Director of Buildings, contains regulations pertaining to the design, construction and management of oil installations and mandates that all industrial wastewaters are discharged to foul sewers or wastewater treatment plants.

1.75 In more general terms, the *Hong Kong Planning Standards and Guidelines (HKPSG)* provide guidance for proper waste disposal associated with the planning and design of public and private projects.

1.76 Finally, fuel or oil spills on the coastal waters surrounding Hong Kong are currently regulated by the Marine Department under the Oil Pollution Ordinance (Cap. 247). The Fire Services Department is primarily responsible for handling chemical spills on land and is also involved in the design of fuel storage facilities.

Tributyltin Antifouling Paint

1.77 Tributyltin (TBT) compounds are the active ingredients that have been extensively used in many antifouling paints to control the growth or attachment of marine organisms, such as crustacea and mollusca on the boat surfaces. They are the most effective and long lasting fouling control ingredients that have been found to date. A concentration as low as 20 parts per trillion (20 ng/L) is effective in controlling fouling (Lau 1991).

1.78 Unfortunately, TBT has been shown to be highly toxic to non-target marine organisms even in the concentration of the order of parts per trillion. Research studies have showed that 20 ng/L caused growth retardation in the Pacific oyster *Crassostrea gigas*. For rainbow trout, growth retardation was evident at 200 ng/L of TBTCl, and mortality occurred at several thousand ng/L for different species of freshwater and marine fishes. It also bioaccumulates in the food chain having a damaging effect on the reproduction and growth of various marine life forms (Lau 1991).

1.79 Stringent regulatory control has been set in some maritime countries (Table 1.8). In the U.K., since July 1987, all antifoulings have been treated as pesticides that require registration under the Food and Environmental Protection Act. Regulations were introduced to prevent the retail sale of TBT paints with high leach rates. The UK Government has set a water objective of 20 ng/L (Lau 1991).

1.80 In the U.S. all antifoulings must be registered with the USEPA. The use of TBT antifoulings have been banned for vessels less than 25 m in length (mostly recreational vessels) with exemption for aluminium hulls and fittings in Canada and the U.S. This is based on the fact that the copper-based alternative paints react chemically with the aluminium. There are controls on TBT release rates, less than 4 microgrammes TBT/sq.cm/day for vessels greater than 25 m in length. The USEPA has further set a limit on water quality to 2 ppt (ng/l) TBT in water.

1.81 All E.E.C. member countries, Australia and New Zealand have no exemption for aluminium at all.

1.82 Among the Asian countries, Japan has regulations for vessels docking every year that TBT free antifoulings should be used. For all coastal vessels irrespective of docking interval, TBT free antifoulings should be used. Singapore, Malaysia, Korea, Taiwan and China did not have any restrictions for any vessels in January, 1991.

Table 1.8 Control Measures adopted by a number of Countries

	Vessels less than 25 m	Vessels greater than 25 m	Other Concerns
Australia & New Zealand	TBT antifoulings banned. No exemption for aluminium	TBT antifoulings restricted to those with release rate less than 5 microgrammes (4 in New Zealand) TBT/sq. cm/day. Concerns over drydock discharges of TBT are raised in Australia.	All antifoulings must be registered.
Canada	TBT antifoulings banned. Exemption for aluminium hulls and fittings.	TBT antifoulings restricted to those with certified release rate less than 4 microgrammes TBT/sq. cm/day. Concerns over drydock discharges to TBT into the Great lake are raised.	All antifoulings must be registered.
EEC	TBT antifoulings banned. No exemption for aluminium hulls and fittings.	TBT antifoulings can only be supplied in containers of at least 20 litre capacity.	- UK, Eire and Holland require registration of all antifoulings. - Holland implements legislation to ban dry blasting. - In UK, Holland and Germany, washing water and blasting abrasive used to prepared TBT antifoulings may be collected and treated as hazardous waste.
Japan	-	-	- For vessels docking every year, TBT free antifoulings should be used. - For vessels docking at intervals in excess of one year, TBT free antifoulings should be used wherever practical, and always on the flat bottom areas. - All coastal vessels irrespective of docking interval, TBT-free antifoulings should be used. - Exemption for aluminium hull is granted.
Norway, Sweden & Finland	TBT antifoulings banned.	No restrictions.	-
Singapore, Malaysia, Korea, Taiwan and China	-	-	No restrictions for any vessels.
USA	TBT antifoulings banned. Exemption for aluminium bulls and fittings.	TBT antifoulings restricted to those with certified release rate less than 4 microgrammes TBT/sq. cm/day EPA limits on water quality expected to be fixed at 2 ppt TBT in water.	- All antifoulings must be registered. - Antifoulings may only be applied by certified applicators. - TBT antifoulings are banned in the states of Virginia, Alaska and Michigan.

Source: Agriculture and Fisheries Department

1.83 Hong Kong Government controls the import and sale of TBT products by including them under the Pesticides Ordinance, PO, (Cap. 133) which was declared in 1991. Both Tributyltin (TBT) & Cu-based antifouling paints are controlled under the PO.

1.84 TBT paints are restricted to use by "permit". Manufacturers, suppliers and users need to have applied for their own permits. Each permit should be renewed every six months.

1.85 All copper-based paints should be registered with AFD by the suppliers. Licences will be issued by the Director of AFD and need to be renewed every twelve months.

1.86 Any paints scrapped off or washed to the sea is under the control of the solid waste group of Environmental Protection Department (EPD). Storage, disposal, collection and transport of TBT and copper-based wastes should be registered with EPD by the "Chemical Wastes Producer".

Chemical Waste

1.87 Organotin compounds and paints are in the chemical waste list (part B of Schedule 1) under the Waste Disposal (Chemical Waste) (General) Regulation (Cap. 354). This regulation is implemented by the Waste Control Group of Environmental Protection Department.

1.88 The definition of chemical waste is clearly defined in Cap. 354 and abstracted as follows.

> *"Any substance or thing being -*
>
> *(a) scrap material;*
> *(b) effluent; or*
> *(c) an unwanted substance or by-product arising from the application of or in the course of any process or trade activity, and which is or contains any substance or chemical specified in Schedule 1 shall be regarded as chemical waste for the purposes of this Regulation if such substance or chemical occurs in such form, quantity or concentration so as to cause pollution of constitute a danger to health or risk of pollution to the environment.*

Any -

(a) *thing which is of a class or description specified by the Director in a notice published in the Gazette for the purposes of this section; or*
(b) *other thing being a discharge or deposit which is made in accordance with a licence granted under the Water Pollution Control Ordinance (Cap. 358) or in conformity with a technical memorandum issued under that Ordinance,*

shall not be chemical waste for the purposes of this Regulation."

1.89 Under Cap. 354, the owner of these companies should be registered as a "chemical waste producer" to the Director of Environmental Protection Department (DEP). Every registered waste producer should follow the Ordinance to store, collect, transport and dispose the chemical wastes.

1.90 Chemical wastes should be disposed of by licensed waste collectors to the specified Chemical Waste Treatment Plant in Tsing Yi or dumped in specified landfill sites, e.g. Pillar Point or SENT landfill sites. The waste should be packed properly and sealed in labelled containers with capacities not exceeding 450 litres unless they have the approval of the DEP. If the storage area is located inside a multi-storey building, there should be no obstruction to any use of escapes or exits from the building. Collection and transportation of chemical waste is controlled by the issue of "trip ticket" to licensed waste collectors. The purpose of trip ticket is specified in Cap. 354 as abstracted in the following:

"The Director may issue any document (in this Part referred to as a "trip ticket"), in such form as he may determine, for the purpose of recording particulars or obtaining information in relation to the production, collection, transportation, reception, transfer, import or export of chemical waste and in such document specify -

(a) *particulars or information to be furnished by a waste producer, waste collector or reception point manager;*
(b) *matters to be certified by any such person; or*
(c) *any other requirement to be complied with by any such person."*

1.91 The Chemical Waste Control Scheme is being upgraded by the Waste Policy Group of EPD. A more detailed classification of wastes will be issued.

2. PENNY'S BAY SHIPYARD

General

2.1 This chapter of the Report describes the layout and function of the existing Penny's Bay Shipyard and explains, in general terms, the basic processes behind the ship building activities. This overview is important as these processes and activities, and the constraints imposed, have to be considered when formulating layouts for the proposed replacement shipyard on the To Kau Wan Reclamation. This is discussed in a later chapter.

2.2 Cheoy Lee Shipyards Limited established their Penny's Bay shipyard in 1963 on reclaimed land leased from the Government. Their shipbuilding business is composed of three main activities: fibreglass or glass-reinforced plastic (GRP) boat manufacture, metal (usually steel or aluminium) boat manufacture, and boat repair and maintenance. In the past, Cheoy Lee manufactured timber boats and, although demand has fallen, they retain the resources and facilities to produce this type of boat. Of the two boat-building activities, Cheoy Lee carry out complete fabrication from raw materials to the finished article and attempt to minimise the number of finished parts or items for the boats that they have to purchase from other suppliers. Cheoy Lee have a tradition of fabricating as many of the parts of each ship or boat as possible: often as far as the smallest screws or bolts. It is an approach they maintain is cost-effective.

2.3 The ships and boats fabricated range from the smallest launches to ocean-going yachts, passenger ferries, tugs and luxury pleasure craft. Cheoy Lee maintain that their flexibility to build all sizes and types of boats and ships has allowed them to meet changing market conditions and demand over the years and that this flexibility has been, and remains, a key factor in the success of their business.

2.4 The boat repair and maintenance aspect of the business includes general repair of boat hulls and superstructures, re-painting, and the repair, or removal for renovation, of marine engines.

2.5 To retain flexibility over time, the Penny's Bay Shipyard layout has evolved and has been modified to suit changing demand. Cheoy Lee increased the Shipyard land area by further reclamation: the hillside being quarried to provide the materials for reclamation. The reclaimed area currently being used by Cheoy Lee Shipyard totals approximately 14 ha; of which about 4.2 ha is occupied by buildings, 2.1 ha for the storage of fibreglass boat moulds and 7.5 ha which comprises general open areas and roads for access, cranes, storage, manoeuvring, slipways and open-air boat fabrication. A photograph overviewing the Penny's Bay Shipyard is given in Plate 2.1. Penny's Bay Power Station can be seen in the upper right hand corner.

2.6 The layout of the Shipyard is shown on Figure 2.1, together with building sizes and areas by type of use. Two views of the Shipyard are shown in Plates 2.1 and 2.2. To give an initial broad impression of land usage, generalised building areas by use are shown below in Table 2.1.

Table 2.1 : Generalised Building Areas by Use

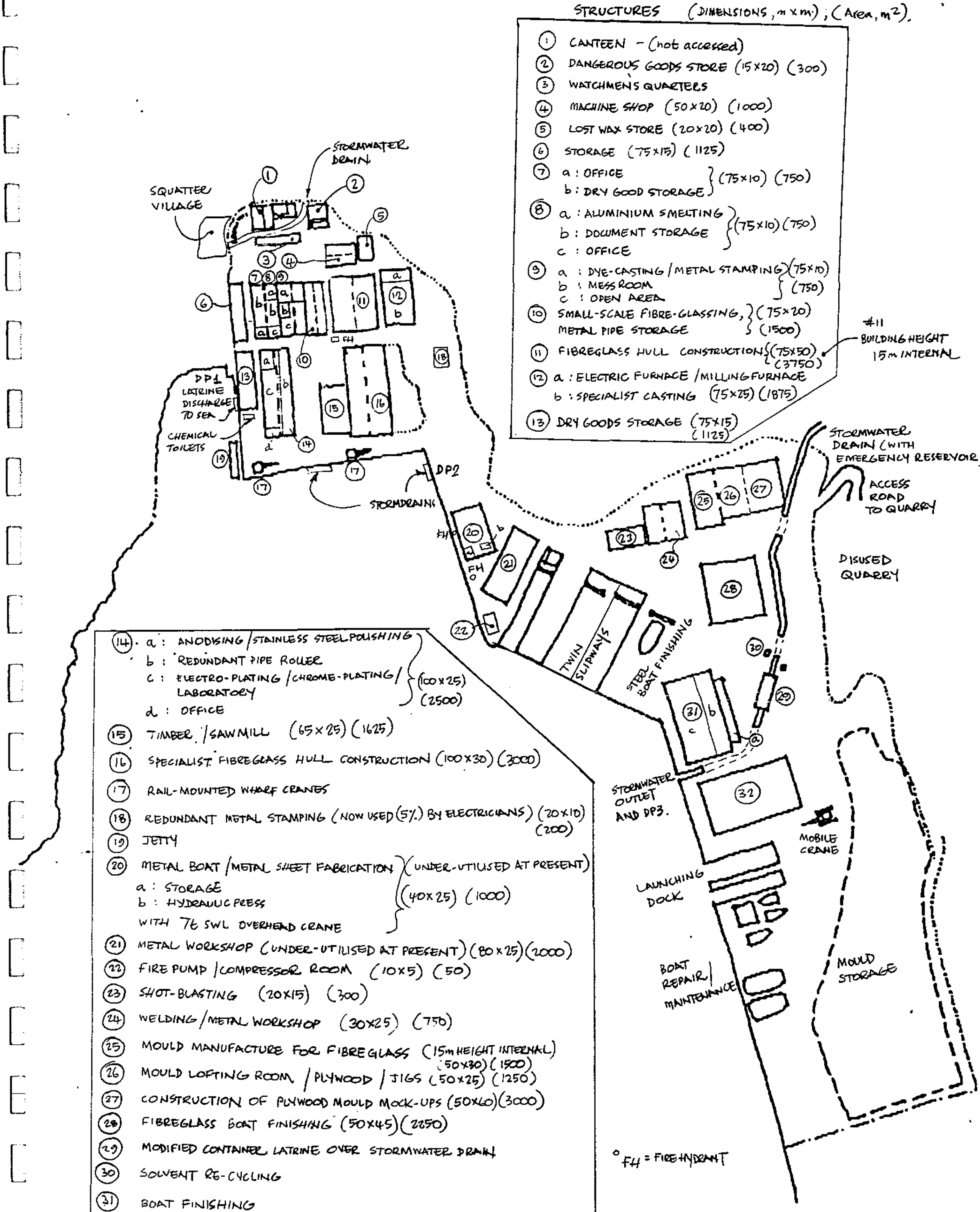
Buildings Use	Approximate area, m^2
Dangerous Goods	300
Document Storage/Offices	1,000
Dry Goods Storage	2,750
Foundry/Casting/Smelting	2,775
Plating	1,000
Metalwork/Metal Sheet fabrication/Shot-blasting	5,050
Mould manufacturing	5,750
Fibreglass boat fabrication and finishing	18,500
Timber, Sawmill	1,625
Canteen, Quarters, miscellaneous other areas	4,000
TOTAL	42,750 m^2

2.7 Before discussing the shipyard processes, activities and layouts in detail, several key points should be borne in mind. Firstly, the nature of business activities at the Shipyard is constantly changing. At any one time, part of the Shipyard may be under-utilised but this may rapidly change: at the time of the site inspection on 30th November 1994 the company was concentrating on fibreglass boat manufacture, with only one steel boat being fabricated. However, at the time of writing of this chapter in mid December 1994, a new aluminium boat has been commissioned and the metalwork and associated areas are now busy.

2.8 Secondly, a significant portion of the site area is occupied by storage areas for fibreglass boat moulds. Moulds are used to form fibreglass boats. These moulds are retained by the company for their standard designs: the moulds are multiple-use and represent a significant capital investment. The cost of producing a mould is a substantial portion of the total capital cost of the boat and to increase profitability the company must spread the mould production cost across several boats.

Plate 2.1

PLATE 2.2



STRUCTURES (DIMENSIONS, m x m); (Area, m²).

1. CANTEEN – (not accessed)
2. DANGEROUS GOODS STORE (15x20) (300)
3. WATCHMENS QUARTERS
4. MACHINE SHOP (50x20) (1000)
5. LOST WAX STORE (20x20) (400)
6. STORAGE (75x15) (1125)
7. a : OFFICE; b : DRY GOOD STORAGE } (75x10) (750)
8. a : ALUMINIUM SMELTING; b : DOCUMENT STORAGE; c : OFFICE } (75x10) (750)
9. a : DYE-CASTING / METAL STAMPING; b : MESS ROOM; c : OPEN AREA } (75x10) (750)
10. SMALL-SCALE FIBRE-GLASSING, METAL PIPE STORAGE } (75x20) (1500)
11. FIBREGLASS HULL CONSTRUCTION } (75x50) (3750)
12. a : ELECTRIC FURNACE / MILLING FURNACE; b : SPECIALIST CASTING (75x25) (1875)
13. DRY GOODS STORAGE (75x15) (1125)
14. a : ANODISING / STAINLESS STEEL POLISHING; b : REDUNDANT PIPE ROLLER; c : ELECTRO-PLATING / CHROME-PLATING / LABORATORY; d : OFFICE } (100x25) (2500)
15. TIMBER / SAWMILL (65x25) (1625)
16. SPECIALIST FIBREGLASS HULL CONSTRUCTION (100x30) (3000)
17. RAIL-MOUNTED WHARF CRANES
18. REDUNDANT METAL STAMPING (NOW USED (5%) BY ELECTRICIANS) (20x10) (200)
19. JETTY
20. METAL BOAT / METAL SHEET FABRICATION (UNDER-UTILISED AT PRESENT); a : STORAGE; b : HYDRAULIC PRESS; WITH 7t SWL OVERHEAD CRANE } (40x25) (1000)
21. METAL WORKSHOP (UNDER-UTILISED AT PRESENT) (80x25) (2000)
22. FIRE PUMP / COMPRESSOR ROOM (10x5) (50)
23. SHOT-BLASTING (20x15) (300)
24. WELDING / METAL WORKSHOP (30x25) (750)
25. MOULD MANUFACTURE FOR FIBREGLASS (15m HEIGHT INTERNAL) (50x30) (1500)
26. MOULD LOFTING ROOM / PLYWOOD / JIGS (50x25) (1250)
27. CONSTRUCTION OF PLYWOOD MOULD MOCK-UPS (50x60) (3000)
28. FIBREGLASS BOAT FINISHING (50x45) (2250)
29. MODIFIED CONTAINER LATRINE OVER STORMWATER DRAIN
30. SOLVENT RE-CYCLING
31. BOAT FINISHING; a : PLUMBING; b : JOINERY (FIRST FLOOR); c : BOAT PAINTING / JOINERY / FINISHING (GRP) } (100x40) (4000)
32. AS 31 (100x40) (4000)

Figure 2.1

SITE SURVEY RECORD
CHEOY LEE SHIPYARD, PENNY'S BAY
LANTAU ISLAND
SNG 30 NOV 1994

2.9 During our inspection it was clear that there are significant restrictions on particular shipbuilding operations. The first of these is height and relates predominantly to fibreglass boat moulding and finishing operations. Currently a minimum of about 15 m interval height is required for the associated buildings. Secondly, there is manoeuvring space. Sufficient space is needed around buildings to allow for the manoeuvring of access cranes loaded with large completed/semi-completed ships and boats. Thirdly, there is a need for proximity to the seawall for access and the loading/unloading of vessels. A length of suitable seawall is required to act as a wharf. A fourth restriction is that several of the operations need to be located at ground level to avoid the need for major cranage, or for safety reasons.

Shipbuilding Processes and Activities

2.10 In this section, a general explanation is given of the processes and activities undertaken at the Penny's Bay Shipyard, with particular reference to the general buildings use classification given in Table 2.1 above. Chemical aspects of these processes are considered in more detail in Chapter 3.

2.11 All goods and materials are delivered to the Shipyard by sea and are unloaded by wharf crane. There is no road access. "Dangerous Goods" required to be part of the finished product or used in the processes are stored at the north end of the Shipyard in a designated building which is away from 'hot' processes involving high temperatures or chemical reaction. These goods include toxic chemicals, organic compounds and highly-flammable goods.

2.12 "Dry Goods" include inert materials used in shipbuilding: namely the glass-fibre sheets used for fibreglass boat manufacture, screws, bolts, metal and some non-flammable chemicals and paints such as can be classed as non-dangerous goods.

2.13 Foundry, casting and smelting activities refer to the use of furnaces to heat, melt and mould metals to make boat fittings. The Shipyard has an electric furnace capable of temperatures up to 1350°C, a milling furnace and an aluminium smelter. Associated with the two furnaces in the same building are specialist small units for the casting of items such as propellers.

2.14 Plating activities include anodising and electro-plating. This is where boat metal fittings such as handrails are dipped in charged chemical solutions to be 'plated' or coated with a protective or decorative layer, such as chrome. Final polishing activities are also included under this activity.

2.15 Metalwork, metal sheet fabrication and shot-blasting activities are those activities primarily associated with the production of large metal sections which are eventually welded together to form the vessel. Also included in this section are the welding activities. Shot-blasting is a specialised activity in which iron shot is fired at metal faces to remove surface layers such as paint or rust, exposing a clean surface for finishings such as paint. Shot-blasting requires a single-use segregated area.

2.16 Table 2.1 shows that the greatest floor area is required for the fabrication of fibreglass boats. Figure 2.1 also notes that this form of boat construction also requires vertical heights within buildings to about 15 m. Several activities have to be undertaken sequentially in the fabrication of a fibreglass boat. Upon receipt of a design from a naval architect, plans for the boat mould are drawn out full-scale on a large floor-mounted blackboard. This process is known as "lofting". Using timber, a full-scale mock-up of the boat is made so that a mould can be made around it. Usually the timber mock-up may be in several large sections: usually one for the hull and the other for the superstructure. Using glass-reinforced fibre sheets and resin, mould pieces are made around this timber mock-up. The mould is then assembled from individual pieces. By using glass-reinforced fibre sheets and resin, the boat is then fabricated inside the assembled mould.

2.17 Once the boat, or large sections are complete they are extracted from the mould and transported to a finishing building. The moulds are retained since they can be used again. In the finishing building, the boat is completed by painting, the addition of all fixtures and fittings e.g. seats, handrailing, metal cleats, capstans, and the marine engine. Associated with this finishing building are joinery and plumbing sections where other fittings are completed before they are fixed to the boat or ship. The completed vessel is then transported by crane from the finishing building for launching. The finishing buildings are conveniently located adjacent to the seawall to aid this activity.

2.18 It should also be noted that the fibreglass mould and boat construction activities produce noxious odours and that Cheoy Lee rely, quite successfully, on natural ventilation through large door openings to maintain a safe working environment.

2.19 Metal boat finishing tends to take place in the open-air: metal plate being welded together to complete the vessel, which is then painted and finished in a similar manner to the fibreglass vessels.

2.20 In view of the extent of fibreglass boat fabrication activities, a more detailed breakdown of areas by use is given in Table 2.2:

Table 2.2: Building Areas for Fibreglass Boat Production

Buildings Use	Approximate area, m^2
Mould "lofting"	1,250
Timber mock-up construction	3,000
Mould manufacture	1,500
Small-scale fibreglassing	1,500
Fibreglass boat construction	9,000
Fibreglass boat finishing	8,000
TOTAL	24,250 m^2

2.21 Detailed flow diagrams supplied by Cheoy Lee Shipyards showing the boat/ship manufacturing and repairing processes are given on Figures 2.2 to 2.4.

Layout of Facilities

2.22 Despite the effect of the addition of further buildings and structures over time, the Shipyard can be divided into four broad geographical areas matching particular stages of boat fabrication.

2.23 At the head of Penny's Bay, partially on reclaimed land, the first area is composed of storage, office and administration, and general preparation facilities. A jetty provides for personnel access by boat: there is no road access to the site so all access for personnel and goods is made by sea. Two rail-mounted travelling cranes, adjacent to the 150 m long seawall in this area, are used for the unloading of goods.

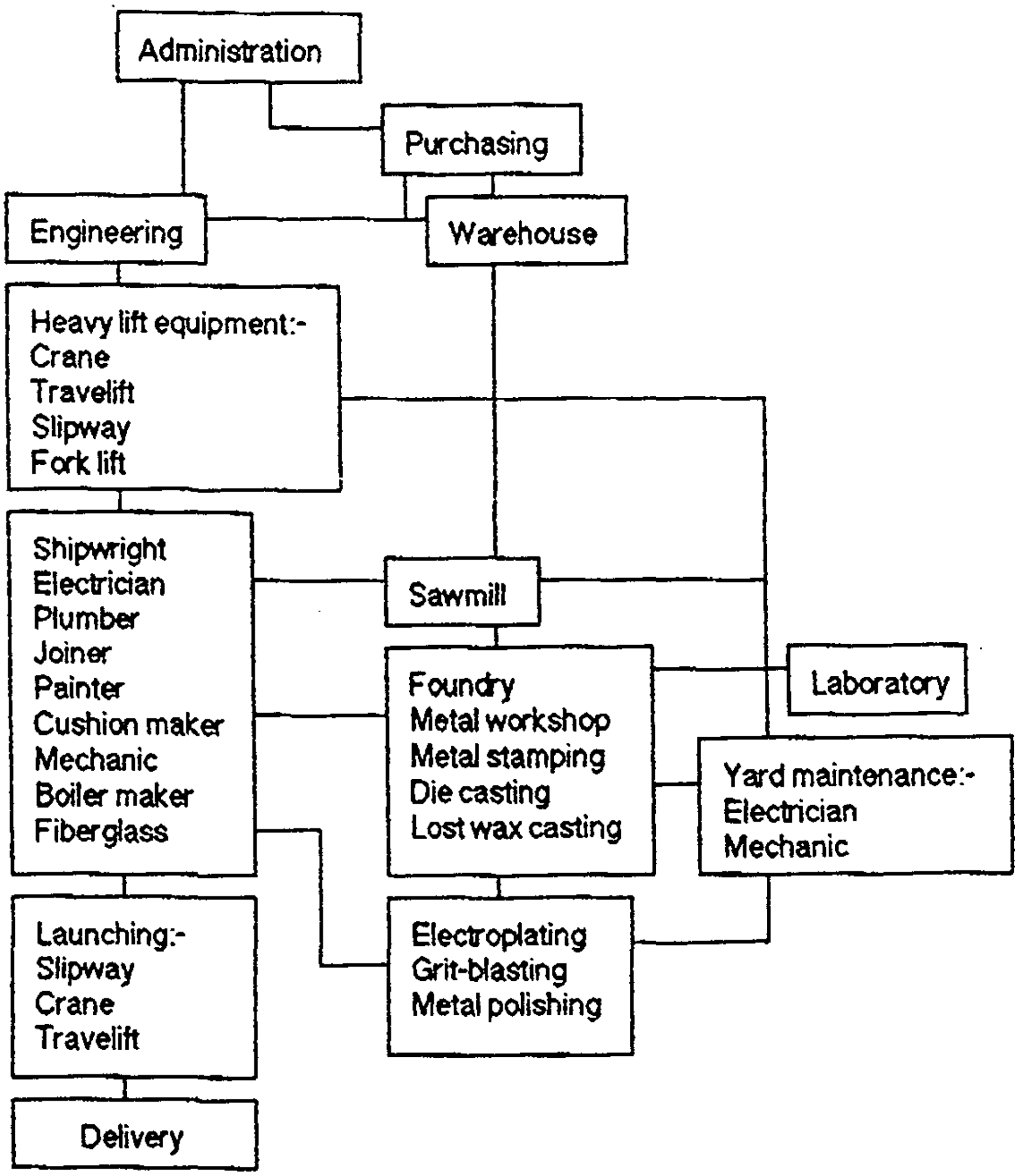
2.24 The Shipyard canteen and watchman's quarters are located at the northern end of area one, together with the Dangerous Goods Store which is isolated from the "hot" processes buildings. Several buildings are designated for single-use but many are compartmentalised and several diverse activities take place under one roof. Dry goods storage, offices and document archives are located on the western side of area one, while small-scale activities such as aluminium smelting, dye-casting and small-piece fibreglassing are located in the centre of the area. The eastern sector is composed of a machine shop, a lost wax store, a timber mill, the foundry and two large, open-plan steel frame buildings for fibreglass boat mould production. These two buildings require significant headroom: one of the buildings has a clear internal height of 15 m.

2.25 The second area is located to the south of area one and is concerned primarily with metalwork preparation, shotblasting and open-air metal boat fabrication, although there are three mould manufacturing-related buildings to the east. Twin slipways for boat launching are also provided. The area is currently under-utilised due to Cheoy Lee's present concentration on fibreglass boat manufacture.

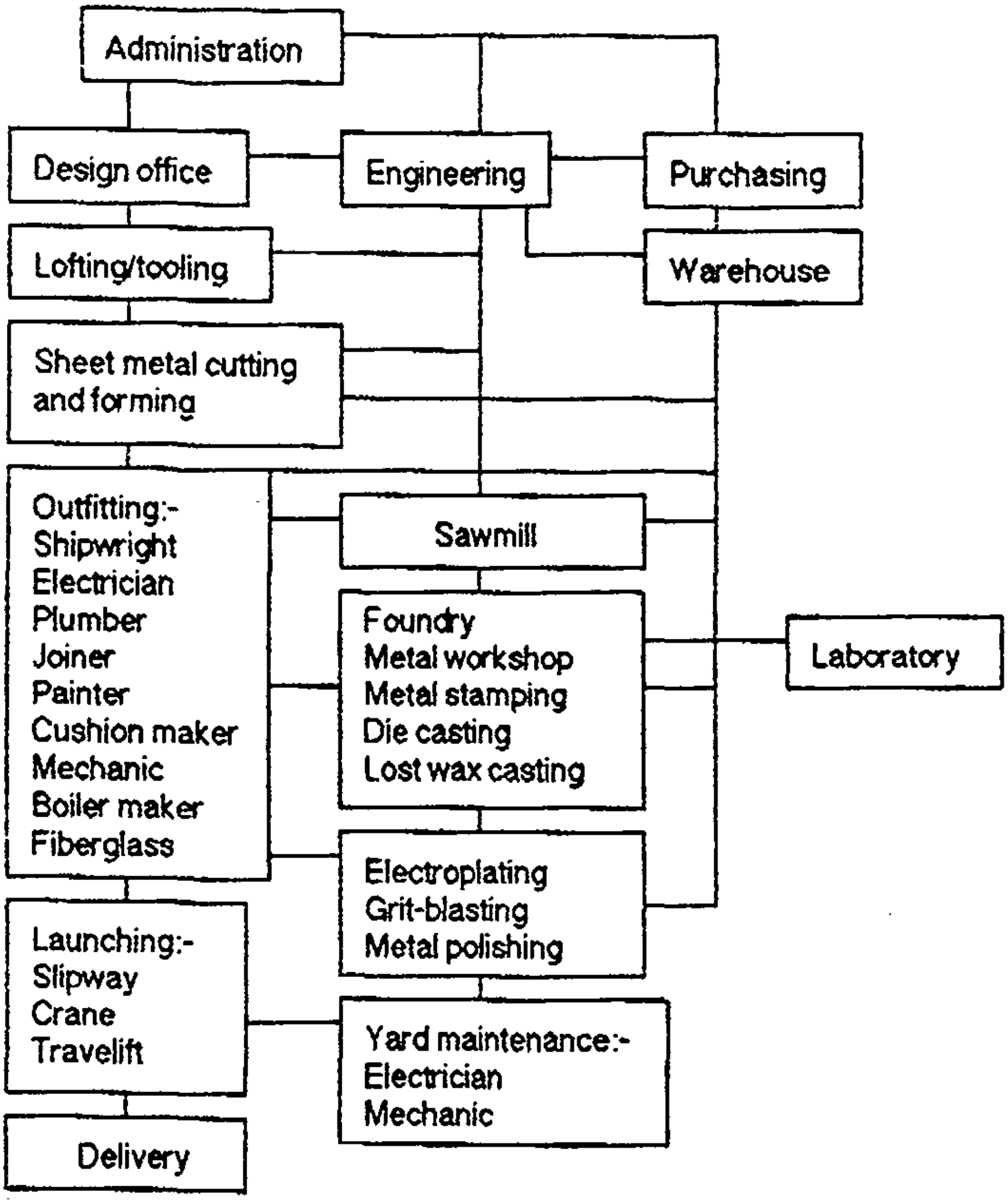
2.26 The third area is characterised by three large buildings, in contrast to the large number of small units in area one. In this third area, to the south of area two, final assembly of fibreglass boats is carried out, including plumbing, joinery, painting and other finishing activities. Cranage is provided in the form of mobile cranes along the seafront for transportation and launching of the finished boats. A specialist launching dock is also provided using twin sheet-piled inlets.

2.27 The final area, area four, to the south of the launching dock, is used for mould storage and for boat repair and maintenance.

2.28 Seawall of approximately 400 m is provided for areas three and four.

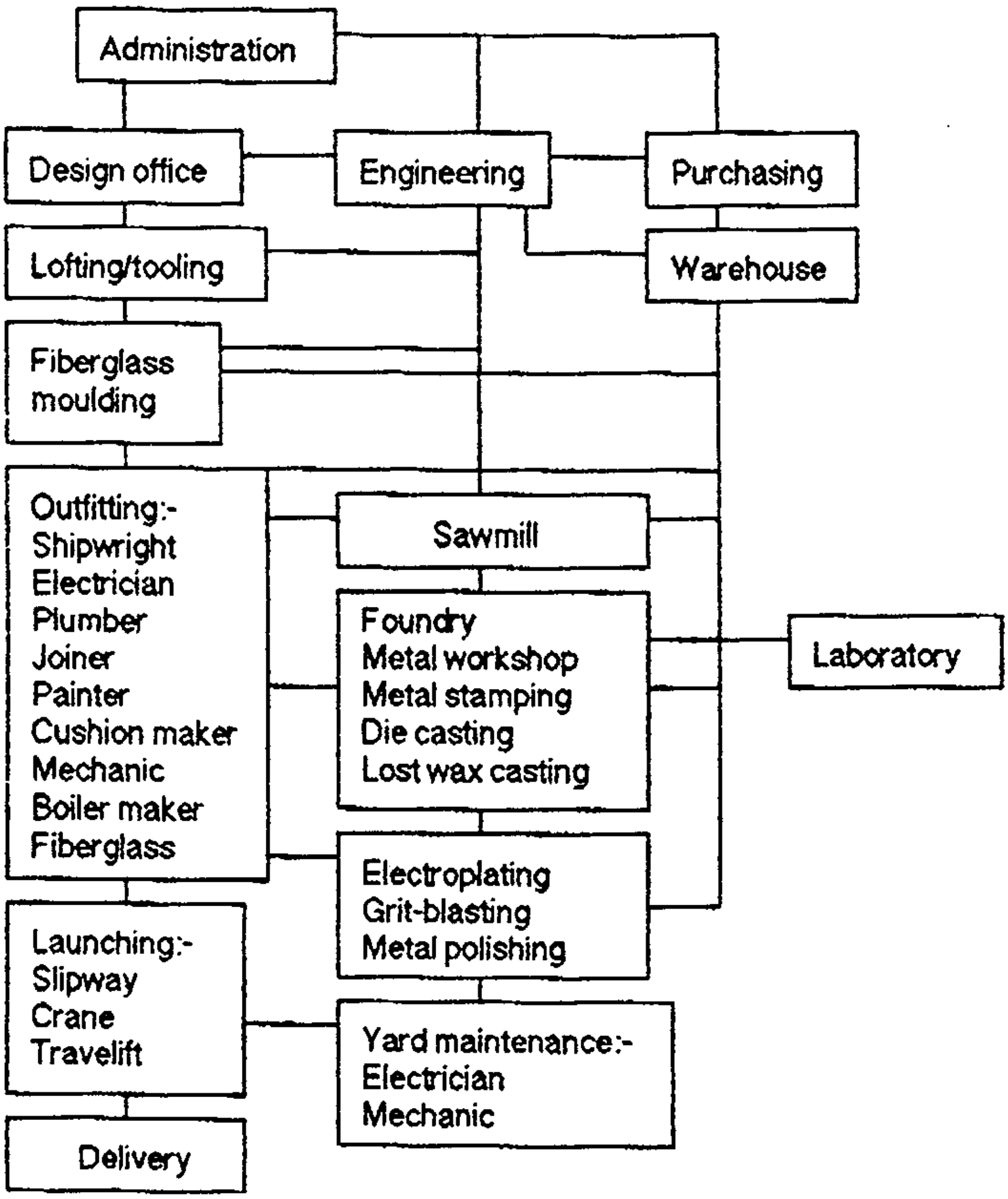


TO KAU WAN OPERATIONAL EIA VESSEL REPAIR / SERVICE FLOW CHART (provided by Cheoy Lee Shipyards Ltd.)	BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 CONSULTING ENGINEERS 賓尼	Date DEC 94	Scale
	土木工程署 Civil Engineering Department	Initial PC	Figure No. 2.2



Note: All scrap metal will be returned to foundry for recycling.

TO KAU WAN OPERATIONAL EIA	BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 CONSULTING ENGINEERS 賓尼	Date DEC 94	Scale
TYPICAL STEEL VESSEL PRODUCTION FLOW CHART (provided by Cheoy Lee Shipyards Ltd.)	土木工程署 Civil Engineering Department	Initial PC	Figure No. 2.3



Note: All scrap metal will be returned to foundry for recycling.

TO KAU WAN OPERATIONAL EIA TYPICAL GRP VESSEL PRODUCTION FLOW CHART (provided by Cheoy Lee Shipyards Ltd.)	BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 CONSULTING ENGINEERS 賓尼	Date DEC 94	Scale
	土木工程署 Civil Engineering Department	Initial PC	Figure No. 2.4

Site Drainage, Sewage Disposal and Water Supply

2.29 Stormwater from the surrounding catchment is collected and channelled through stormwater culverts across the reclamation and into Penny's Bay. Runoff from buildings is generally discharged by downpipes into channels around each building before being collected into open channels which discharge into the sea. The Shipyard also relies on sheet discharge across the reclamation into the bay. Cheoy Lee Shipyards also collects and stores part of the surrounding catchment runoff in a reservoir within one of the stormwater culverts to act as an emergency, non-potable supply. This supply may also be used in certain fabrication processes where the quality of the water is not of prime importance.

2.30 We understand that all potable water is imported into the site by Cheoy Lee Shipyards and that there is no connection to a piped supply.

2.31 Seawater is used for fire-fighting services. A small seawater pumping station provides a supply for a fire services main and associated hydrants.

2.32 Sewage treatment and disposal from the Shipyard is governed by a Water Pollution Control Ordinance Section 23A Licence to discharge into Hong Kong waters. CLS's Penny's Bay operation is licensed by EPD for three discharge points. Very little wastewater is discharged. Discharge Point 1 (DP1), near the dry goods storage area 13 in Figure 2.1, only deals with sewage disposal after treatment in a septic tank and a soakaway pit.

2.33 Discharge Point 2 (DP2) is licensed for a maximum of 1.5 m^3 of wastewater/day from "Electroplating, Laboratory, Ship Manufacturing and Sewage from Toilet". The effluent pretreatment processes are described as "rinsing tank, septic tank and soakaway system". The limitations on discharge are lower than the standards for inshore waters.

2.34 Discharge Point 3 (DP3) is near buildings 31 and 32 for "wastewater from ship manufacturing": cooling tower and solvent recycling apparatus. The limitations on discharge are identical to DP2: 1.5 m^3/day and tighter standards than the TM standards for inshore waters for toxic metals, iron and phosphorus.

2.35 These volumes would suggest that CLS at Penny's Bay is close to being a zero effluent site.

3. CURRENT SHIPYARD OPERATIONS AND FACILITIES - CHEMISTRY REVIEW

3.1 The current activities at the Penny's Bay site will essentially be transferred to the new To Kau Wan site. Due to space restrictions, some of the older equipment and equipment that is used only infrequently will be disposed of. All current operations will be continued at the new site although some will continue in a much reduced fashion.

3.2 The current shipyard operations as they are carried out at the Penny's Bay site are listed below. These operations were observed and investigated in detail during two site visits conducted on the 12 October and the 30 November and a meeting with Mr Lo Shu Yang and Mr Martin Lo, Owner/Directors and Production Manager at Penny's Bay. During the first visit a general inspection of the operation was conducted with a view to gain an overall impression of the operation and processes involved in ship production. During the second visit a more detailed inspection was carried out with the help of Mr Martin Lo. The specialists involved in this second visit consisted of three environmental scientists with majors in chemistry, an engineer, a waste water specialist, a noise assessment specialist and a visual impact consultant. All operations and processes were investigated thoroughly and the general impression during this and the previous visit was that the shipyard was very environmentally acceptable. There was very little visual waste on site, the water in the bay showed no obvious visual signs of contamination, even at the re-fuelling station and the repair yard areas where visual pollution from oil and grease would be visible. All operation and construction sheds were very clean and generally Cheoy Lee Shipyard (CLS) appeared to be taking all necessary environmental and health and safety measures. A description of the processes which potentially may have the greatest environmental impact are listed below. Extensive background data on the various chemical substances has been collected by the EIA team particularly from USEPA sources (Aquire 1986, ASTDR 1989, ASTDR 1989, ASTDR 1990, MSDS 1986). Summaries of this data are included.

Saw-mill

3.3 The sawmill currently occupies a very large area in an open-ended shed approximately 1,600 m^3 and is used to produce timber of various shapes and sizes for ship mould production and joinery. Raw timber (logs) are brought in and all cutting and finishing operations are conducted on site. A large multi-band saw cuts the timber into planks and the planks are then cut to the required size using a circular saw.

Refuelling Station

3.4 Near the jetty at the main site entrance, there is a boat fuelling station. Other fuelling stations are situated near the launching slip-ways. These stations carry marine diesel fuel. During the two site visits there was no evidence of excessive spillage from any of the fuelling stations but there is a possibility that there will be or has been some leakage and spillage of fuel into the environment, in particular into the water nearby.

Fibreglass (GRP) Ship Mould Production

3.5 One of CLS's major business is the production of Glass Reinforced Plastic (GRP) boats, often commonly referred to as fibreglass boats. The boats are made by building up layer upon layer of fibreglass cloth into a fibreglass mould and applying an epoxy-resin mixture. The resin hardens and a very strong and flexible material is formed. The GRP mould is originally made by laying fibreglass cloth over a wooden replica of the intended boat hull and applying epoxy resin. Separate moulds may be needed for the hull and the superstructure. The wooden moulds are used once and the wood recycled where possible. The resulting fibreglass mould is fixed within a sturdy wooden frame and can be reused many times. There is a large mould storage area on-site and boats can therefore be built very quickly from existing designs.

3.6 The GRP used for the mould construction and for the construction of the hulls consists of woven glassfiber cloth of different thickness and weaves which is embedded in a polyester resin. The resin is an unsaturated polyester resin with styrene monomer which is polymerised by the addition of methyl ethyl ketone peroxide which acts as a catalyst. The catalyst acts to dramatically speed up the polymerisation reaction whereby the styrene monomers and the mixture of polyester monomers link together to form longchain molecules. The polymerisation occurs through a free radical reaction resulting in a polymerisation reaction between the styrene and the polyester. The exact nature of the polyester is unknown as each manufacturer has it's own special propriety formulation. Excess resin is cleaned off using acetone solvent and any fibreglass fibres are swept up and stored for disposal.

3.7 The chemicals involved in GRP ship mould production are listed below. A brief description of the potential health hazards is included as an indication of the potential environmental impact these chemicals may have on any Air Sensitive Receivers (ASRs) at the To Kau Wan site. The Hong Kong Labour Department regularly carries out health and safety inspections and hence it is assumed that all the measured chemicals have been within the recommended levels as set out in the publication "A Reference Note on Occupational Exposure Limits for Chemical Substance in the Work Environment, Labour Department Hong Kong 1992" (LD 1992).

Styrene

3.8 Styrene is a colourless oily liquid with an strong distinct aromatic odour. It is flammable, having a flash point of 31.1°C, and explosive above 65.5°C producing poisonous gases. Styrene has an odour threshold of 0.08 ppm. As mentioned above, most of the free styrene is polymerized, only small quantities escaping into the air.

3.9 The Hong Kong Labour Department recommends exposure limits set out under the United States Department of Labour's Occupational Safety and Health Administration (OSHA) standards with an airborne permissible limit (PEL) of 50ppm over an 8 hour shift and 100 ppm not to be exceeded during any 15 minute period. The US National Institute of Occupational Safety and Health (NIOSH) recommend 50 ppm averaged over a 10 hour period and 100 ppm during any 15 minute period.

3.10 Styrene has been identified as causing cancer at toxic levels. It is a mutagen, causing genetic mutations and repeated exposure can cause memory loss, slowed reflexes, headache, drowsiness and numbness. Styrene must therefore be used in a well ventilated environment and direct exposure must be avoided. CLS is regularly inspected by the Hong Kong Labour Department so that OELs can be checked.

3.11 Styrene has an acute short-term and long-term toxic effect on animals, birds and fish with effects seen within two to four days. However, styrene is only moderately soluble in water and has a half life of less than 2 days. About 99% of the free styrene will eventually end up in the air and the remainder in water, soil and sediment.

Polyester resin

3.12 The exact nature of the polyester resin is unknown with each mixture being proprietary for each manufacturer. Polyester resin is dissolved in styrene and so the regulations and hazards pertaining to styrene will apply.

Methyl ethyl ketone peroxide (MEKP)

3.13 MEKP is highly flammable and is explosive with a flash point of 82°C. There are no standard exposure limits for MEKP, but at very high levels methyl ethyl ketone (MEK) has been identified as an irritant and possible teratogen (an agent that causes malformation of embryos). Care should therefore be taken in it's handling, avoiding all contact if possible. The Hong Kong Labour Department recommends a ceiling exposure limit, the maximum permissible concentration at any time, of 0.2 ppm for MEK and carries out regular checks to ensure compliance with these limits. MEKP should be used in a well ventilated environment.

Acetone

3.14 Acetone is a highly flammable colourless liquid with a sweet odour. It has an odour threshold of 13 ppm. US OSHA PEL is 1,000 ppm averaged over an 8 hour shift. NIOSH recommend 250 ppm over 8 hours whilst the American Conference of Governmental Hygienists (ACGIH) recommend 750 ppm over 8 hours and short term exposure limit (STEL) of 1,000 ppm. The Hong Kong Labour Department recommends exposure limits based upon ACGIH and conducts regular inspections to ensure compliance. Acetone has been classed as an irritant and causes breathing problems and dizziness at high levels and excessive dryness of the skin. Long term exposure to toxic levels can cause liver and kidney damage. Acetone should therefore be used in a well ventilated environment and skin contact should be avoided.

Glass fibres

3.15 Glassfiber fibres may pose a cancer risk in the same manner as asbestos (Rachel 1988) although no regulatory agency has set limits or recommendations for exposure. Glassfibers are a known skin irritant and due to the unknown health hazard involved in their handling, care should be taken. ACGIH is currently investigating glassfibers and the Hong Kong Government is considering regulating glassfibers as a chemical waste.

3.16 Due to the health hazards and the flammability of the above chemicals, all work is currently carried out in well ventilated sheds preventing the buildup of toxic fumes. Only small quantities of chemicals are kept in the working area at any one time. CLS currently use about 32,000 litres of polyester/styrene resin every year, ordering around 70-80 200 litre drums of resin every 6 months which is stored in the special flammable solvent store until needed. They use approximately one drum of acetone every 3-4 months (about 200 litres). Glassfiber matting is also ordered in bulk, one container load every 3-4 months, and stored in the dry goods storage shed.

3.17 During two site visits there was no, or very little, styrene odour, the most abundant chemical used in GRP production, outside of the buildings in which fibreglass work was being carried out. There was very little sawdust produced from the joinery work and any excess was swept up for later disposal. Due to the woven nature of the fibreglass, there was very little waste fibres. Any cloth off-cuts were reused and applied on some other part of the mould. The small amount of waste glassfiber/ fibres produced were swept up and collected in bins for disposal.

Lofting

3.18 Lofting is the process whereby blueprints are turned into full-scale templates which are then used to fabricate the various sections needed to construct either the wooden moulds or the steel ships. The lofting shed is basically a very large open shed with a wooden floor painted with blackboard paint. There is no direct environmental impact from this operation except in the re-painting of the floor. This only occurs infrequently as more than one design can be laid out at any one time.

GRP Ship making

3.19 GRP ships are made in a very similar way to that used to produce the moulds. First a layer of resin is applied to the mould, called a Gel Coat, which provides a smooth protective layer for the GRP laminate. For decorative purposes, this gel coat usually has a coloured dye added. Next, fibreglass cloth is layered into the mould and resin applied to produce a laminate in a process called Hand Layup. The materials are then compressed or densified with a roller to eliminate entrapped air and to spread the resin evenly. This process is illustrated in Plate 3.1. Many layers may be needed to produce the finished ship. During this process, the GRP may also be coloured by using different resins which have had a coloured dye mixed into them. Reinforcing structures may need to be added, especially for the superstructure, and this is accomplished by using a process called Encapsulation. Blocks of high density polyurethane foam or plywood are placed in strategic areas of the hull or superstructure where additional strength is required and GRP layered over the top forming a box like structure. This results in a very strong structure which also provides additional flotation in the event of hull rupture. The chemicals and hence the environmental and health hazards are the same as for the mould building described above.

3.20 All GRP ship building is carried out in large open sheds or in a shed with a special controlled environment in which temperature and humidity are tightly controlled. This shed is used to produce ships to Government specifications.

3.21 During two site visits the two sheds were both in operation and, like the mould building sheds, the smell of styrene was only noticeable inside the shed. The operation is regularly inspected by the Hong Kong Labour Department to ensure compliance with occupational health and safety levels.

Steel Ship Making

3.22 The construction of steel ships involves many different processes to that of GRP ship construction. Much of the work is carried out in a large open yard near the slipways illustrated in Plate 3.2. Fabrication of the metal plates is carried out in two large open sheds near to the slipways and a third shed behind the shotblasting shed. In the past, CLS constructed all its metal ships from raw materials and had a rolling shed to produce steel sheets. These steel sheets were then primed using various metal based paint primers containing either lead or zinc. Today, the rolling shed has gone and CLS buys most of their steel plates pre-cut and pre-primed and therefore uses very little lead based primer. The steel sheets are formed in two sheds, the one nearest the slipways has a large hydraulic press which is used to form curved sections and the one behind the shotblasting shed is used for small scale fabrication and moulding involving cutting, grinding and welding. All the steel sheets need to be cut into special shapes and the templates for these are drawn in the lofting room. During actual construction of the steel ships, as many as 50-100 men may be working in the same area at any one time. The processes involved include welding the steel plates together, cutting, hammering and chipping of the welds. The potentially most noisy operation is the chipping which uses a pneumatic chipper much like a pneumatic road drill to chip away excess metal from welds. This process has recently been superseded by thermal cutting devices.

Laboratory

3.23 There is a small on-site laboratory which is used to measure the quality of metals formed in the foundry and to monitor the quality of the solutions and effluent from the electroplating and anodising operations. There are two main instruments in the laboratory, an atomic absorption spectrophotometer (AAS) for measuring the quality of metals and the electroplating and anodising solutions, and a carbon analyzer for determining the quality of steel. There is only one chemist and the quantities of chemicals used are very small.

Foundry

3.24 There is a large foundry on site which consists of one large induction furnace which operates at 1650°C, three smaller gas fired crucible furnaces and a large annealing furnace housed in a single open plan shed. Plate 3.3 shows one of the gas fired crucible furnaces. This shed is also used for sand moulding and centrifugal moulding (for ships propellers). In another area, next to the machine shops and the foundry there is a lost wax moulding area which also has a small gas fired crucible furnace which is used to melt copper and bronze. In another nearby shed there is a die-casting facility which also has a small gas powered crucible furnace.

Plate 3.1 : GRP Ship Making Process

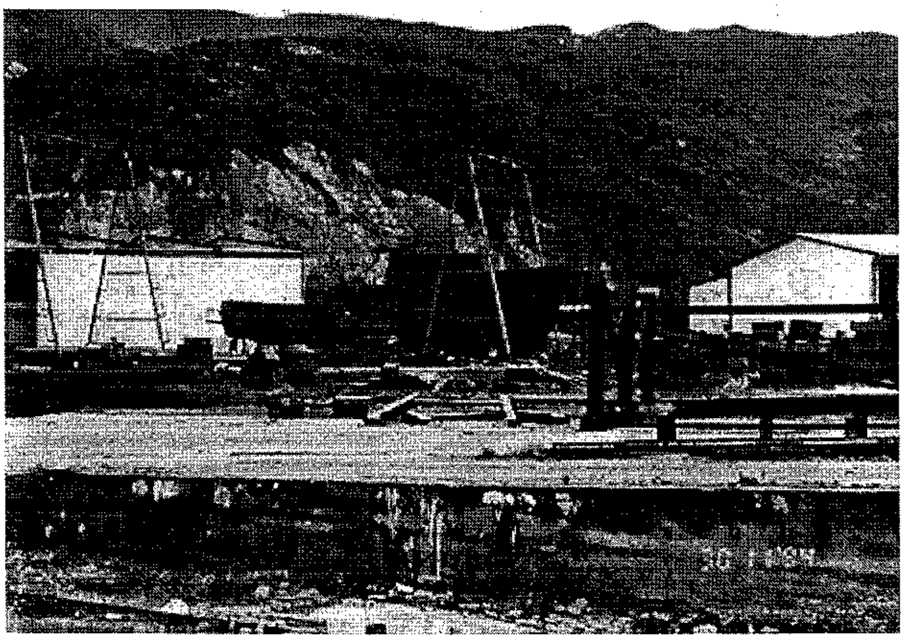


Plate 3.2 : Steel Ship Making Process

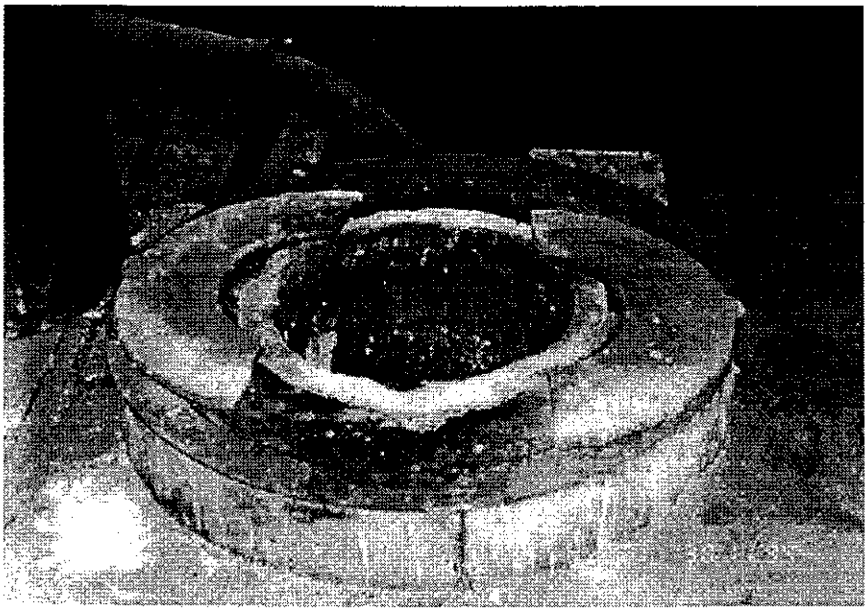


Plate 3.3 : Gas-fired Crucible Furnace

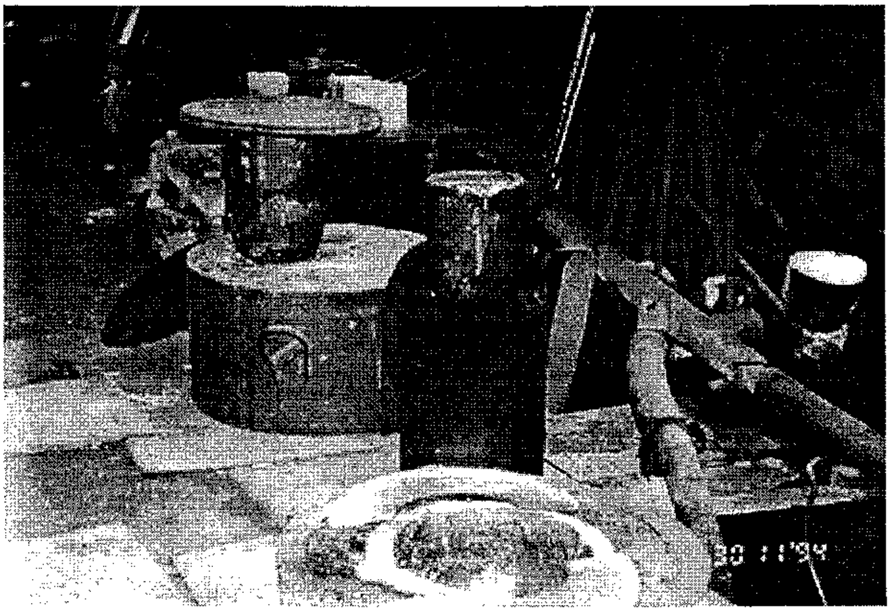


Plate 3.4 : Foundry - Area near the Crucible

3.25 As can be seen from Plate 3.4, the area around the crucible and furnaces is very clean. Plate 3.5 shows two workers forming sand moulds. The whole area appeared to be very well maintained and cleaned. All slag from the steel furnace is collected in large steel drums until sufficient quantity has been collected for disposal. Slag from other metals, such as copper, is collected and sold for recycling to China. All spilt sand is swept up and recycled as is the sand used for the moulds. Plate 3.6 shows a worker cleaning the sand ready for re-use.

3.26 The main metals used include iron, steel, aluminium and bronze (an alloy of copper and tin, often confused with brass which is an alloy of copper and zinc although the names are often interchangeable). Iron and steel are used in the production of the steel ships whilst bronze is used to manufacture the propellers and some fittings. Aluminium is used for the manufacture of various fittings.

Metal Moulding

3.27 Almost all of the metal parts used in CLS's ship construction are made from raw materials on site. Currently, CLS employ three main processes for metal moulding, the lost wax process, sand moulding using fine "Zirconite Sand A" and die-casting. The lost wax process is used for aluminium, copper and bronze moulding whilst the sand moulding is used for iron and steel and die-casting for aluminium. Raw metals (e.g. steel, aluminium, copper) are either imported or obtained from on-site scrap. All scrap metal is recycled and the final quality of the metal checked by the in-house laboratory. All wax and sand are also recycled where possible although there is some loss of wax and sand over time but this is very slow and does not appear to be a problem. Each process is described in more detail below.

Lost Wax Moulding

3.28 The lost wax moulding process involves creating a wax replica of the intended item and packing it in very fine zirconite sand (an inert sand). The wax is then melted and poured off for re-use and the molten metal pored in to replace it. When the metal has cooled, the moulded object is broken away from the sand which is also kept for recycling. The metal parts are then sent to another area for finishing which may involve machining, electro-plating, anodising or polishing. All wax and sand is recycled although there is some loss of wax over time due to vaporization and spillage. The sand and wax spilt on the floor are swept up and, if they cannot be recycled, are stored in bins for disposal. Cheoy Lee Shipyards Ltd management strongly discourages waste.

3.29 The waste slag produced during the foundry process is collected in large steel drums until sufficient quantities have been accumulated at which point it is sold to companies in China where the remaining metal is extracted and recycled.

Sand Moulding

3.30 Sand moulding is carried out in the foundry shed. A large area of the foundry has been turned into a sand pit which is filled to several feet in depth with very fine inert zirconite sand. Using a master die, a hole is dug in the sand and the master die placed into the hole. Sand is built up around the die and packed down hard. The die is then removed leaving a mould into which the molten metal is then poured.

3.31 Any excess metal which is spilled during pouring is collected after cooling and returned to the furnace for recycling. All sand used is recycled for further use (see Plate 3.6). The sand has a very low dust concentration and during the two site visits there was no visible dust from the moulding process. After repeated use the sand may build up high levels of metals but these will be primarily iron and aluminium with some copper and tin. If sand is deemed unsuitable for recycling it is collected in bins for disposal.

Die Casting

3.32 Die-casting involves moulding metal in a similar manner to injection moulding for plastics. Molten metal from the small crucible furnace (shown in Plate 3.7) is injected under pressure into a preformed metal mould and allowed to cool. Because the mould is made of metal it can be reused many times. Any spilt metal is recycled in the same manner as for the other processes and waste slag is collected and sold for recycling.

Electroplating and Anodising

3.33 CLS currently has both an electroplating and an anodising operation which are housed in separated areas of the same building. The open middle area of the building is used for polishing and finishing the plated and anodised metals. At the far end, next to the electroplating room is the laboratory. The plating process is used for non-aluminium metals and usually involves either chromium or nickel plating whilst aluminium is anodised. A brief description of each process and the chemicals used in each is outlined below:

Nickel Plating

3.34 For the majority of non copper based metals, a thin layer of copper must first be applied which forms a base for the nickel plating. The general process is described below:

a) The metal parts are first polished and then degreased by placing in a tank of sodium hydroxide solution.

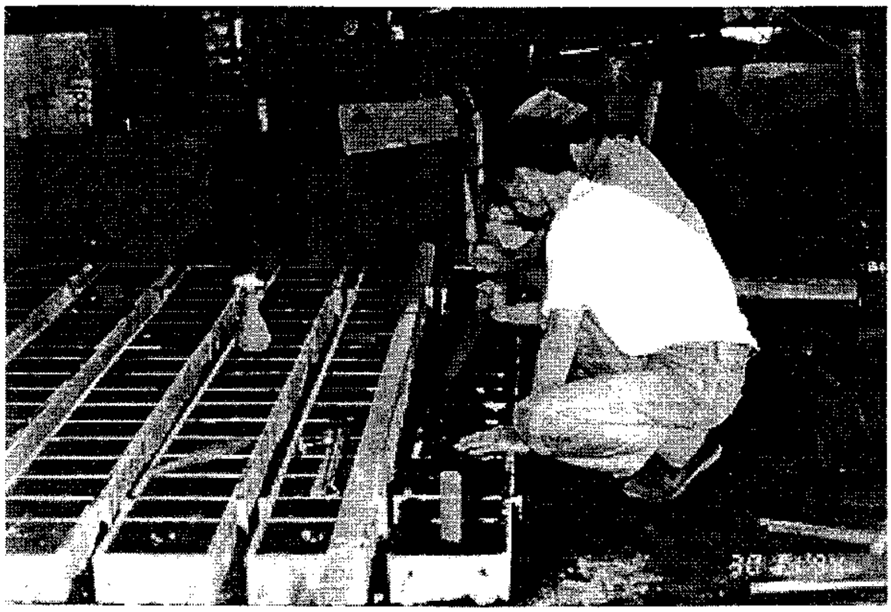


Plate 3.5 : Sand Moulding

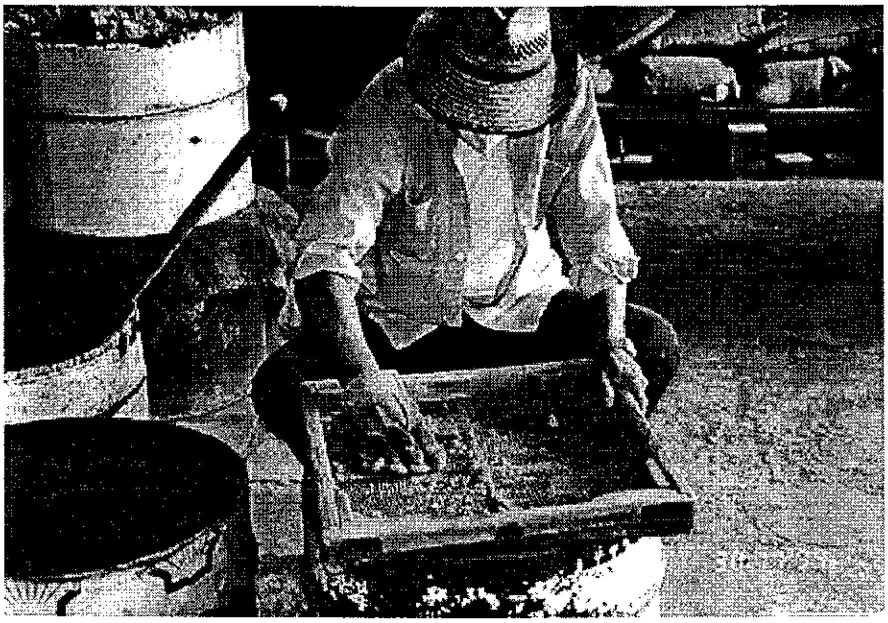


Plate 3.6 : Sand Recycling

b) The degreased metal parts are then placed in an alkaline electrolysis bath to remove any oxides before being soaked in dilute sulphuric acid.

c) The metal parts are then triple rinsed with water before plating can begin.

d) When clean, the metal parts are placed in an electrolysis bath containing a solution of copper cyanide, sodium cyanide and sodium carbonate for primary electroplating whereby a fine layer of copper is deposited.

e) After primary electroplating, the metal parts are triple rinsed with the first rinse tank removing the copper cyanide solution which is then recycled.

f) After cleaning, the metal parts are then placed into the nickel plating tank containing a concentrated solution of nickel sulphate and nickel chloride together with a commercial brightening agent, an organic compound of which the exact formulation is a trade secret. When the plating is completed to the required thickness the plated parts are removed, washed and sent for polishing.

Chromium Plating

3.35 Chromium plating is similar to nickel plating in that all non-copper based metals must first have a layer of copper deposited before further plating can take place. The process is outlined below:

a) The metal items are washed, cleansed and copper plated as in a) - e) for nickel plating above.

b) The copper plated metal items are then placed as the anode into a chromic acid resistant tank which is connected to the cathode. The bath contains a hot solution of chromic acid in concentrated sulphuric acid. When the plating is completed to the required thickness the plated parts are removed, washed and sent for polishing.

Aluminium Anodising

a) The aluminium items are first polished and cleaned as above.

b) The items are then "activated" in dilute nitric acid, washed with water and oxidised in a solution of phosphoric acid. The metal parts are connected to the cathode and a thin layer of aluminium oxide builds up on the surface. After oxidising, the aluminium is washed in water and may be "sealed" by being placed in a bath of nickel sulphate although this does not seem to be a common process at CLS. The aluminium may then be coloured using various organic coloured dyes before being finally rinsed and dried.

A full list of the chemicals used in the plating and anodising process are listed below. Not all of these chemicals are used at the same time and different chemicals may be substituted in different processes depending upon the exact nature of the plating:

Copper Plating

- Copper cyanide
- Sodium hydroxide
- Sodium carbonate

Nickel Plating

- Nickel sulphate
- Nickel chloride
- Boric acid

Chromium Plating

- Chromic acid
- Sulphuric acid

Aluminium Anodising

- Phosphoric acid
- Nitric acid
- Nickel sulphate
- Sodium hydroxide

3.36 Various other chemicals may be used, such as trisodium phosphate of sodium carbonate during the alkali wash or ammonia, to neutralise the waste water.

3.37 Of the above chemicals, cyanide and hexavalent chromium are probably of most concern due to their known acute toxicity. The other chemicals are either very corrosive such as the acids and alkalines or toxic such as the nickel and copper solutions. Plating and anodising is carried out as a batch process. All of the plating and acid baths do not discharge any waste into the drainage system but are either continually topped up with fresh chemicals or, when the potency of the solution falls below that required, poured into a container for disposal.

3.38 The washing tanks are often in series of two or three. For the copper plating the first tank is only to remove and recover the copper cyanide solution. The triple wash tanks are linked in series and only the effluent from the final tank in the series is discharged. The waste discharges from each of the washing process are collected in a large underfloor "diffuser" before being discharged to the drainage system. The drainage discharge is continually monitored for pH, nickel, copper, iron, cyanide and phosphorus by the in-house laboratory so as to comply with the discharge regulations specified in their Water Pollution Control Ordinance licence. It is believed that CLS has met all of the discharge limits imposed by their licence.

Metal Stamping Shop

3.39 CLS currently operate eight metal stamping machines in a shed next to the die-casting shed. Metal parts are stamped out from sheet metal which is either bought in or made on-site. Any remaining waste metal or off-cuts are recycled in the foundry.

3.40 During the two site visits, the machines were not in operation. However, there was evidence that they are used on a regular basis and the floor around each machine was kept very clean.

Paint Shop

3.41 All GRP ships are either spray painted or hand painted depending upon the application requirements and the part of the ship being painted. Spray painting is carried out under cover in a special painting shed which is open at one end for ventilation and to aid drying. At any one time, only one or two workers will be spray painting the same boat. The paint is not usually diluted and so airborne paint mist is kept to a minimum. Hand painting is also carried out in covered ventilated shed or out in the open at the steel ship construction area.

3.42 Although the word paint is used above, many different finishes are used on ships including polyurethane finishes, non-slip deck paint and various other finishes, varnishes and wood preservatives.

3.43 Before part of the ship can be painted, a primer must be applied. This primer will vary depending upon the type of material used in construction. Different primers are used for GRP, aluminium and steel vessels. The most commonly used primer, which is used on the GRP vessels, is zinc based although primers for other vessels may be lead based. The choice of primer often will depend on the specific requirements of that vessel or on requests by the customer. After applying the primer a polyurethane or epoxy based paint is then usually applied.

3.44 For areas of the hull below the water line anti-corrosive, anti-fouling paints are applied. These paints usually contain copper which is impregnated in a slow dissolving epoxy resin. During use, when the hull is below the water line, the copper will slowly leak out and prevent marine organisms from attaching themselves to the hull. Another type of paint that is gaining popularity does not contain any metals at all but slowly dissolves in the water constantly presenting a new surface. Any organisms that try to attach themselves to the hull will be easily washed off when the paint dissolves. These two types of paint must be replaced every year as the active ingredient either dissolves or the paint washes off completely.

3.45 For special purposes, such as large steel ships, tributyl tin (TBT) issued. This is a highly toxic antifouling agent that has been highly regulated in Hong Kong and in most places throughout the world. The regulations governing the use of these compounds are included in "Environmental Legislation and Guidelines" of Chapter 1. For each usage, purchase and storage of TBT, a licence must be applied for.

3.46 All of the paint used to finish the vessels (except for the antifouling paints) are epoxy based and use xylene or toluene as a solvent and thinner. Whilst there are many other chemicals in the paints these are the major ingredients and both chemicals are extremely hazardous. A brief description of these and some of the other major chemicals found in the paints and finishes are included below:

Toluene

3.47 Toluene is a clear colourless liquid with a sweet smell. It is extremely flammable and has an odour threshold of between 0.16-2.9 ppm. OSHA PEL is 200ppm averaged over an 8-hour work shift, 300 ppm during any 15-minute period and a maximum peak concentration of 500 ppm. NIOSH has recommended 100 ppm averaged over 8 hours and 200 ppm over any 10-minute period. The Hong Kong Labour Department set much lower recommended levels of 50 ppm over an 8-hour shift and 150 ppm over any 15-minute period.

3.48 Toluene is an irritant and even low levels can cause headache and loss of concentration. At toxic levels toluene can cause dizziness, lightheadness and even death. Chronic long term exposure to toxic levels may result in liver, kidney and brain damage, bone marrow damage, skin rashes and possibly cancer. CLS is regularly inspected by the Hong Kong Labour Department and found to comply with their recommended levels.

3.49 When using toluene, all skin contact should be avoided and it should be used in a well ventilated environment. If high concentrations are expected, full protective clothing should be worn including a respirator.

3.50 Toluene has moderate to acute toxicity to animals, plants and aquatic life. It is however only very slightly soluble in water (less than 1 mg in 1 litre of water) and has a half life in water of less that 2 days. About 99.5% of waste toluene will eventually end up in the air.

Xylene

3.51 Xylene is a clear colourless liquid with a strong odour. It is extremely flammable. It has an odour threshold of 1.1ppm. OSHA PEL is 100ppm averaged over an 8 hour work period and 150ppm over 15 minutes. NIOSH recommend 100ppm averaged over a 10 hour period and 200ppm over 10 minutes. ACGIH recommend 100ppm over an 8 hour period and 150ppm as a short term exposure limit (STEL). The Hong Kong Labour Department has recommended the same exposure limits as OSHA.

3.52 Exposure to xylene can cause irritation to eyes, nose and throat, headache, nausea, vomiting and tiredness. At toxic levels it may cause dizziness and lightheadness and even death. Long term exposure to toxic levels may result in liver and kidney damage, bone marrow damage, drying and cracking of the skin, poor memory and damage to the surface of the eyes.

3.53 Xylene should be handled the same as for toluene, in a well ventilated room and if necessary with protective equipment including breathing apparatus.

3.54 Xylene is actually a mixture of 3 isomers with possibly trace amounts of ethylbenzene. It has moderate to acute toxicity to animals, plants and aquatic life. It is however only slightly soluble in water and has a half life in water of less than 2 days. About 99.3% of waste xylene will eventually end up in the air.

Cellosolve acetate (2-ethoxyethylethanoate or 2-ethoxyethly acetate)

3.55 This is the main ingredient of modified polyester resin which is used as a polyurethane topcoat. It has been classed as a teratogen at toxic levels. OSHA PEL is 100 ppm averaged over an 8 hour work period. The Hong Kong Labour Department has recommended a PEL of 5 ppm, much lower than OSHA.

Diisobutyl ketone

3.56 This is a minor ingredient of modified polyester resin which is used as a topcoat. It has been classed as an irritant. OSHA PEL is 50 ppm.

Butyl acetate

3.57 This is a minor ingredient in many modified epoxy resin mixes and in the fast evaporating reducer for spray applied urethane topcoats. It is flammable and has been classed as an irritant. OSHA PEL is 150 ppm. The Hong Kong Labour Department has recommended a PEL of 150 ppm and a STEL of 200 ppm.

Methyl ethyl ketone

3.58 This is a flammable liquid and has been classed as an irritant. OSHA PEL is 50 ppm. The Hong Kong Labour Department has recommended 200 ppm and a STEL of 300 ppm.

3.59 As most of the paint is used undiluted, the main route of environmental exposure to these solvents is during cleaning of the painting equipment and vapour from the spray painting and drying process. The current paint shop is open-ended and well ventilated which prevents the buildup of toxic and flammable fumes. During the second site visit the paint shop was inspected and there was little evidence of excess paint either on the floor or walls indicating that great care is taken during the painting process to prevent wastage or spillage. Any excess solvent from the cleaning process is stored in sealed containers and recycled by distillation at the solvent recycler. Empty paint cans are currently either collected for disposal or recycled in the foundry as scrap metal. Other chemical drums are treated in the same manner.

Solvent Recycling

3.60 CLS currently operates a small solvent recycling system which it uses for xylene, toluene and acetone recovery. The recycler operates on the distillation principle and is shown in Plate 3.8. The solvent mixture is placed into a container which itself is incased in an oil-bath. The oil bath is heated electrically which then in turn heats and boils the solvent mixture. As the solvents boil the vapour is carried away from the original solution through a water cooled column. The vapour condenses as it passes along this column and the resultant liquid, the distillate, is collected in a separate vessel. As different solvents have different boiling points (acetone 56°C, toluene 110.6°C, xylene 137-144 °C) they can easily be separated from one another by collecting the distillate at the various boiling point temperatures associated with that solvent. Any solvents or liquids that distils over at lower temperatures or are left in the original solution are collected in sealed containers for disposal.

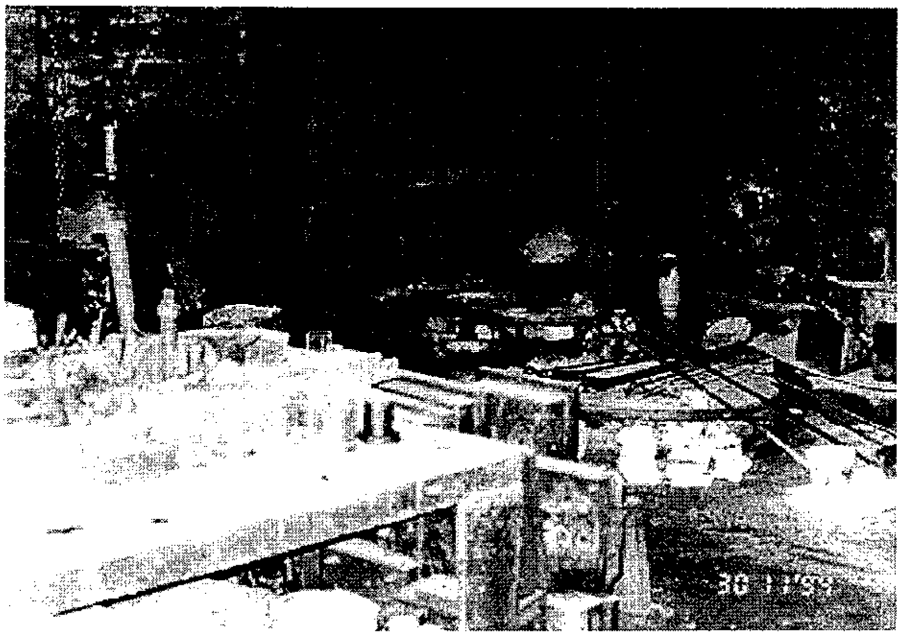


Plate 3.7 : Crucible Furnace For Die Casting

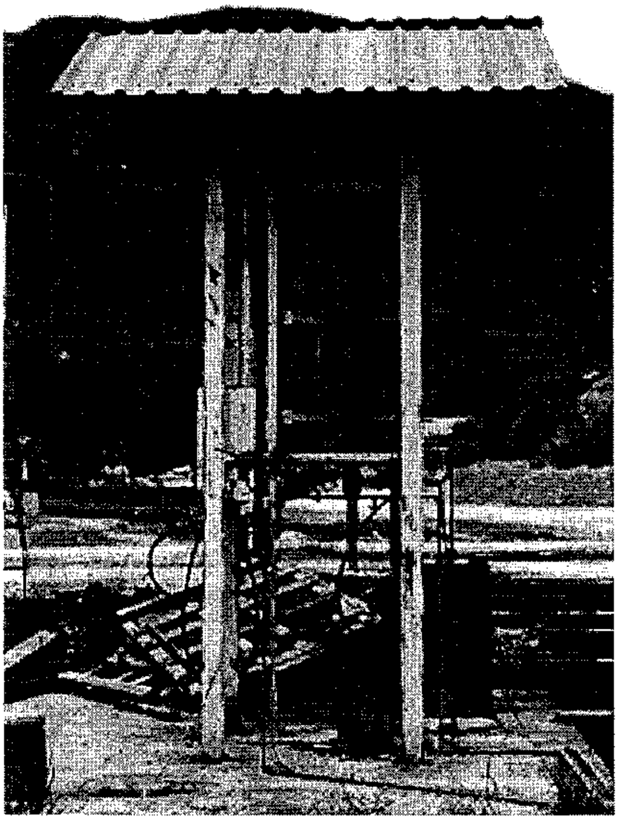


Plate 3.8 : Solvent Recycling Apparatus

Joinery

3.61 There are two main areas where joinery takes place; in an open shed next to the mould building shed and on an upper floor of the painting and finishing/fitting out shed. The main environmental impact and health effect of joinery is saw dust which, because of the scale of the operation and the open nature of the sheds poses little problem.

Machine Shop

3.62 The metal workshops are separated into 2 areas. A small shed is used for stamping steel which is mentioned above whilst the other larger shed is used for metal turning works. The floors of the machine shop are all concrete and appeared very clean on the two occasions when site visits were conducted. The areas around each of the lathes or machines was very clean Plate 3.9 and all swarf was swept up, collected and separated depending upon the metal and stored in large drums for recycling due to the cost of the raw material Plate 3.10. The cooling water/cutting liquid used in the lathes is constantly recycled in a closed loop system. No liquid waste is produced as the liquid is continually topped up with water and any metals are filtered out for recycling. CLS management expressed the view to the EIA team that they enforce good housekeeping for the purpose of safety.

Metal Cutting Machinery

3.63 There are two large metal cutting machines, one behind the foundry and one behind the shot blasting shed. The first one behind the foundry is shown in Plate 3.11. Scrap metal off-cuts can be seen piled next to the cutting jaws awaiting recycling. The second machine is looked like it had not been used for some time. The main environmental concern regarding the use of these pieces of equipment is noise. At the time of the two site visits, the machine was not in operation and so noise levels could not be determined.

Dangerous Goods Storage

3.64 All dangerous goods are currently stored in a special locked, ventilated and environment controlled storage facility separated from other buildings (see Plate 3.12). There are five separate rooms for MEKP, paints, xylene, sulphuric acid and acetylene respectively. This storage facility is separated form all other buildings and appropriate (powder) fire extinguishers are on hand.

Metal Finishing/Shot-blasting

3.65 Shotblasting of steel is conducted is an open shed which can be closed off during blasting with a heavy cloth to prevent dust and shot from escaping. The shot used is a mixture of irregular silica/iron slag about 1mm diameter. About 1-2m^3 of shot is used at any one time. Shotblasting is usually carried out in the morning with the afternoon reserved for sweeping up the shot for recycling. The operation is small scale, about 1-2 weeks per month as most metal is bought from the supplier already finished and painted with undercoat. The shotblasting shed is of an open design because during the construction of steel ships, large sections may have to be brought in for blasting. However, normally only smaller pieces are shotblasted of recent years.

Repair Works

3.66 Repair work is carried out in the area closest to CLP's power station. A variety of operations take place here including engine overhauling, hull scraping, painting, bilge cleaning and many others. This is perhaps the least important of CLS's main operations.

3.67 Boat hulls are scraped for repainting resulting in paint flakes which are swept up and collected for disposal. The hulls are then repainted with the appropriate antifouling paints.

3.68 Engine oils are changed and the engines overhauled. The oil is carefully recovered and recycled either by using as an anticorrosive agent in ships rudders or by sending to a company that recycles oil. Whilst there was some evidence of oil run-off from the site into the bay, this was obviously from many years of operation and there was no visual evidence that oil had entered the bay. Oil had only stained the surface soil and all the rocks and seawall below the drainage outflow were clean and showed no evidence of oil contamination. The floor of the engine workshop was covered with sawdust, which absorbs the oil, and this is cleaned around once per year and the oil/sawdust waste collected for disposal .

3.69 The bilges of boats are cleaned using regular household detergent and the waste is currently disposed of either into the sea or into the drains. The bilge waste is expected to contain oil and possibly phosphates from the detergent, both of which are considered environmental hazards. The frequency of bilge cleaning is very low and there was no visual evidence of any resulting contamination at the drainage outfall into Penny's Bay. This however was targeted for further testing and is discussed in later chapters.

Solid Wastes Storage

3.70 Solid waste is currently stored in either large steel drums or in a special waste storage area situated near the solvent waste recycling plant. All used steel drums are stored in various places, depending upon available space, ready for disposal or recycling, either as raw steel for the foundry or as waste containers.

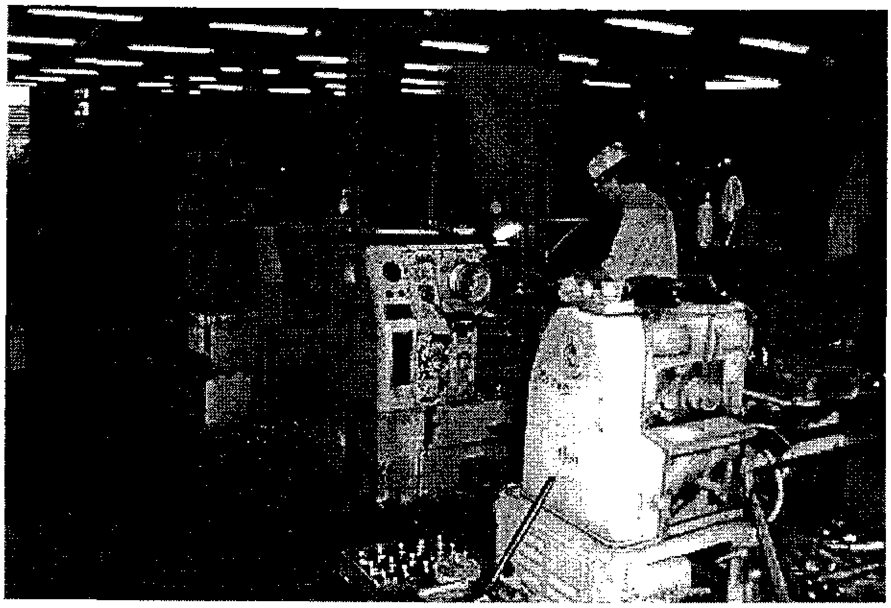


Plate 3.9 : Machine Shop

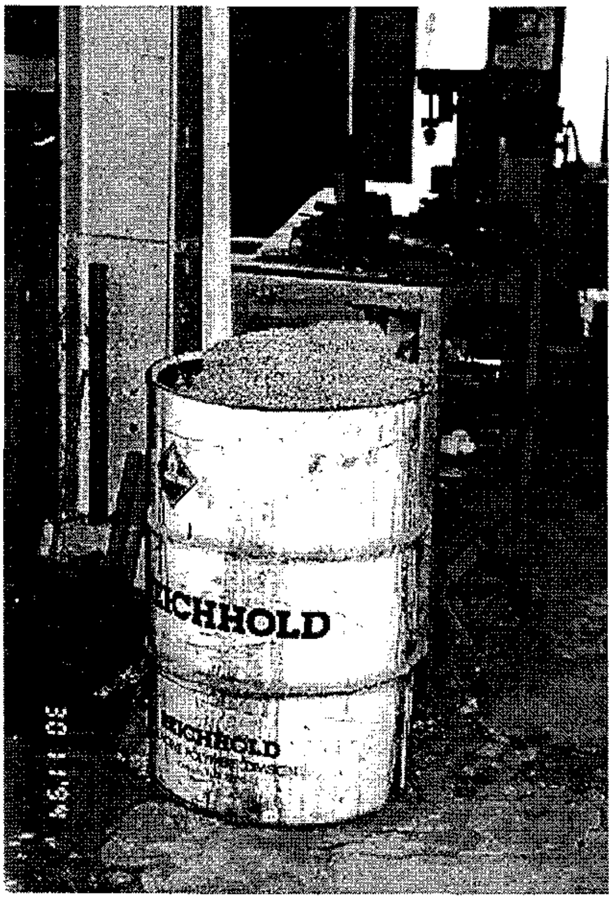


Plate 3.10 : Metal Scrap Collection

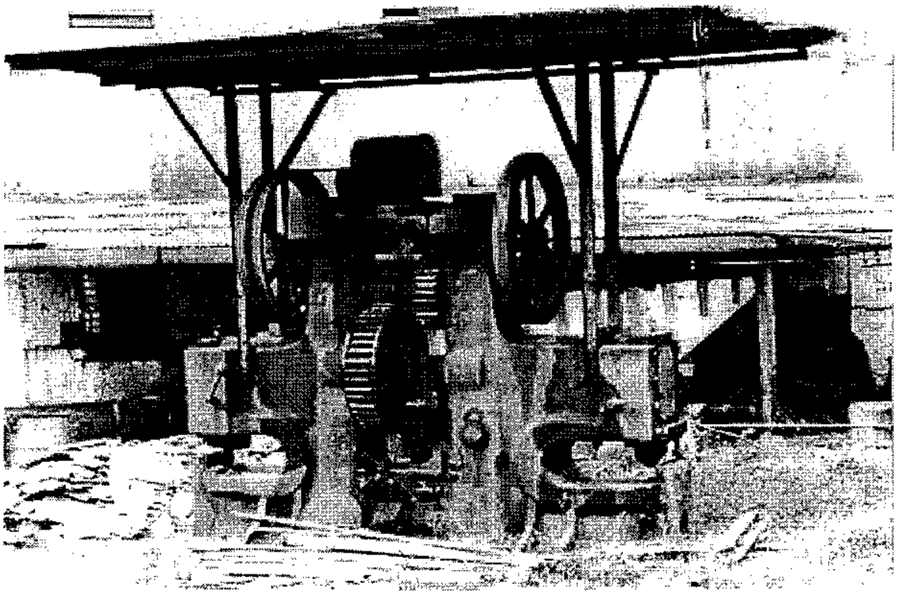


Plate 3.11 : Metal Cutting Machine

Plate 3.12 : Dangerous Goods Storage

4. VISUAL IMPACT

Introduction

4.1 The visual impact analysis has been carried out using a notional, new Shipyard layout first described in this chapter. The essential elements and design philosophy are shown in Figure 4.1. Additional details are given in later chapters where necessary for assessment.

4.2 Current operations at the existing Penny's Bay boatyard require only simple roofed shelters for the main areas of preparation, manufacturing and assembly. Vertical enclosure of these areas is required only for protection from adverse climatic conditions, except where advocated elsewhere in this report for environmental mitigation. Specific, detailed requirements for a commercially viable and operational boatyard are dependent on the owners specification.

4.3 However the layout illustrated in this report is assumed to be viable and has been adopted solely for the purposes of this environmental impact assessment. As stated in Chapter 1, it has been assumed that virtually all activities and enclosed areas have been shifted to To Kau Wan in order to assess the worst case scenarios.

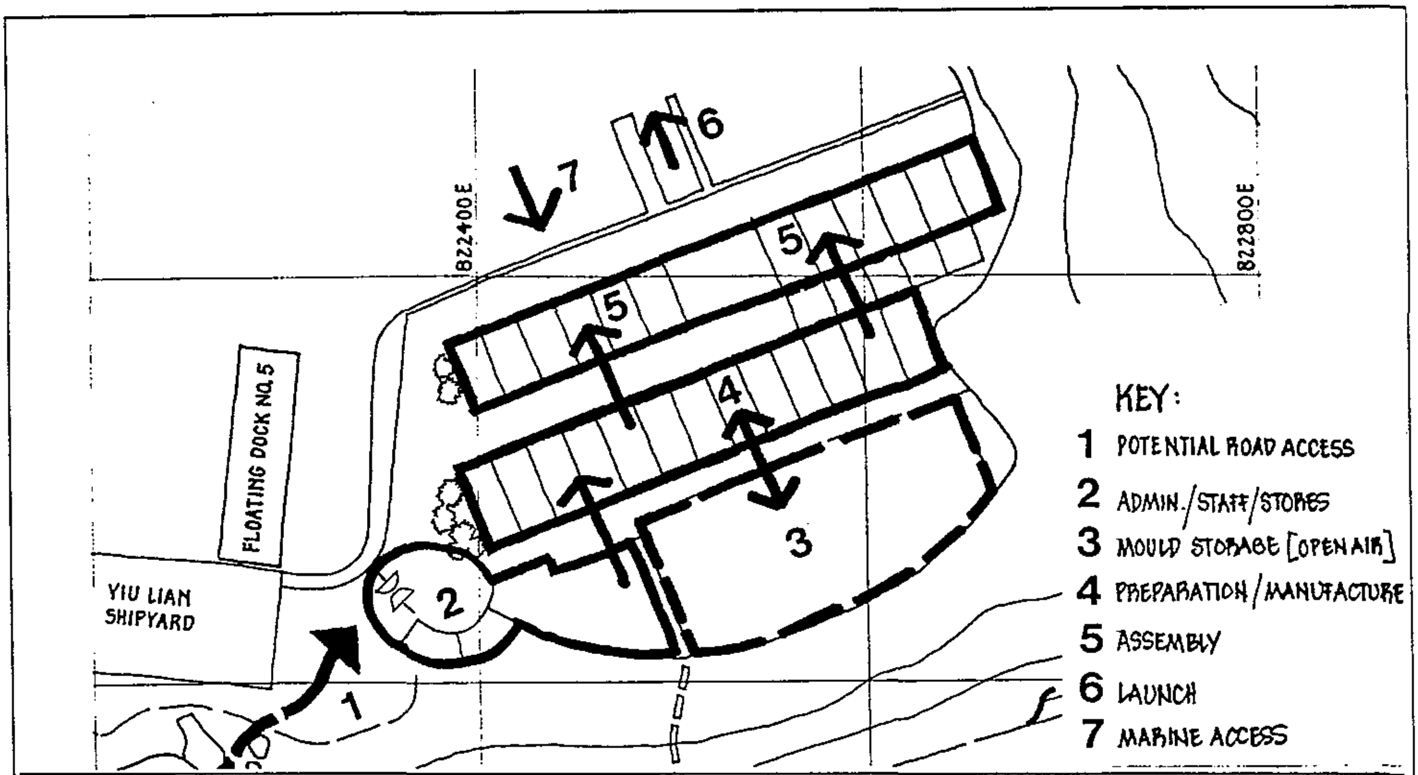
4.4 The following sections of this chapter describe and illustrate the visual envelope in relation to potential sensitive receivers, visual analysis and assessment by photomontage and sketches, an indication of mitigation measures that may be adopted and, finally, concluding remarks.

Visual Envelope

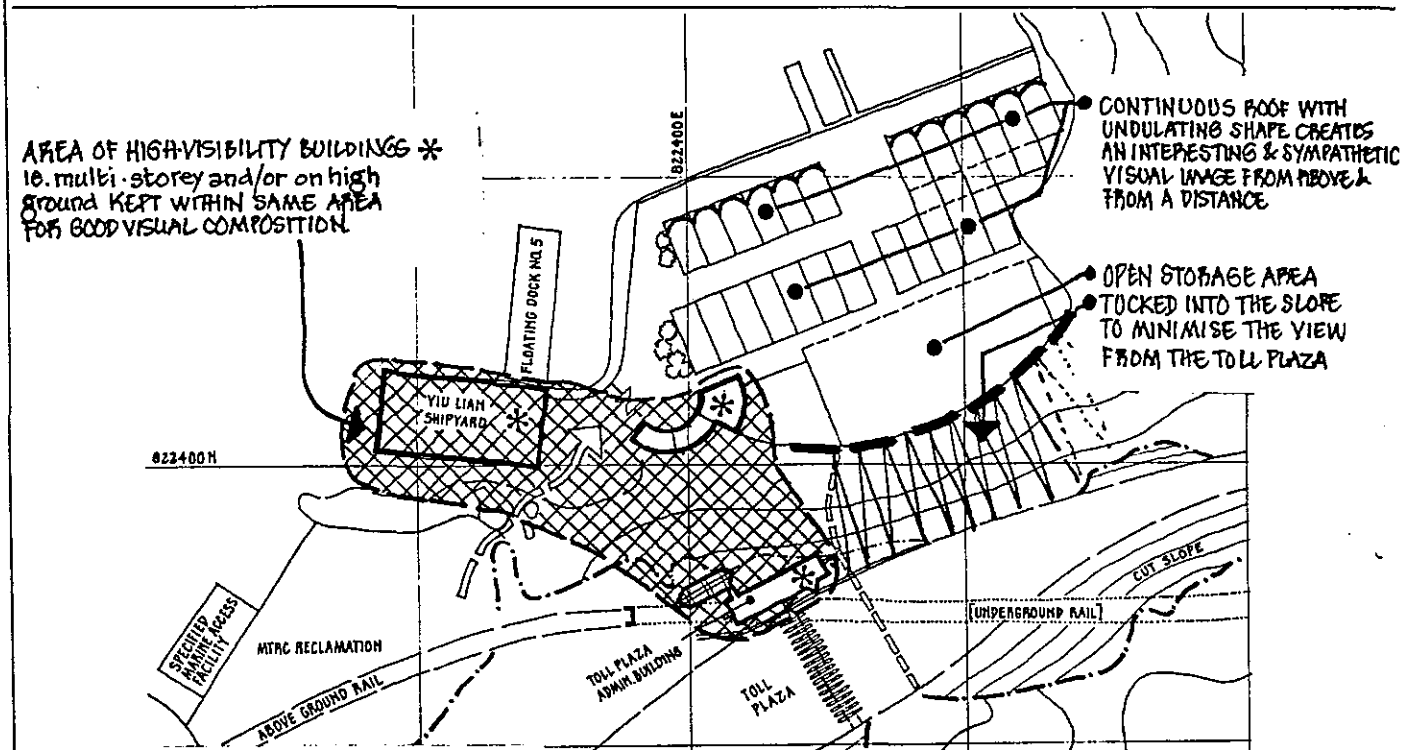
4.5 The proposed site is located in an area where the natural land-form and environment is undergoing considerable change. These are illustrated on Figure 4.2, and include:

- massive cut and fill slopes for the formation of the North Lantau Expressway, particularly for Toll Plaza area;
- a future, 3 to 4 storey high Toll Plaza administration building;
- elevated road leading to the Toll Plaza; and
- the reclamation to the west for the AEL/LAL railway.

4.6 The existing Yiu Lian Shipyard lies immediately west of the proposed site, with 4 large floating docks moored approximately 300m off-shore. Figure 4.3 illustrates the current and future visual envelope seen in perspective from ground/sea level.

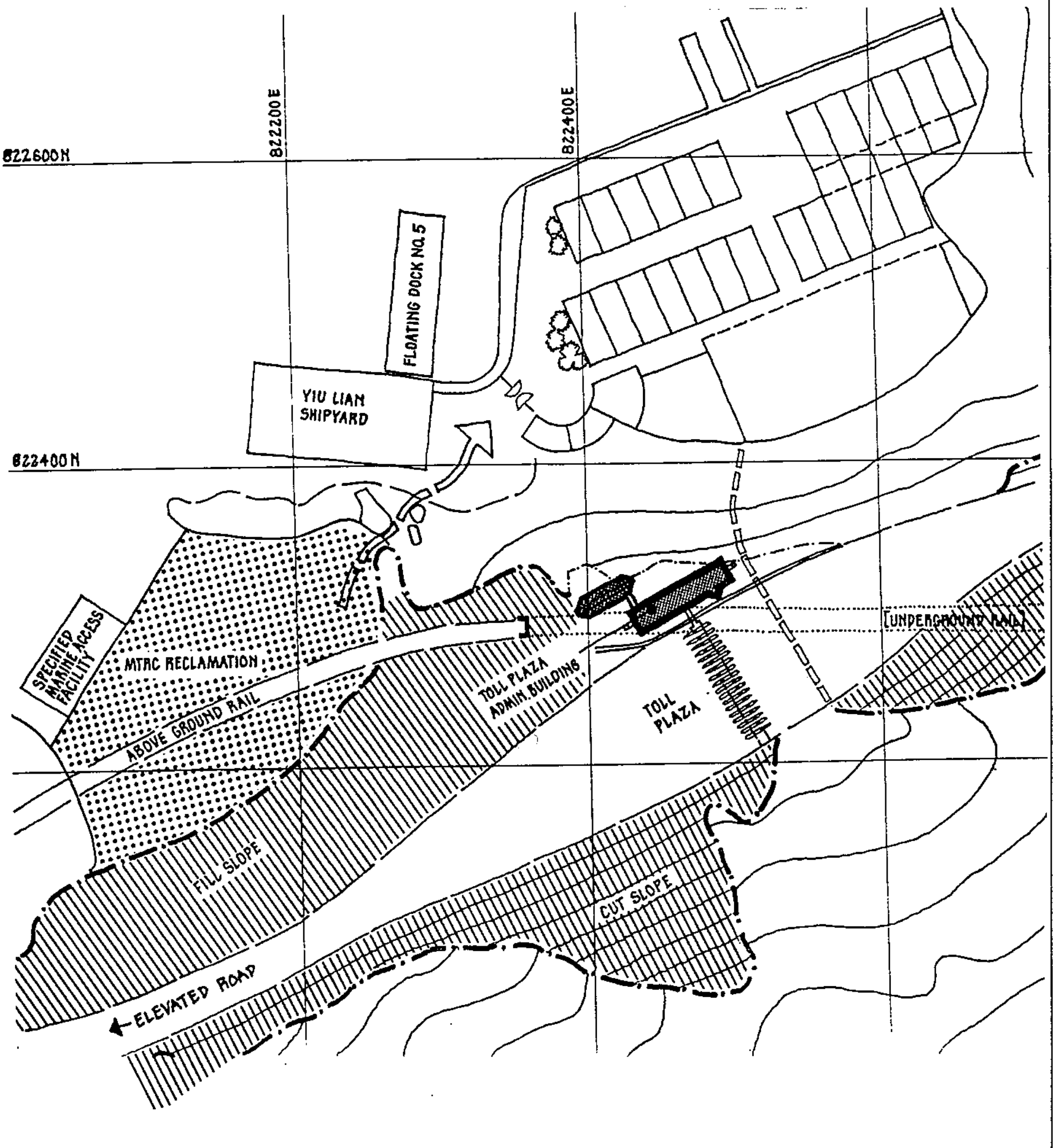


BOATYARD • ESSENTIAL ELEMENTS

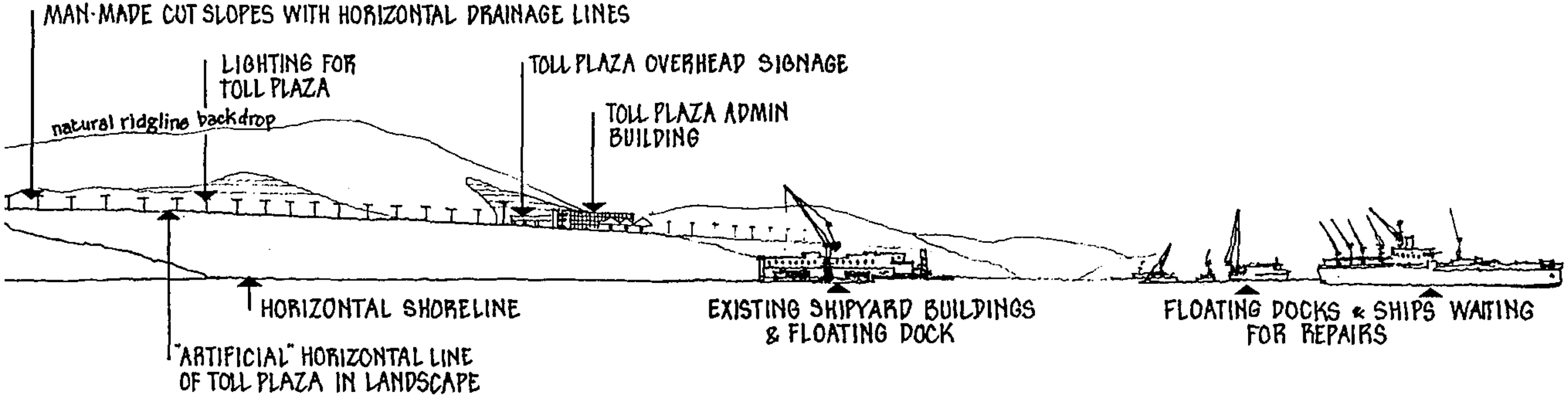


BOATYARD• DESIGN PHILOSOPHY

TO KAU WAN OPERATIONAL EIA	BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 CONSULTING ENGINEERS 賓尼	Date FEB 95	Scale
NOTIONAL BOATYARD LAYOUT	土木工程署 Civil Engineering Department	Initial GM	Figure No. 4.1



TO KAU WAN OPERATIONAL EIA	BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 CONSULTING ENGINEERS 賓尼	Date FEB 95	Scale N.T.S.
VISUAL ENVELOPE - SITE CONTEXT	土木工程署 Civil Engineering Department	Initial GM	Figure No. 4.2



TO KAU WAN OPERATIONAL EIA VISUAL ENVELOPE - PERSPECTIVE VIEWS	BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 CONSULTING ENGINEERS 賓尼	Date FEB 95	Scale
	土木工程署 Civil Engineering Department	Initial GM	Figure No. 4.3

4.7 In due time the cut and fill slopes will mature with re-established vegetation. Extensive landscaping of the cut and fill slopes will be undertaken under the Toll Plaza Roadworks contract as well as supplementary planting on the natural slopes above and below the Toll Plaza. However, the large extent of cut slope particularly will retain a certain "artificial" appearance due to the regular angle of slope and horizontal drainage lines. The Toll Plaza imposes a quite severe and extensive horizontal line on the natural landscape. The future administration building is situated in a prominent, elevated location. Its design, according to ASD drawings, has very clean, sharp lines.

4.8 The Yiu Lan Shipyard administration building and floating docks create a strong and active marine image, with their bulky structures and tall cranes punctuating the skyline.

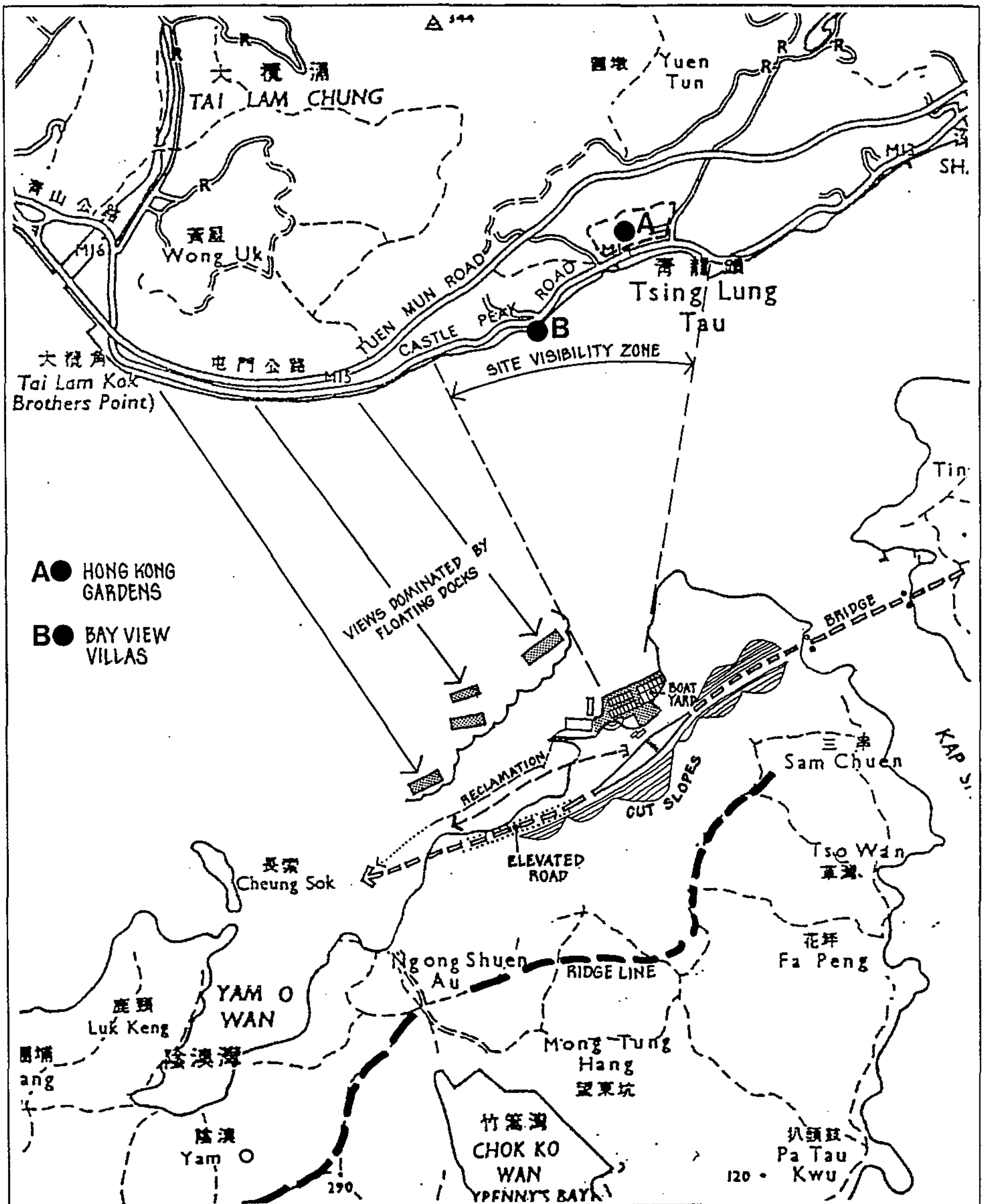
4.9 In the wider context of North Lantau and the mainland, the aforementioned visual elements also form the major elements of the total visual envelope of the specific site context. This situation also helps determine the location of the most sensitive receivers in terms of the proposed sites's potential visual impact. Figure 4.4 clearly illustrates this wider context and identifies the location of sensitive receivers.

4.10 The off-shore floating docks tend to dominate the visual environment as viewed from the western areas of the mainland up to Brother's Point. The backdrop to this marine view is a combination of the imposed land-form changes mentioned in 4.5 and the natural ridge-line of the North Lantau hills.

4.11 The proposed site area is only clearly visible within a shallow arc as shown in Figure 4.4. Within this arc, along the Castle Peak Road, only two developments have this clear view. These are the large high-rise residential development of Hong Kong Garden and the small, low rise enclave of Bay View Villas at Tsing Lung Tau.

4.12 The distance between these sensitive receivers and the proposed boatyard is almost 2 kilometres. This distance means that the views received by the developments at Tsing Lung Tau include all the structures and activities described above. The new Shipyard will, in effect, be only one more element in the overall scene.

4.13 In order to provide a detailed impression of the Shipyard proposal, a close-up photomontage view is presented in Figure 4.5. This viewpoint is taken approximately 300 meters off-shore from sea-level. It must be stressed that this image does not represent the actual view obtained at the points of sensitive reception. The illustrations showing the actual viewpoints from the receivers are based on this close-up impression and presented in the section of "Visual Analysis and Assessment".



TO KAU WAN OPERATIONAL EIA	BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 CONSULTING ENGINEERS	Date FEB 95	Scale
VISUAL ENVELOPE - WIDER CONTEXT AND SENSITIVE RECEIVERS	土木工程署 Civil Engineering Department	Initial GM	Figure No. 4.4

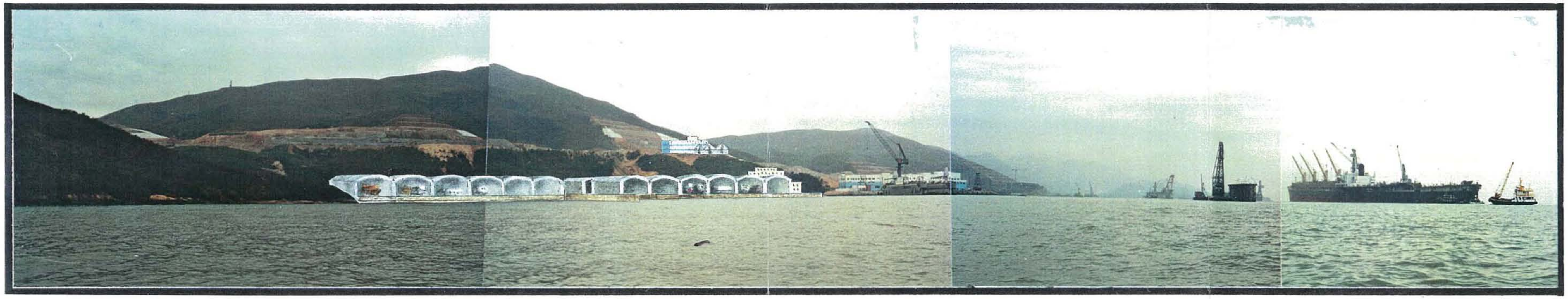


FIGURE 4.5: CLOSE-UP MONTAGE
(71% reduction)

4.14 Potential sensitive receivers in close proximity to the proposed shipyard (Figure 4.6) include:

- Staff in the Yiu Lian Shipyard administrative building;
- Staff in the future Toll Plaza administrative building; and
- Drivers entering and leaving the Toll Plaza from west to east.

4.15 Given that the Yiu Lian Shipyard carries out a similar business to that of the proposed Shipyard, it can be assumed that their staff would be willing recipients of the new Shipyard view. Passengers on the AEL or LAL trains will not have any real view of the proposed Shipyard.

Visual Analysis and Assessment

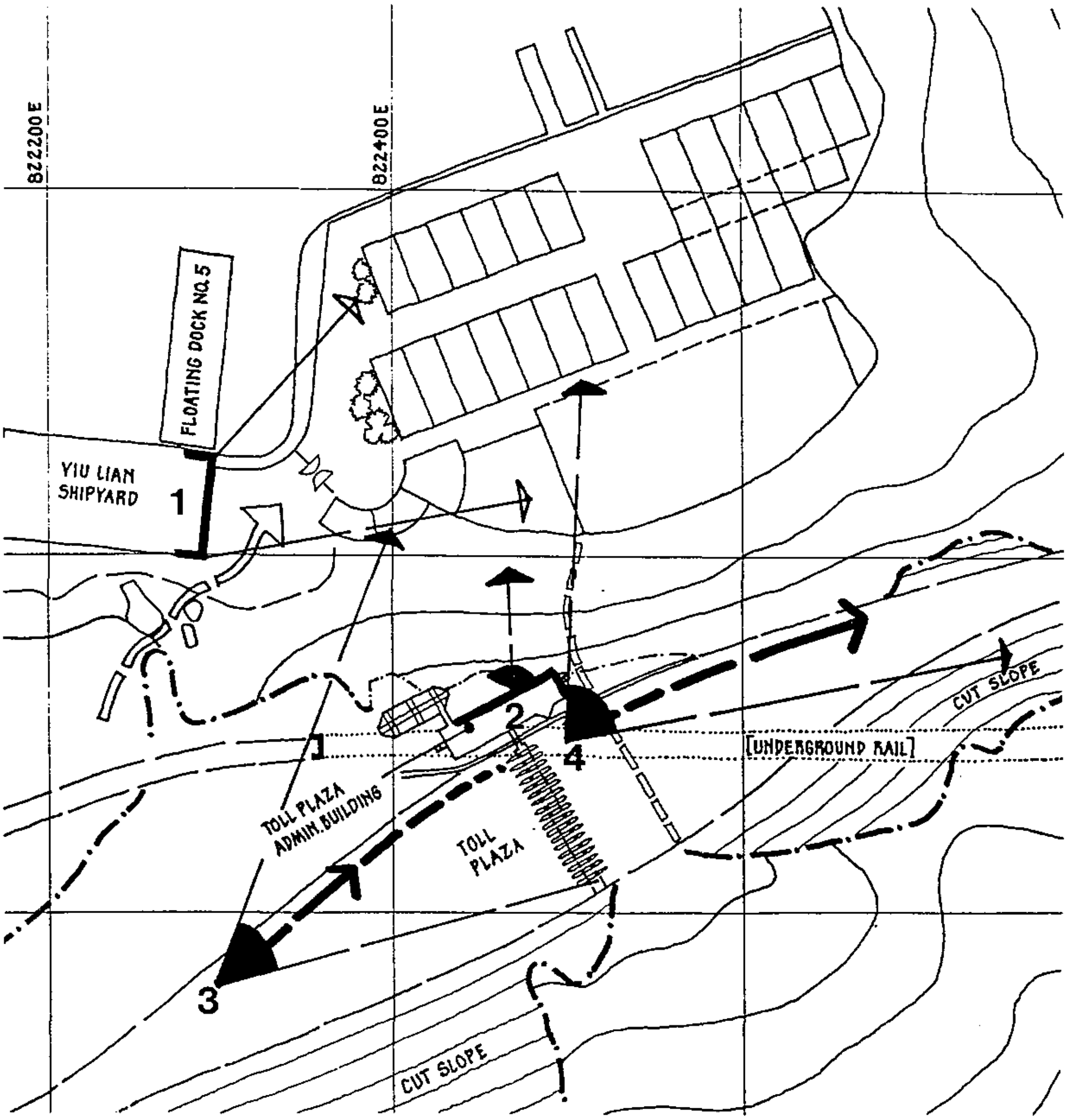
4.16 Figure 4.7 shows the current view from the Hong Kong Gardens development and a line drawing indicating the future visual environment. The view is taken from an elevated ground level point within the development at the western end.

4.17 The photograph provides a clear impression of the visual effect of the distance between the viewpoint and the proposed shipyard. The line drawing picks out in equal emphasis the eventual cumulative effect of all the visual elements. Whilst the addition of the Shipyard to the overall scene cannot be said to positively improve the visual environment, it can also be argued that neither does it create an unacceptable addition to an already disturbed natural environment.

4.18 The long, horizontal rhythm of the boat-yard buildings at sea-level, reflects the higher horizontal line imposed on the landscape by the Toll Plaza. This combined geometry tends to bring some visual harmony to a view currently dominated by the more random elements of cut slopes and floating docks.

4.19 The night-time view will be dominated by the illumination system for the Toll Plaza area and any administration building activities required for 24-hour operations. This line of illumination will be quite prominent along the whole of the north Lantau coast-line. Navigation lights required on the floating docks and anchored ships will complete the night-time view. Only minimum security lighting will be provided within the proposed shipyard and should not add significantly to the nocturnal view.

4.20 From high-floor flats on the Hong Kong Gardens development an oblique view of the roofs of the shipyard may be perceived. However, given the distance between, this should not increase any visual intrusion significantly. If anything, the activities on the Toll Plaza would provide a more prominent impact.



1 STAFF IN EXISTING SHIPYARD
2 TOLL PLAZA ADMINISTRATION STAFF
3 ARRIVING MOTORISTS
4 DEPARTING MOTORISTS

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CLOSE PROXIMITY SENSITIVE RECEIVERS	土木工程署 Civil Engineering Department	Initial GM	Figure No. 4.6

FIGURE 4.7: VIEW FROM HONG KONG GARDEN

4.21 Bay View Villas is a small, 2 storey residential enclave located on the beach. The views are almost from sea-level. Figure 4.8 shows the existing view and a line drawing of the future view. This is very similar to that described above and the same points of assessment apply, except, of course, for those relating to the high-floor views.

4.22 The impact on potential nearby receivers is illustrated on Figure 4.9 by means of an annotated section.

4.23 It is very difficult to assess the extent of visual impact on the staff of the Toll Plaza administration building. However, two main assumptions can be made:

- the overall view from the building, looking north, will include the boat/shipyard building in the foreground, the floating docks in the middle distance and the New Territories hills in the background.

- the staff will be in a working environment where external views are secondary to the job requirements.

4.24 Given these assumptions it is expected that the proposed shipyard will not adversely affect the visual environment of the administrative workforce. Any disturbance to the immediate view is compensated by the more impressive and expansive distant views.

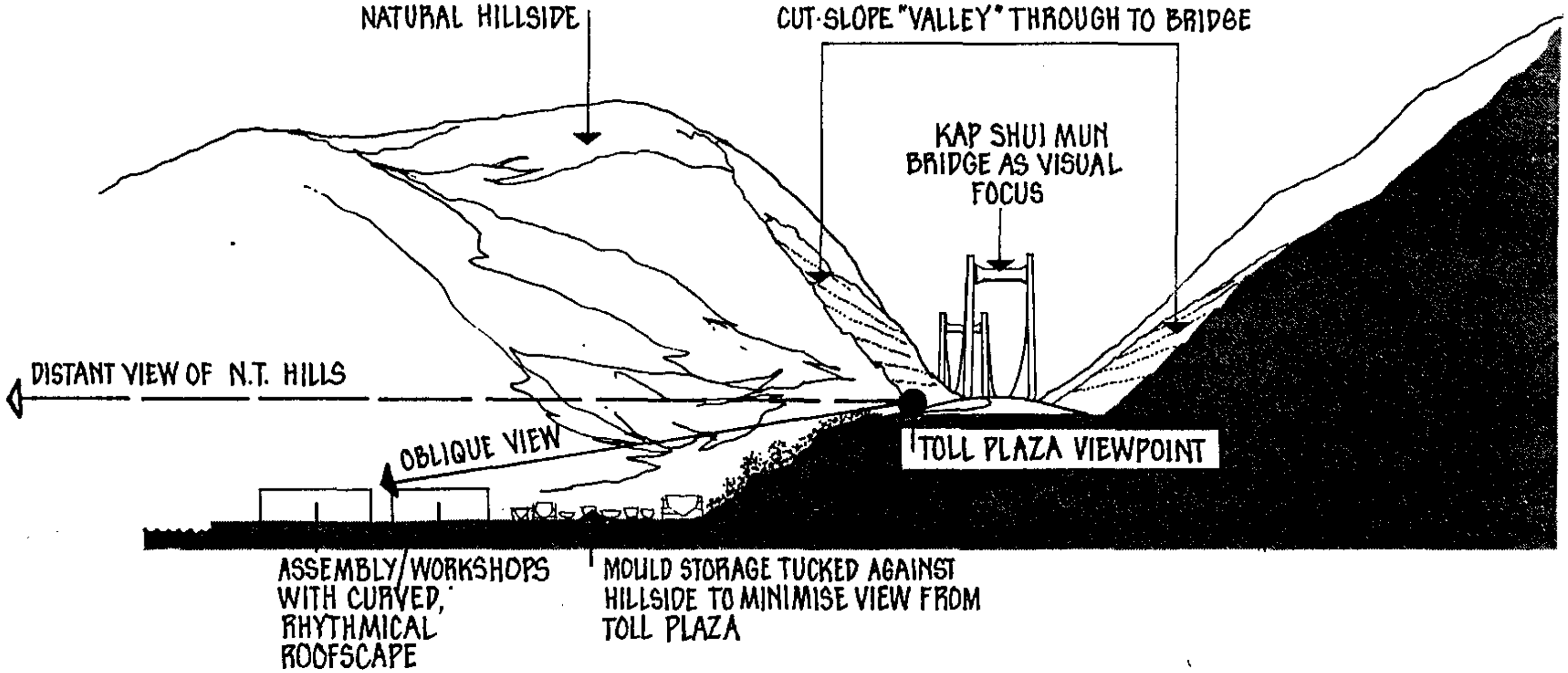
4.25 Motorists approaching and leaving the toll plaza in an easterly direction are potential "viewers" of the shipyard area. Traffic travelling in the opposite direction, towards the airport will not be able to see it.

4.26 Approaching the Toll Plaza from the airport direction, the motorist's immediate view will be of the administration building and the Toll collection-facilities stretching across the road. On leaving the Toll booth, the motorist's attention will be drawn towards the hill side landscape, the Kap Shui Mun Bridge straight ahead or, possibly, the distant hills of the New Territories. The local vistas of the ship/boatyards will be only fleeting.

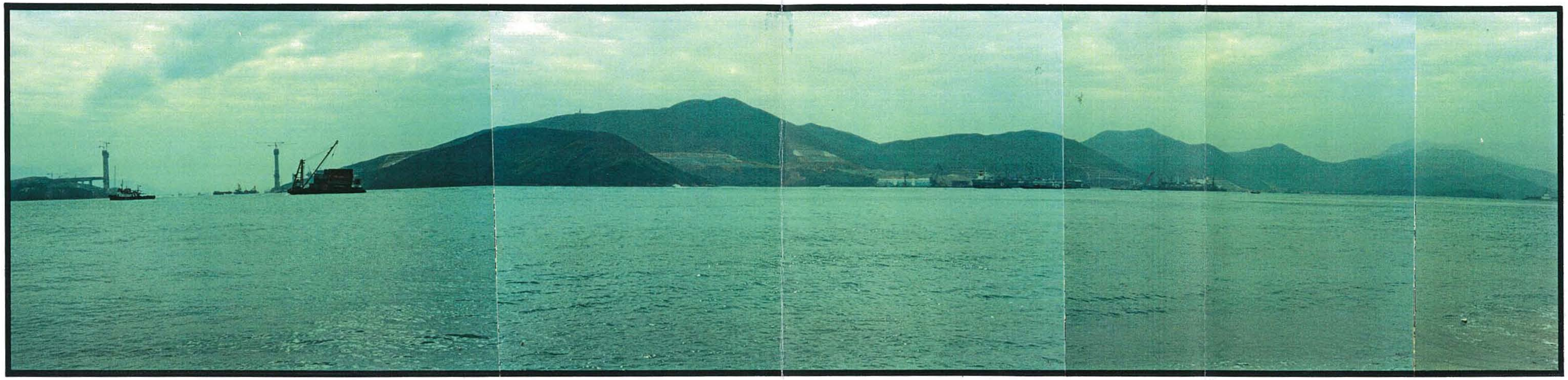
Mitigation Measures

4.27 From the outset of this EIA, the most relevant environmental mitigation measures have been included within the adopted layout plan. These have included:

- distribution of boat-yard processes in order to present a rational balance between the manufacturing sequence and screening of the more visually untidy storage areas.



TO KAU WAN OPERATIONAL EIA CLOSE PROXIMITY VISUAL ASSESSMENT	BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 CONSULTING ENGINEERS 賓尼	Date FEB 95	Scale
	土木工程署 Civil Engineering Department	Initial GM	Figure No. 4.9



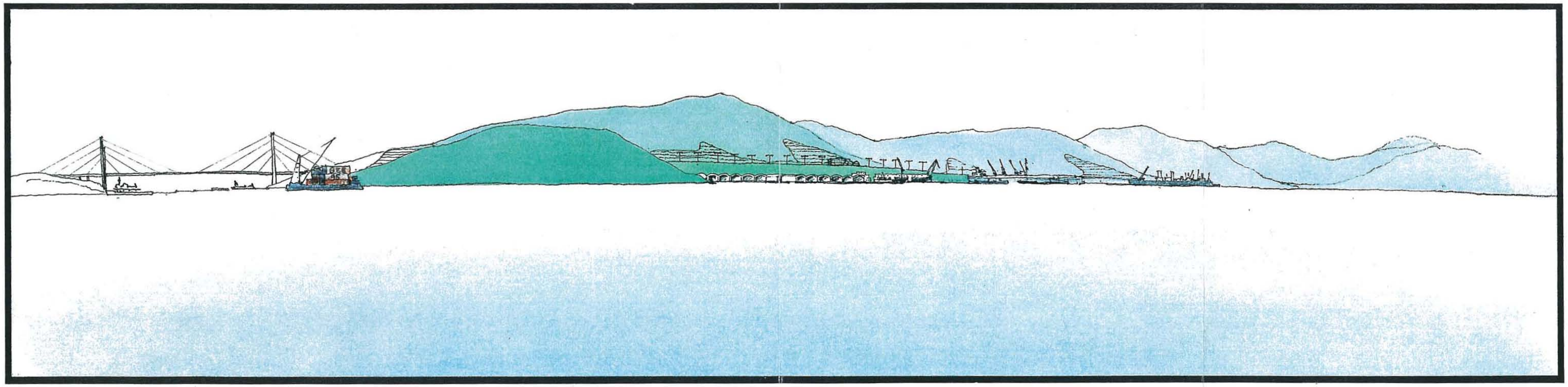


FIGURE 4.8:
VIEW FROM BAY VIEW VILLAS
(71% reduction)

- provision of a simple, geometric rhythm for the major built-form elements which harmonise with the natural (shoreline) and imposed (Toll Plaza) horizontal geometry.

- locating the administration building in a position that creates a coordinated group with other buildings when seen from afar or close-up.

4.28 Further mitigation measures could include:

- a colour scheme for the main production and assembly buildings that allows the structures to "dissolve" into the background landscape. The illustrations show a light-coloured finish. Other colours that may be considered appropriate could be a dark olive green or grey/brown.

- landscaped roofs on the administration/staff/storage area.

- a contribution to the landscape of the slope between the shipyard and the Toll Plaza.

- suitable plantings within the site to soften the landscape and provide a better working environment.

Conclusions

4.29 The general area of the site for the proposed shipyard has already changed from an unspoiled rural landscape into one of imposed activities and transportation engineering.

4.30 The addition of the shipyard does not create adverse visual imbalance, either from distant or nearby viewpoints.

4.31 The adopted site layout has been organised to include in-built mitigation measures and sympathetic built form elements.

4.32 The overall changes being made to the visual environment of North Lantau are far more dominant than those created by the proposed shipyard.

5. NOISE POLLUTION

Introduction

5.1 Using the worst case scenario layout plan presented in the previous chapter, noise pollution during both the construction of the new shipyard at To Kau Wan and its operation have been assessed. This assessment is presented in this chapter.

5.2 The methodology for assessing construction and operational noise activities associated with the To Kau Wan site has been developed based on the following Technical Memoranda issued under the Noise Control Ordinance (Cap. 400):

- *Technical Memorandum on Noise From Construction Work Other Than Percussive Piling* (EPD 1991b: TM1).
- *Technical Memorandum on Noise From Percussive Piling* (EPD 1991c: TM2).
- *Technical Memorandum for the Assessment of Noise From Places Other Than Domestic Premises, Public Places or Construction Sites* (EPD 1994d: TM3).

5.3 In general terms, the methodology used involved the following steps:

- Establishment of worst case scenarios.
- Identification of the noise sensitive receivers (NSRs) and determination of the appropriate Acceptable Noise Level (ANL).
- Listing of all equipment likely to be used for each scenario.
- Calculation of total Sound Power Level (SWL) of equipment associated with each activity.
- Calculation of Predicted Noise Levels (PNL) based on distance attenuation and barrier corrections from the notional noise source point to the NSRs.
- Recommendation of noise mitigating measures as required.

The Background Noise Environment

5.4 As discussed in Chapter 1, there are several major projects underway adjacent to the To Kau Wan site. These projects will impact on the To Kau Wan site both during their construction and during their operational phases.

5.5 At the current time, the noise characteristics of the area are being dramatically and permanently altered from that of an undeveloped, unpopulated area.

5.6 A number of earlier EIAs have examined the noise environment of North Lantau before development began. The closest monitoring site to To Kau Wan where both baseline and construction noise data have been measured is Luk Keng Tsuen. Luk Keng Tsuen lies north of Yam O Wan.

5.7 Some of this data was presented in the EIA undertaken for the reclamation phase of To Kau Wan (BCL 1994a). Before the PADS projects began on North Lantau, the whole area was extremely quiet, with a very low population in traditional village houses and an area rating of 'A' as defined in the TMs.

5.8 The future noise setting is no longer rural. All villages in the vicinity have been resumed. The study area lies well within the NEF 25 contour for 2030 and it has been recommended that no residential development be allowed within this contour (GM 1991).

5.9 During the operational phase, the site will be impacted by aircraft noise, the NLE traffic noise and rail noise. In addition, industry nearby such as the Yiu Lian Shipyard as well as future planned uses will raise background noise levels from increased water transport noise and operational noise from their activities. Fortunately the topography near the site including the Toll Plaza cutting and the rail tunnels will act to reduce part of the impact.

Noise Assessment Criteria

Construction Noise

5.10 For this assessment, the area around To Kau Wan during the construction phase has been assumed to have an Area Sensitivity Rating (ASR) of 'A'. According to the Noise Control Ordinance (NCO) and (EPD 1991b: TM1), the Basic Noise Levels (BNLs) of the site are as follows :

Evening (1900 to 2300 hours)	: 60 dB(A)
General holidays including Sundays (0700 to 1900 hours)	: 60 dB(A)
Night-time (2300 to 0700 hours)	: 45 dB(A)

5.11 During the normal working day of 0700 to 1900, Monday to Saturday, the assessment criteria used is 75 dB(A).

Percussive Piling

5.12 According to the TM_2, during percussive piling, the ANL for NSR with windows or other openings but without central air conditioning system is 85 dB(A).

Operational Noise

5.13 During the operation of the shipyard, the ASR of the area, according to TM_3, is expected to be 'B' with the following ANLs :

Day-time (0700 to 1900 hours)	: 65 dB(A)
Evening (1900 to 2300 hours)	: 65 dB(A)
Night-time (2300 to 0700 hours)	: 55 dB(A)

Noise Sensitive Receivers (NSRs)

5.14 There are no true noise sensitive receivers in the study area and there will not be any in the foreseeable future. The study area lies well within the NEF 25 contour in 2030. The future land use will be decidedly industrial. The nearest true noise sensitive receivers are probably at Discovery Bay 5 km away and shielded by a range of hills some 100 metres high.

5.15 The Yiu Lian Dockyards Ltd's staff quarters is and will be the only residential building in the area. This substantial brick building is not considered to be a true noise sensitive receiver since it is situated inside an industrial undertaking which omits noise.

5.16 The other noise sensitive use (and users) will be the Toll Plaza Administration Building. This will be the operational centre for the Toll Plaza which will be situated close by.

5.17 For assessment purposes, Yiu Lian Dockyards Ltd. staff quarters adjacent to the construction site has been chosen as a noise sensitive receiver (NSR) to assess the construction noise impact of the To Kau Wan construction.

5.18 The administration building of the Toll Plaza in addition to Yiu Lian Dockyard Ltd. staff quarters has been chosen as an NSR to assess the operational noise impact from the shipyard.

Assessment Methodology

5.19 The noise level calculations used in this report follow the procedures described in the TMs.

Summation of Noise Levels

5.20 Summation of noise levels has been calculated base on the following formula :

$$\textbf{Total SWL (dB(A))} = 10 \log_{10} \Sigma \, Ni10^{(SWLi/10)}$$

where :
SWL is the sound power level.
SWLi is the SWL of a particular type of powered mechanical equipment (PME).
Ni is the number of that type of PME.

Calculation of Actual Distances

5.21 The actual distance between the NSR and the noise source has been calculated by the following formula :

$$D = (D_H^2 + H^2)^{1/2}$$

where :
D is the actual distance between the NSR and the noise source.
D_H is the horizontal distance between the NSR and the noise source.
H is the height of the NSR above the noise source.

Distance Attenuation

5.22 The predicted noise level at the NSR due to distance attenuation has been calculated as follows :

for construction and operational noise :
PNL at the NSR (dB(A)) = Total SWL - 20 $\log_{10}$ D - 8

for percussive piling :
PNL at the NSR (dB(A)) = Total SWL - 23.27 $\log_{10}$ D - 5.269

where :
PNL is the predicted noise level.
D is the distance between the NSR and the noise source in metres.

Correction for Acoustic Reflections

5.23 A positive correction of 2.5 dB(A) for construction and operational noise while 3 dB(A) was added for percussive piling to the PNL for acoustic reflections from the facade of the NSRs since it is a building.

Barrier Correction

5.24 During the construction phase, there are no natural or manmade barriers between the noise sources and receivers hence barrier correction was not considered. During the operation of the shipyard, it is assumed that no equipment will be visible from any window, door or other opening of any facade of the NSRs. The NSRs can be considered to be partially screened and a negative correction of 5 dB(A) will be applied to the PNL.

Construction Noise

5.25 Three scenarios have been chosen which reflect the noisy stages of construction.

5.26 The likely types and numbers of equipment to be used during these construction scenarios for the To Kau Wan site are given in Table 5.1.

Table 5.1 Construction Equipment for the Construction of the Shipyard Facilities

Scenario	Type of Equipment	Sound Power Level (dB(A))*	No. of Equipment	Sound Power Level for each Scenario (dB(A))
1	Excavator	112	3	127
	Tug boat	110	2	
	Dump truck	117	3	
	Air compressor	100	2	
	Pneumatic breaker	122	2	
2	Concrete lorry mixer	109	2	120
	Concrete pump	109	1	
	Concrete vibrator	113	3	
	Bar bender and cutter	90	1	
	Generator	100	2	
	Drill, hand held (electric)	98	1	
	Saw, circular, wood	108	1	
3	Generator	100	2	119
	Crane, mobile	112	1	
	Drill, hand-held (electric)	98	3	
	Planar, hand-held	117	1	
	Saw, circular, wood	108	1	

* All figures are from Table 3 *Source Sound Power Level for Items of Powered Mechanical Equipment* in the *Technical Memorandum on Noise from Construction Work other than Percussive Piling.*

5.27 Two notional source positions for the construction activities have been chosen, one at the centre of the site and the other nearest to the NSR showing the worst case scenario. The distance between the notional source positions and the NSR is shown below in Table 5.2 and in Figure 5.1.

Table 5.2 Distances between Yiu Lian Dockyards Ltd. Staff Quarters and the Construction Activities (in metres)

Notional Source Position assume at the centre of the site	Notional Source Position assume closest to NSR (worst case scenario)
270	145

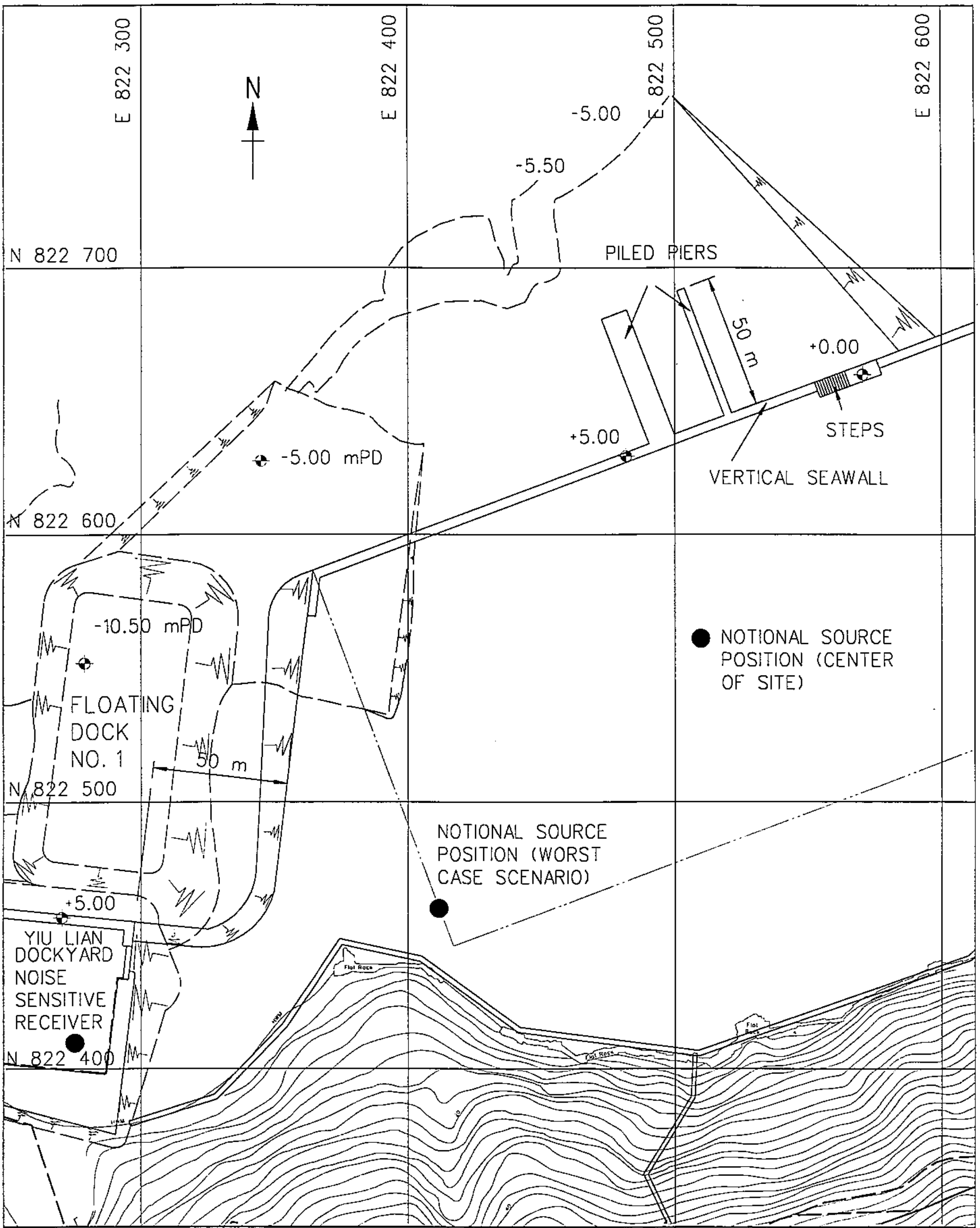
5.28 The predicted noise levels at the Yiu Lian Dockyards Ltd. staff quarters during the construction phase are presented below in Table 5.3.

Table 5.3 Predicted Noise Levels at Yiu Lian Dockyards Ltd. Staff Quarters during the Construction Phase

Scenario	Predicted Sound Pressure Levels (dB(A)) **	
	Notional Source Position assume at the centre of the site	Notional Source Position assume closest to NSR (worst case scenario)
1	73	76
2	66	71
3	65	70

** Assuming the worst affected facade at G/F of the Yiu Lian staff quarters.

5.29 Table 5.3 shows that most of the predicted noise levels at the Yiu Lian Dockyards Ltd. due to To Kau Wan construction does not exceed the daytime criteria of 75 dB(A) except the worst case in scenario 1 which shows a PNL of 76 dB(A). In practice, it would not be possible to use all the equipment in Scenario 1 at the worst case position. For example the tug boat will need to remain north of the main vertical seawall. No day-time exceedances are expected.



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LOCATIONS OF NOTIONAL SOURCES AND NOISE SENSITIVE RECEIVER (CONSTRUCTION NOISE)	土木工程署 Civil Engineering Department	Initial MC	Figure No. 5.1

5.30 The Yiu Lian staff quarters will be occupied during the evening and night-time. In order to undertake restricted hours construction, the contractor responsible for the project would need to apply for a Construction Noise Permit from EPD and show lower levels of activity than those modelled in this assessment and possibly mitigative protection. Noise levels could be reduced by 5-7 dB(A) using simple measures such as earth bunds between the noise source and the staff quarters. The line of sight between the top floor and the equipment would need checking.

5.31 There are no plans for restricted hours workings and these are most likely totally unnecessary.

Percussive Piling

5.32 It is possible that some percussive piling may be required. The worst case scenario for percussive piling has been examined in this section. The type and number of equipment used in three scenarios for the piling works at the To Kau Wan site are given in Table 5.4.

Table 5.4 Equipment Required for the Piling at To Kau Wan Site

Scenario	Type of Equipment	Sound Power Level (dB(A))*	No. of Equipment	Sound Power Level for each Scenario (dB(A))
1	Diesel hammer driving steel pile	132	1	132
2	Diesel hammer driving steel pile	132	2	135
3	Diesel hammer driving steel pile	132	3	137

* All figures are from Table 2 *Source Sound Power Level for Percussive Piling* in the *Technical Memorandum on Noise from Percussive Piling.*

5.33 The notional source position for the piling work is assumed to be that closest to the NSR at 145 m and shown in Figure 5.1.

5.34 The predicted noise levels at the Yiu Lian Dockyards Ltd. staff quarters during such piling works are presented below in Table 5.5.

Table 5.5 Predicted Noise Levels at Yiu Lian Dockyards Ltd. Staff Quarters during the Piling Work

Scenario	Predicted Sound Pressure Levels (dB(A)) ** Notional Source Position assume closest to NSR (worst case scenario)
1	79
2	82
3	84

** Assuming the worst affected facade at G/F of the Yiu Lian staff quarters.

5.35 Table 5.5 shows that even in the worst situation calculated when 3 diesel hammers driving steel piles are operating simultaneously, noise levels do not exceed the ANL of 85 dB(A). This is the level for piling operations permitted on "normal" working days from 0700 to 1900.

5.36 Diesel hammer piling is a particulary noisy form of piling and may soon be phased out by EPD.

Operational Noise

5.37 Operational noise has been assessed by two methods:

- calculation using TM_1; and
- comparison with monitored data.

5.38 During site visits, all noisy equipment noted was monitored, where possible from several angles, at a fixed distance. In many cases, equipment usage was very irregular and intermittent. Some equipment like the sea-water pump is tested and run during the lunch-break when other equipment is quiet. None of the equipment despite its age had noise levels higher than the TM equipments.

5.39 The Penny's Bay site is not a noisy one. Most activity occurs within buildings of most concern is the assembly stage of large steel vessels which occurs in the open air. The clean up of welding seams using hand-held chippers is by far the most intrusive operation. Increasingly younger operatives are adopting the quieter method of using electric grinders. The majority of the noise at the site is generated by small hand-held equipment.

5.40 For the assessment of a total of 8 locations in the new shipyard layout have been identified as potentially generating noise. The likely type and maximum number of equipments to be used at each locations is given in Table 5.6.

Table 5.6 Powered Mechanical Equipments Required during the Operation of the Shipyard

Location	Type of Equipment	Sound Power Level (dB(A)) *	No. of Equipment	Sound Power Level for each Location (dB(A))
Pump Room	Air compressor, standard Sea-water pump (petrol) Generator, standard	109 103 108	1 1 1	112
Timber Mill	Saw, circular, wood	108	1	108
Open Area	Crane, mobile (diesel) Hoist, material (electric) Hoist, material (petrol) Lorry Forklift Crane, on rail (electric)	112 95 104 112 112 112	1 1 1 1 1 1	118
Shot-blasting	Air compressor, silenced	100	1	100
Steel Assembly	Chipper, hand-held Drill, hand-held (electric) Grinder, hand-held (electric)	112 98 98	4 1 1	118
Steel Works (including workshops)	Chipper, hand-held Drill, hand-held (electric) Grinder, hand-held (electric) Metal stamping machine Metal cutter (chopper)	112 98 98 115 90	4 1 1 1 1	120
Fibreglass Moulding	Drill, hand-held (electric) Grinder, hand-held (electric) Planar, hand-held (electric)	98 98 117	1 1 3	122
Fibreglass / Aluminum Assembly	Drill, hand-held (electric) Grinder, hand-held (electric) Planar, hand-held (electric) Metal polisher	98 98 117 98	1 1 3 2	122

* All figures are from Table 3 *Source Sound Power Level for Items of Powered Mechanical Equipment* in the *Technical Memorandum on Noise from Construction Work other than Percussive Piling.*

5.41 The notional source position for each location is assumed to be at the centre of each location. The distance between the notional source positions and the NSRs is shown below in Table 5.7 and Figure 5.2.

Table 5.7 Distances between the NSRs and the Shipyard (in metres)

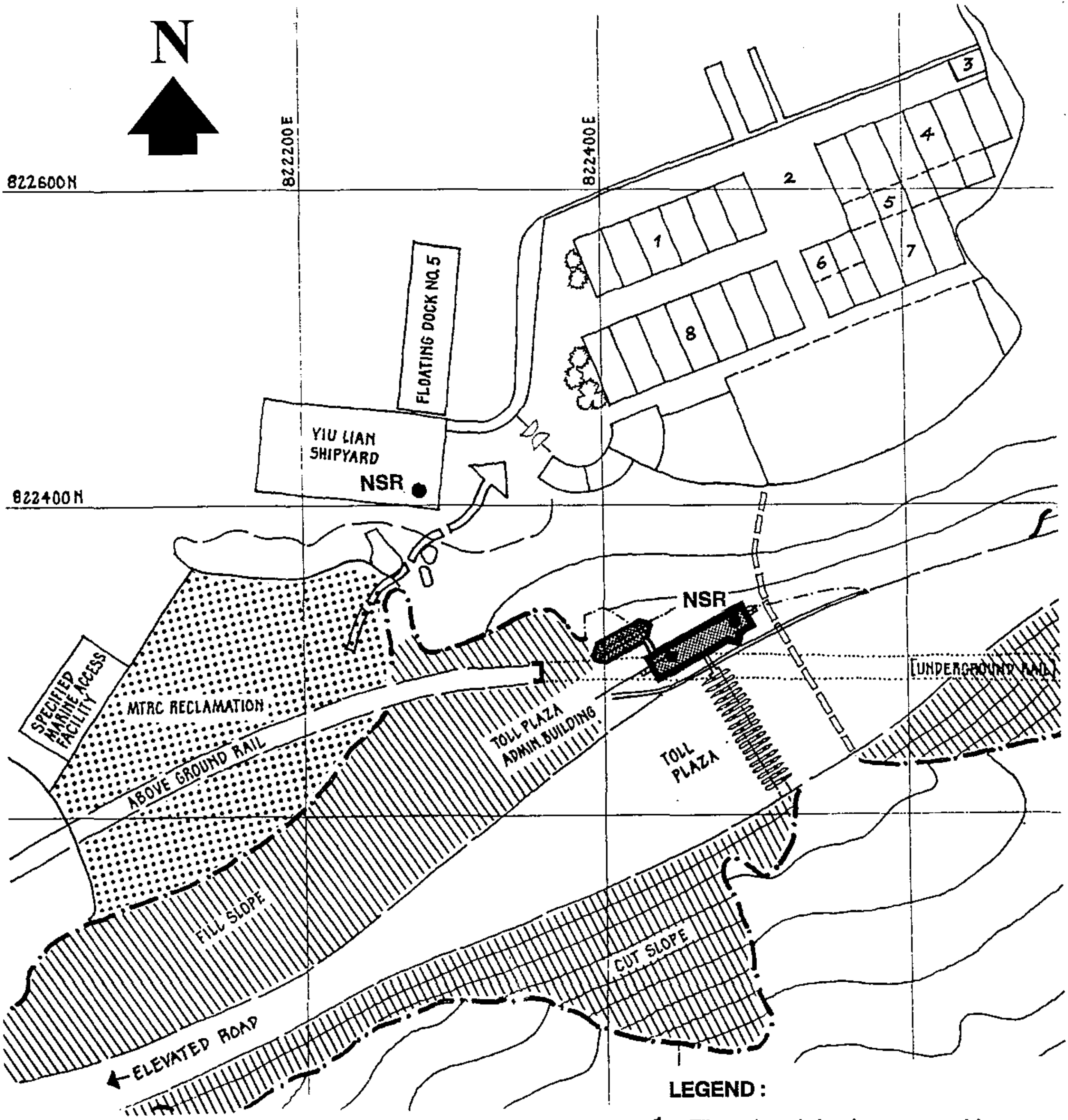
Type of Activity	Horizontal Distance (in metres)		Vertical Distance (in metres)	
	Yiu Lian	Admin. Bldg.	Yiu Lian *	Admin. Bldg.**
Pump Room	450	390	0	43
Timber Mill	310	240	0	43
Open Area	310	275	0	43
Shot Blasting	380	300	0	43
Steel Assembly	395	330	0	43
Steel Works	345	260	0	43
Fibreglass Moulding	205	180	0	43
Fibreglass/ Aluminum Assembly	230	240	0	43

* Assuming the worst affected facade at G/F of the Yiu Lian staff quarters.
** Assuming the worst affected facade at G/F of the administration building.

5.42 The predicted noise levels at the Yiu Lian Dockyards Ltd. staff quarters and the administration building of the Toll Plaza during the operational phase assuming a completely open-air site is presented below in Table 5.8.

Table 5.8 Predicted Noise Levels at Yiu Lian Dockyards Ltd. Staff Quarters and the Administration Building of the Toll Plaza during the Operational Phase. Barrier Effects of Buildings are not included

Predicted Sound Pressure Levels (dB(A))	
Yiu Lian Dockyard Ltd. staff quarters	Administration Building of the Toll Plaza
69	70



LEGEND :

1 Fibre-glass / aluminum assembly
2 Open area
3 Pump room
4 Steel assembly
5 Shot-blasting
6 Timber mill
7 Steel works (including workshops)
8 Fibre-glass moulding

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LOCATIONS OF NOTIONAL SOURCES AND NOISE SENSITIVE RECEIVER (OPERATIONAL NOISE)	土木工程署 Civil Engineering Department	Initial MC	Figure No. 5.2

5.43 The barrier effect of the buildings would reduce operational noise levels by at least 5 dB(A).

5.44 The assessment is a very conservative one. From Table 5.6 and Figure 5.2 it can be seen that the noisiest activities have been placed closest to the NSRs. Even so, exceedances are not expected even if the shipyard were to function until 2300 hours. In practice, the equipment is used intermittently so that it is unlikely that all this activity would operate simultaneously.

5.45 Furthermore, the Yiu Lian staff quarters is not considered to be a true noise sensitive receiver since it is situated inside an industrial undertaking which emits noise.

5.46 The adminstration building of the Toll Plaza, on the other hand, is highly likely to have central air-conditioning with no opening windows. Moreover, the noise will be dominated by the traffic noise from the North Lantau Expressway.

5.47 Further evidence of the general relative quietness of the CLS operation is given in the data collected for the environmental baseline as part of the Lantau Port and Western Harbour Development Studies. This presents completely independent data collected for the purpose of assuming background noise data on Lantau and other islands.

5.48 The noise baseline study was carried out between the 30th October and the 13th December 1991 at 13 locations at Cheung Chau, Peng Chau, Discovery Bay, Hei Ling Chau, Lamma Island, Chi Ma Wan, Silvermine Bay and Penny's Bay. In most cases, monitoring was undertaken on the roofs of houses sometimes within sight of ferry operations. In many cases there were no significant noise sources affecting measurement (APH 1991).

5.49 The following description of the Penny's Bay monitoring site was given (APH 1991):

Area Description: *The shipbuilder and site for the new power station at Penny's Bay occupy most of the coastline area. There is no public transport to Penny's Bay, only private ferries transporting staff to site. There is some squatter housing on the shoreline. Construction work is the main contributor to the ambient noise levels.*

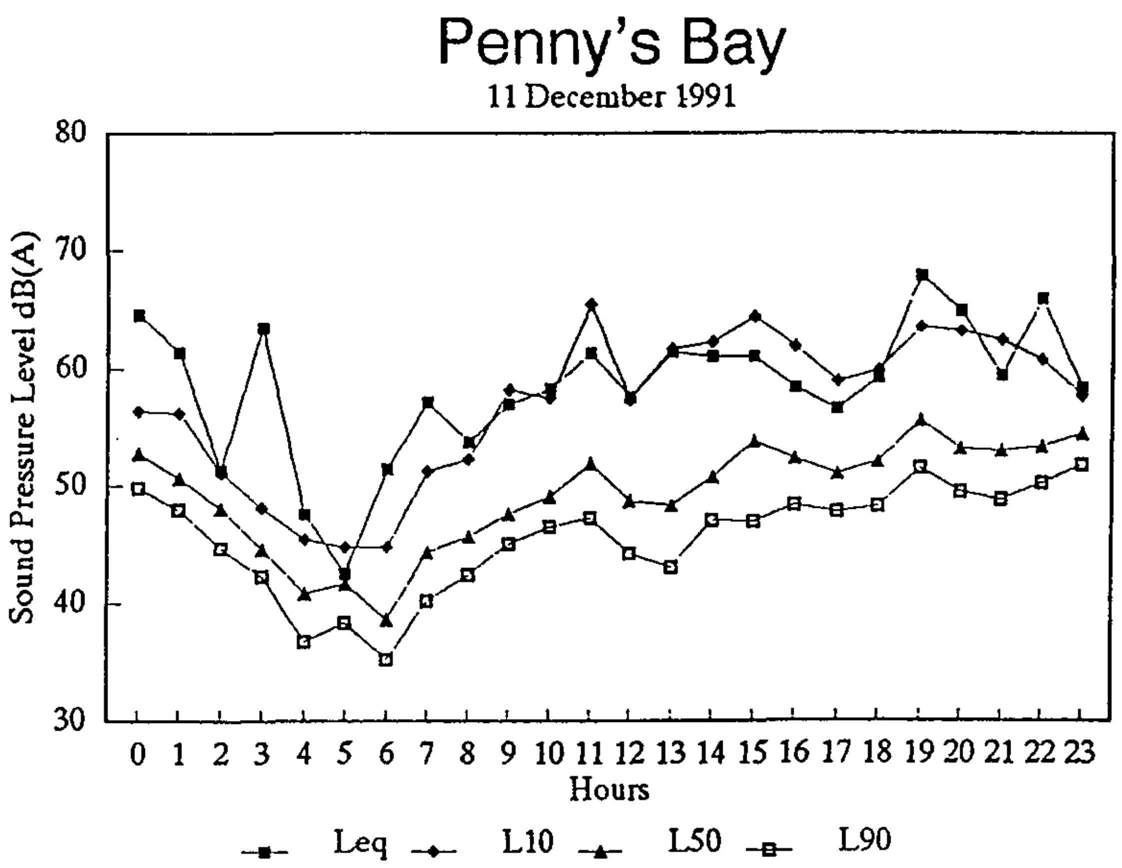
Site: *The monitor was located on the beach next to the Penny's Bay shipyard. The shipyard generates intermittent construction noise, cutting, hammering, machinery operation.*

5.50 The unaudited noise data is reproduced in Table 5.9 and Figure 5.3.

Table 5.9 Noise Data for Penny's Bay: Monitored on the Beach Next to CLS 11 December 1991 (APH 1991)

Monitoring Station 1				
Hour	Leq	L10	L50	L90
0	64.5	56.4	52.8	49.8
1	61.2	56.2	50.7	48.0
2	51.2	51.0	48.1	44.7
3	63.4	48.1	44.6	42.2
4	47.7	45.4	40.8	36.8
5	42.5	44.8	41.7	38.3
6	51.4	44.8	38.6	35.2
7	57.1	51.2	44.3	40.2
8	53.7	52.2	45.7	42.4
9	56.9	58.2	47.6	45.1
10	58.2	57.5	49.1	46.5
11	61.3	65.4	51.9	47.3
12	57.5	57.3	48.7	44.2
13	61.3	61.7	48.4	43.0
14	61.0	62.2	50.8	47.0
15	60.9	64.4	53.8	46.9
16	58.4	61.9	52.4	48.4
17	56.6	58.9	51.1	47.8
18	59.2	59.9	52.1	48.3
19	67.8	63.5	55.6	51.5
20	64.8	63.1	53.2	49.5
21	59.3	62.4	53.0	48.8
22	65.8	60.7	53.3	50.2
23	58.3	57.7	54.4	51.8

5.51 The monitoring site is within a few metres of the CLS docking area. Noise from ferries carrying staff to and from the shipyard and the squatter area would dominate the recorded noise. The monitoring site is also close to the squatter area.



TO KAU WAN OPERATIONAL EIA

GRAPHICAL ANALYSIS OF NOISE DATA TAKEN AT PENNY'S BAY ON 11 DECEMBER 1991
(Source : APH Consultants 1991b)

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土木工程署 Civil Engineering Department

Date	Scale
91	N.T.S.
Initial	Figure No. 5.3

5.52 Table 5.10 is the summary of noise data collected by APH Consultants. It is of note that L_{90} data for Penny's Bay was the lowest of all 13 sites during 0700 to 1900 hours. This provides additional and independent evidence of the relative quietness of the CLS operations.

Table 5.10 Summary of Noise Data collected in 1991 by APH Consultants (APH 1991)

		L_{90} dB(A)					
		Day 0700 - 1900 hrs		Evening 1900 - 2300 hrs		Night 2300 - 0700 hrs	
Monitoring Locations		Min	Max	Min	Max	Min	Max
1	Penny's Bay	40.2	48.4	48.8	51.5	35.2	51.8
2	Discovery Bay North	45.0	49.8	45.5	46.7	39.8	44.8
3	Discovery Bay South	50.4	58.0	47.5	51.1	35.2	48.0
4	Peng Chau North	50.1	54.9	48.2	52.8	42.8	49.0
5	Peng Chau South	52.3	56.7	46.3	52.3	43.1	50.8
6	Silvermine Bay	58.2	61.5	61.6	63.5	58.2	63.4
7	Hei Ling Chau North	46.2	49.3	44.9	45.9	42.3	45.7
8	Hei Ling Chau South	48.8	53.3	47.4	48.8	43.1	47.2
9	Chi Ma Wan	48.3	55.1	45.1	49.2	44.3	47.2
10	Cheung Chau North	56.4	63.3	56.5	57.0	55.3	58.2
11	Cheung Chau South	48.5	55.1	46.5	49.2	44.3	47.2
12	Lamma Island North	55.0	58.4	54.7	55.1	53.3	57.4
13	Lamma Island South	41.8	50.0	41.9	39.5	37.3	42.4

Conclusions

5.53 Very conservative assessment of potential noise generated by the construction and operation of CLS facilities at To Kau Wan suggest that exceedances of acceptable noise levels at the closest noise sensitive users are unlikely.

5.54 There are no true noise sensitive receivers (NSRs) in the study area. Two nearby facilities have been treated as NSRs for the assessment.

6. AIR IMPACT ASSESSMENTS

Introduction

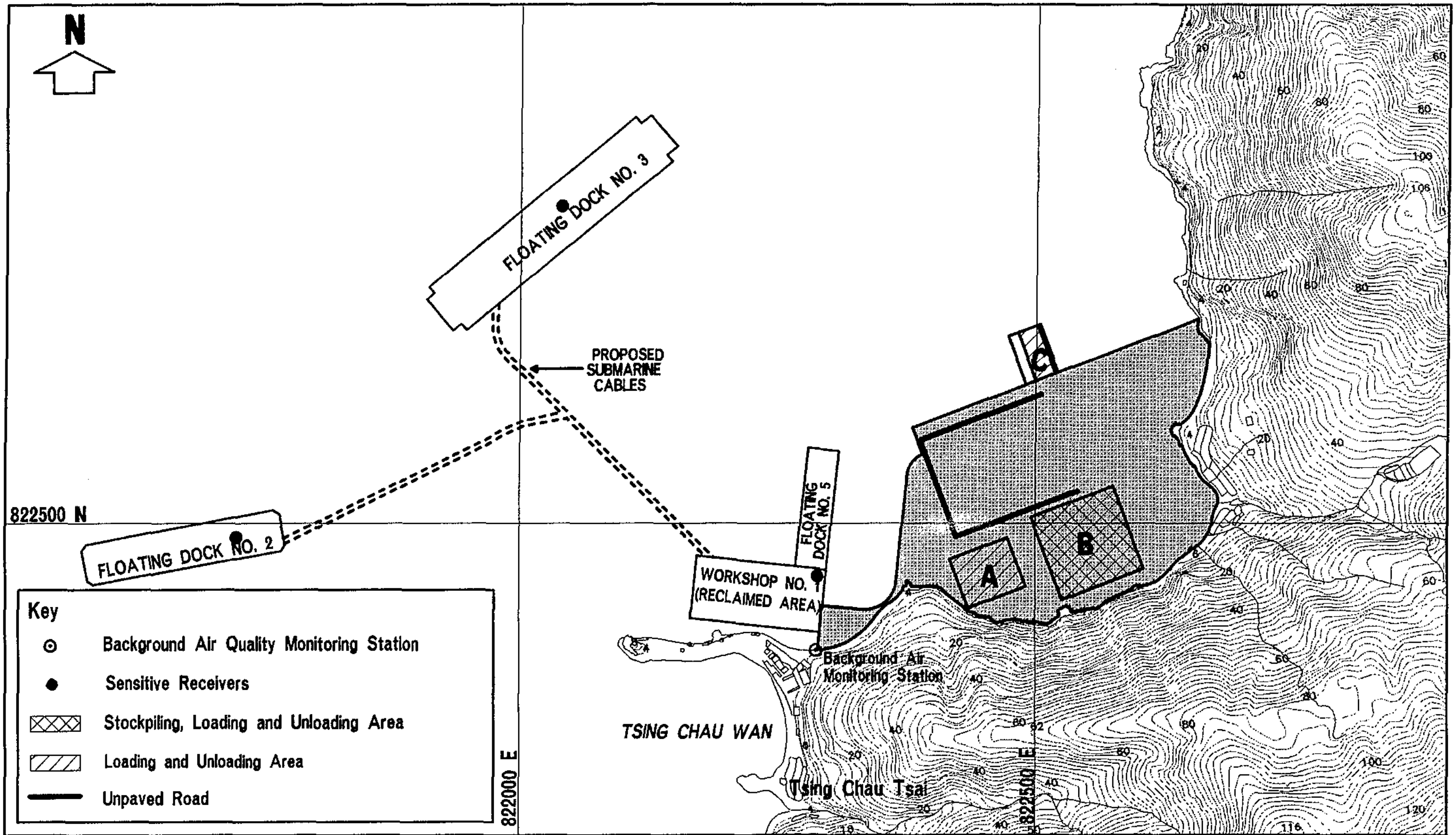
6.1 This chapter records air quality assessment studies undertaken for the construction and operation of shipyard facilities at To Kau Wan. The assessment of dust generated during the reclamation of the site was reported in an earlier EIA (BCL 1994a).

6.2 The Toll Plaza, part of the Lantau Fixed Crossing contracts, is being constructed south of To Kau Wan on the ridge above the bay. Principal earth movement with consequent dust generation occurs under the Advanced Earthworks contract. This contract began in November 1993 and will be completed in early 1995 before the commencement of the construction of any shipyard facilities. This contract has had considerable impact on air quality in the study area. The Toll Plaza itself during operation raises levels of vehicle emission pollutants in the study area.

6.3 The East Lantau rail tunnels will be constructed over a period of about 2½ years commencing within the next month or so. It will involve extensive blasting activities but dust generation will be limited by the blasting being undertaken within the tunnels. The operation of the rail system is not expected to impact on air quality.

6.4 Yiu Lian Dockyards operates in close proximity to the To Kau Wan site. The administration and fixed dock area lie next door (Figure 6.1). Floating docks complete the enterprise. These areas were identified as the closest air sensitive receivers (ASRs) in the Reclamation EIA studies (BCL 1994a). The staff quarters complex close to the site has again been chosen as an ASR and prediction point for modelling studies (Figure 6.1) as well as Floating Dock No. 3.

6.5 Yiu Lian Dockyards operations involve a great deal of painting. The smell of paint is apparent when passing the dockyards. Excessive dust can cause problems for painting operations.



TO KAU WAN OPERATIONAL EIA

LOCATIONS OF DISCRETE RECEIVERS, BACKGROUND AIR MONITORING STATION AND PROPOSED DUST SOURCES

BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 Engineers and Scientists 賓尼	Date: FEB 95	Scale: 1 : 5000
土木工程署 Civil Engineering Department	Initial: YPS	Drawing No.: FIGURE 6.1

6.6 The following extract is from a letter from the LFC Project Management Office of the Highways Department to the Mass Transit Railways Corporation (LFCPMO 1993):

> *"Another major concern of the shipyard was the effect dust caused by blasting and earthworks on the painting activities at the shipyard. This office confirmed that the highest 1 hour total suspended particulate (TSP) concentration at Yiu Lian Floating Docks No. 2 and No. 3 resulting from the LFC works and including background levels is calculated to be 1500 $\mu g/m^3$ and 1700 $\mu m/m^3$ respectively. These figures will be reduced by about 10% as a result of the introduction of mitigating measures where possible, but the largest effect is due to rock drilling and blasting work where no mitigatory actions are available. The 24-hour averaged TSP concentrations, which take account of the fact that rock blasting is intermittent and winds variable, are considerably smaller. Nevertheless, it was understood from a meeting with the Yiu Lian paint supplier that the maximum 1 hour TSP levels quoted can be tolerated during painting operations."*

6.7 It should be noted that this letter suggests that background levels for the To Kau Wan site could be very high at times. It is recommended that careful records be kept in a site logbook of any particularly dusty activities occurring near the site by any Contractor involved with the To Kau Wan site.

6.8 The only source of air pollution generated from the construction of shipyard facilities works of any possible consequence is dust generation. The worst case scenario for dust pollution has been examined quantitatively using the Fugitive Dust Model (FDM). The results are discussed in the context of the background environment. Mitigation measures have been suggested to minimise dust emissions.

6.9 No major operational phase air quality impacts have been identified at the Penny's Bay site. Odour is only apparent inside a limited number of buildings that have been identified during two site visits to the existing shipyard at Penny's Bay.

6.10 At the new site, the more compact nature of the site layout may lead to a need for changes in the approach to ventilation. Review of the situation on the odour emission from the future operation of the shipyard at To Kau Wan is given in the second half of this chapter.

6.11 As in the case for all other assessments, a double worst case scenario approach has been taken. Firstly it has been assumed that virtually all activities have been shifted to the new site and secondly activities have been sited so as to cause 'worst case' impacts on the nearest sensitive receivers. This approach ensures that whatever final layout is chosen environmental impacts will be less than those assessed in this report.

The Construction Phase

The Background Environment

6.12 Dust monitoring has been undertaken under the "Lantau Toll Plaza (Advance Earthworks) of the Lantau Fixed Crossing, Contracts No. HY/93/02". Dust monitoring station 9 of this project is located just beside the To Kau Wan site boundary, on the landward side of the Yiu Lian Dockyards. The dust monitoring work at this location commenced late January 1994. The data made available to the EIA team is presented graphically in Figure 6.2. Total Suspended Particulates (TSP) were measured over 1-hour periods using a small portable monitor initially and later using a high volume sampler.

6.13 This background shows a great deal of variation. It is believed that monitored dust levels have risen again as the result of heavy truck movement of a stockpile from the Toll Plaza to Yam O.

6.14 Before construction of the shipyard facilities start, background levels of dust are expected to drop as the result of completion of the Advanced Earthworks contract. The geometric mean of the data presented here is 70 $\mu g/m^3$. This has been taken as the background TSP level.

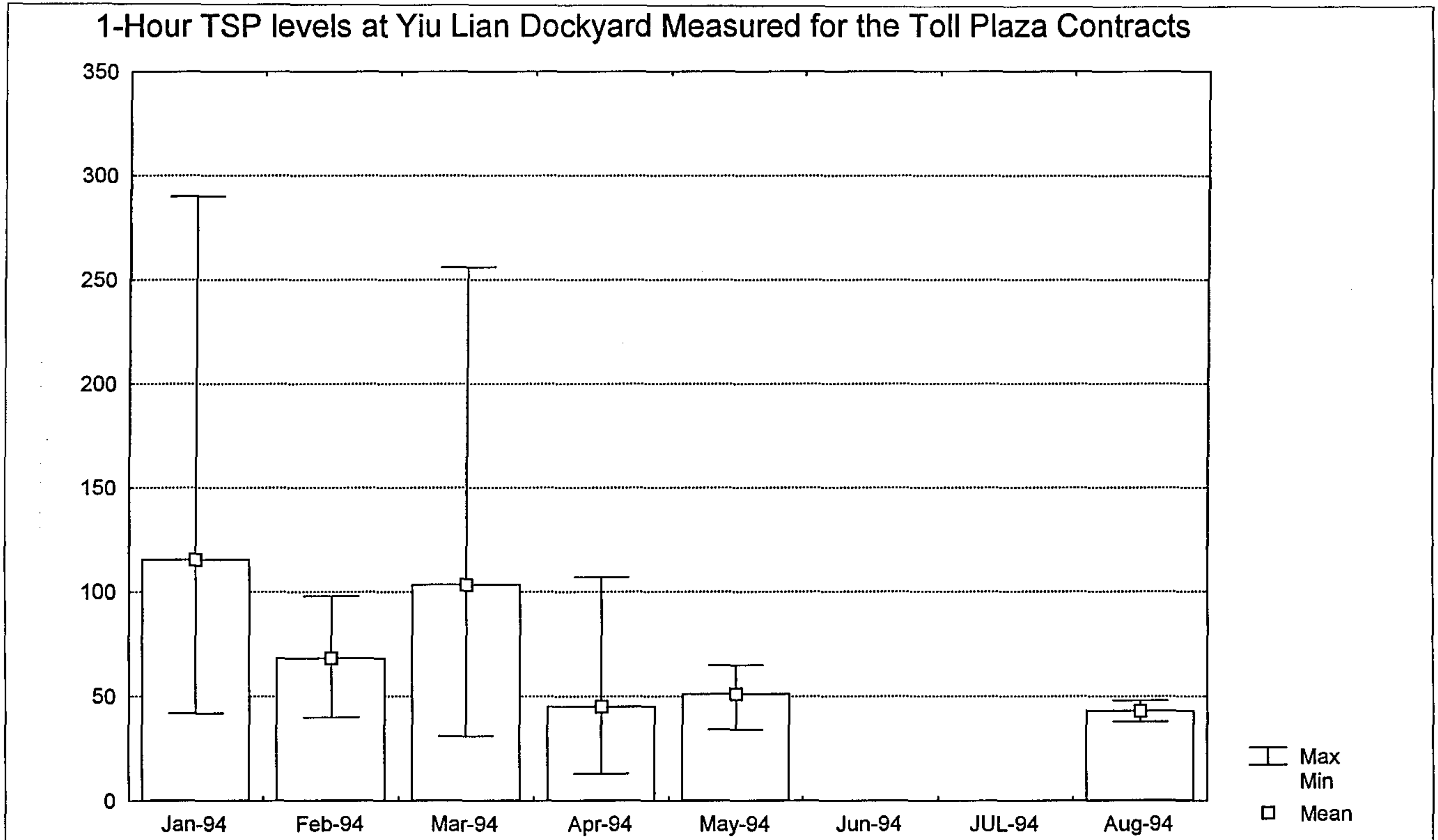
6.15 The Toll Plaza administration building is due for completion in mid 1996. No marine access will be available to the Penny's Bay by the end of 1996. Hence all heavier construction of the new facilities will need completion well before the end of 1996.

Assessment Approach

6.16 The impacts of TSP and RSP on the sensitive receivers have been evaluated using the Fugitive Dust Model (FDM). The results obtained were then compared with the Air Quality Objectives (AQO).

6.17 Two independent assessments have been undertaken:

- a scenario has been formulated which includes the following processes:
    - ground level excavation work;
    - loading and unloading of excavated materials for stockpiling and barging (possibly 30% of excavated materials);
    - stockpiling of 70% of excavated materials;
    - vehicular travel over unpaved roads; and
    - natural wind erosion of top soil.
- by using general emission factors for a heavy civil site.



TO KAU WAN OPERATIONAL EIA

BACKGROUND DUST LEVEL

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土木工程署 Civil Engineering Department

Date	Scale
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Initial	Figure No.
PC	6.2

6.18 Both these assessments are extremely conservative as the buildings are most likely to be single-storey and relatively simple in construction. The main site which has been engineered for occupation is 250 metres x 150 metres. Only the administration building and the steelworks are likely to be multi-storey with consequent heavier foundation requirements.

Dust Impact Assessment Criteria

6.19 The Hong Kong Air Quality Objectives stipulate maximum acceptable concentrations of pollutants in air. The dust concentrations are show in Table 6.1.

Table 6.1 Hong Kong Air Quality Objectives

Pollutant	Concentration ($\mu g/m^3$)		
	1 hour	24 hours[(1)]	1 year
Total Suspended Particulates (TSP)	500*	260	80
Respirable Suspended Particulates (RSP)	Nil	180	55

Notes: Concentrations measured at 298°K (25°C) and 101.325 kPa.

(1) 24-hour criteria not to be exceeded more than once per year.
* This control limit has no statutory basis but is a guideline recommended by EPD.

Assessment Methodology

Fugitive Dust Model (FDM)

6.20 In order to assess the impact of construction dust emissions on the surrounding area, the Fugitive Dust Model (FDM) has been used. A detailed description of the model is given by the User's Guide (TRC, 1990). Briefly, FDM which is an atmospheric dispersion model is specifically designed for the analysis of fugitive dust sources. The model is based on the widely used Gaussian Plume formulation for estimating pollutant concentrations, but has been adapted to incorporate a gradient-transfer deposition algorithm which accounts for the settling out of dust particles, and to include the wind dependence factor on the dust emission rates.

6.21 The site has been divided into a 9 x 7 grid with a grid size of 50 metres. For modelling purposes, the worst case scenario has been considered. Three (3) discrete receivers have also been chosen as calculation points for FDM, the Yiu Lian Floating Docks Nos. 2 and 3, and the workshop and dock No. 1 where staff quarters are sited. These are the nearest air sensitive receivers and have been given identical identification codes as in the Reclamation EIA (BCL 1994a). These sites are regularly downwind of the To Kau Wan site (and the Toll Plaza works).

6.22 The assessment has been based on 1992 sequential meteorological data at the Mobil Oil Depot, Tsing Yi Station containing the hourly wind direction, wind speed, stability and temperature. The surface roughness height used in the assessment is 10 cm.

6.23 The wind rose shows mainly the wind speed and direction of this station. There is a predominant easterly and southerly wind at Tsing Yi Island (Figure 6.3). To Kau Wan is surrounded by ridges in the eastern and southern sides that is naturally sheltered from the prevalent wind.

Dust Sources

6.24 Dust could be generated if our theoretical stockpile of material is moved to the shoreward part of the site. The shifting of the material (70%) for stockpiling would probably be undertaken using two loaders 30% of excavation material being barged directly off-site. To model this situation as 'loading and unloading' and transport over unpaved road is a very conservative approach.

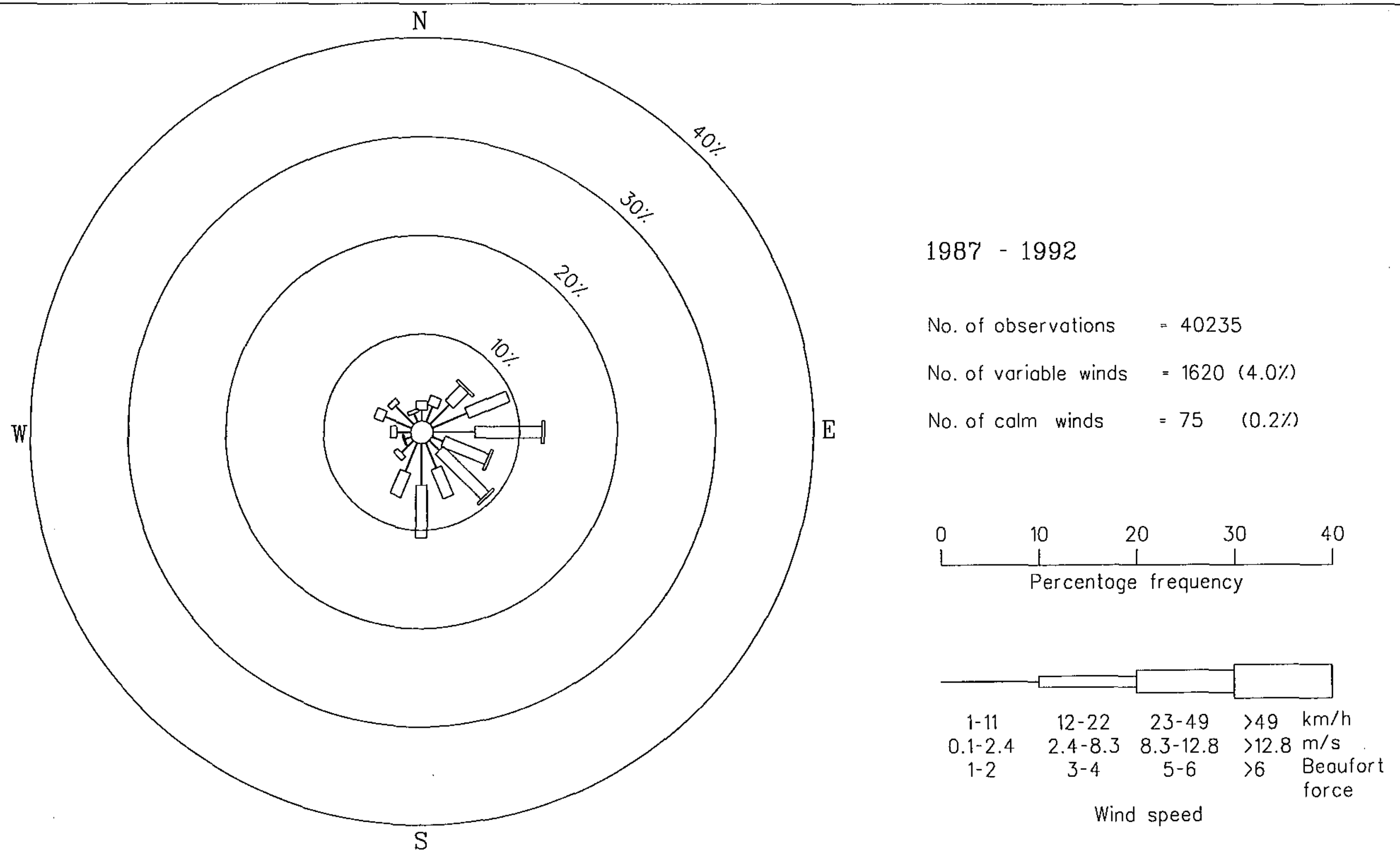
The dust sources would then be:

(i) loading and unloading;
(ii) stockpiling;
(iii) unpaved roads; and
(iv) wind erosion of the whole exposed area.

<u>Loading and Unloading</u>

6.25 The dust sources associated with the loading and unloading of the excavation works have been considered as area sources.

The quantity of particular emissions generated by a batch drop or continuous drop operation, per ton of material transferred, may be estimated with a rating of A using the following empirical expression (USEPA 1994, para. 13.2.2-3):



TO KAU WAN OPERATIONAL EIA	Date : Jan. 95	Scale : -
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$$E = k\,(0.0016)\,\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}\ (kg/Mg) \qquad (6.1)$$

where:

E	=	emission factor,
k	=	particle size multiplier (dimensionless),
U	=	mean wind speed (m/s),
M	=	material moisture content (%).

Equation (6.1) can be generalised as following:

$$E' = Q_o\, U'^{w} \qquad (6.2)$$

where Q_o is the "unadjusted" emission factor which does not consider the change of hourly wind speed and direction, U' is hourly wind speed and w is the wind dependent factor. E is the mean value of E's. It is noted that equation (6.2) is a general equation for all emission factors. The power of U is 1.3 in equation (6.1) that W = 1.3 in equation (6.3).

6.26 Using equation (6.1) and (6.2), the emission factors for TSP and RSP can be estimated by the required data listed in Table 6.2.

Table 6.2 Physical Data for Evaluating the Impact of Loading and Unloading

Parameters of Equation (l)	TSP	RSP
Particle Size Multiplier (k)	0.74 (USEPA 1994: para. 13.2.2-3)	0.35 (USEPA 1994: para. 13.2.2-3)
Material Moisture Content (M)	4%	4%

6.27 By the use of equation (6.1), the "unadjusted" emission factor for TSP becomes:

$$Q_o = 0.74\,(0.0016)\,\frac{\left(\frac{1}{2.2}\right)^{1.3}}{\left(\frac{4}{2}\right)^{1.4}}\ (kg/Mg) \qquad (6.3)$$
$$= 1.61 \times 10^{-4}\ kg/T$$

6.28 The "unadjusted" emission factor for RSP becomes:

$$Q_o = 0.35\ (0.0016)\ \frac{\left(\frac{1}{2.2}\right)^{1.3}}{\left(\frac{4}{2}\right)^{1.4}}\ (kg/Mg) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (6.4)$$

$$= 7.61 \times 10^{-5}\ kg/T$$

The wind dependent factor, w, in this case is 1.3.

6.29 Assuming a density of 1.987×10^3 kg/m^3 and a peak excavation rate of 20 m^3/hr, the material to be shifted per hour is 39.7 T/hr, i.e.

$$1.987 \times 10^3 \text{ kg/m}^3 \times 20 \text{ m}^3\text{/hr} = 39740 \text{ (kg/hr)} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (6.5)$$

The unadjusted emission rate for TSP is 1.78×10^3 g/sec,

$$\frac{1.61 \times 10^{-4}\ kg/T \times 39.7\ T/hr}{3.6} = 1.8 \times 10^{-3}\ (g/\text{sec}) \quad \ldots\ldots\ldots\ldots\ldots \quad (6.6)$$

where 3.6 is the conversion factor for the change of kg/hr to g/sec. The unadjusted emission rate for RSP is 8.4×10^{-4} g/sec,

$$\frac{7.61 \times 10^{-5}\ kg/T \times 39.7\ T/hr}{3.6} = 8.4 \times 10^{-4}\ (g/\text{sec}) \quad \ldots\ldots\ldots\ldots\ldots \quad (6.7)$$

6.30 Three areas, A, B and C, have been used as the loading and unloading area for the construction of shipyard facilities. Area A has been chosen as the most excavated area because of its close proximity to the sensitive receivers and the probable stronger foundation requirement for the administration building. If any material is stockpiled this is most likely in Area B. Hence 70% of excavated material has been stockpiled in Area B and the rest has been barged off site at Area C (Figure 6.1).

6.31 Consequently, the unadjusted emission rate per unit area can be calculated from equation (6.6) and (6.7) and then substituted into equation (6.2).

6.32 Following the same procedures, Table 6.3 are the results of the calculated emission rates for the three areas.

Table 6.3 Emission Rates for Evaluating the Impact of Loading and Unloading

Loading and Unloading Area	Area (m^2)	Emission Rate ($g/s/m^2$)	
		TSP	RSP
A	3584	5.0E-7	2.3E-7
B	7040	2.5E-7	1.2E-7
C	960	1.9E-6	8.8E-7

Stockpiling

6.33 For emissions from wind erosion of active storage piles, the emission rate for TSP is from AP-42 (USEPA 1985, equation 3, p11.2.3-5) with rating C for sand and gravel material (the reclamation is filled with marine sand):

$$E = 1.9\left(\frac{S}{1.5}\right)\left(\frac{f}{15}\right)\left(\frac{365-P}{235}\right) \quad (kg/day/hectare) \quad \ldots\ldots\ldots\ldots\ldots\ldots (6.8)$$

where

E	=	emission rate
s	=	silt content of aggregate (%)
f	=	percent of time that wind speed exceeds 5.4 m/s at mean pile height
p	=	number of days with at least 0.254 mm of precipitation per year

6.34 The parameter 'f' requires some modification. Royal Observatory (RO) measures the wind speed at a height of 10 metre above ground level. In case of height less than 10 metre, a log wind profile (Roland 1988) can be used to estimate the wind speed at the pile height (Appendix C). The ratio between the wind speed at 10 metre and that at pile height is the conversion factor that converts the percentage provided by RO to the percentage at pile height. For an example of pile height of 5 m, the conversion factor is 83%. Given the RO percentage of 8.44% that wind speed exceeds 5.4 m/s at mean pile height, the percentage at pile height is thus 8.44% x 0.83 = 7.0%.

6.35 With this 7.0% percentage and 1.6% silt content of aggregate, based on Table 11.2.3-1 in AP-42 (mean value for stone processing), the emission rate is 1.06 kg/day/hectare.

$$E = 1.9\left(\frac{1.6}{1.5}\right)\left(\frac{7}{15}\right)\left(\frac{365-100}{235}\right) \quad \ldots\ldots (6.9)$$

$$= 1.06 \quad (kg/day/hectare)$$

Given 1 hectare = 10^4 m^2, the emission rate is

for TSP = 1.2 E-6 g/s/m^2.

6.36 Since there is no specified emission rate for RSP given in AP-42, 50% TSP is assumed as the emission for RSP. Thus, the emission rate is

for RSP = 0.6 E-6 g/s/m^2.

Unpaved Road

6.37 The top soil and other fill materials at the excavation site would be transported by a maximum of two dump trucks. They would cause dust emission when they travel over unpaved roads.

6.38 The emission factor to be used is from AP-42 (USEPA 1985; equation 1, p11.2.1-1) with emission factor rating A:

$$E = k\,(1.7)\left(\frac{s}{12}\right)\left(\frac{S}{48}\right)\left(\frac{W}{2.7}\right)^{0.7}\left(\frac{w}{4}\right)^{0.5}\left(\frac{365-p}{365}\right) \quad (kg/VKT) \quad \ldots\ldots (6.10)$$

where

E	=	emission factor
k	=	particle size multiplier (dimensionless)
s	=	silt content of road surface material (%)
S	=	mean vehicle speed, km/hr
W	=	mean vehicle weight, Mg(ton)
w	=	mean number of wheels
p	=	number of days with at least 0.254 m of precipitation per year
VKT	=	vehicle kilometre travelled

6.39 The data for estimation the emission rates from unpaved roads due to construction are summarised in Table 6.4.

Table 6.4 Physical Data for Evaluating the Impact of Unpaved Road

Parameters	TSP	RSP
Particle size Multiplier (k)	0.8	0.36
Silt content of Road Surface Material (s)	15%	15%
Mean Vehicle Speed (S) km/hr	25	25
Mean Vehicle Weight (W) tonnes	20	20
Mean number of Wheels (w) (Nissan Motor Co. and Caterpiller Inc. USA)	8	8
Number of Rainy Days per year (Royal Observatory)	100 days	100 days

6.40 The safe speed for the vehicles travelling on the dirt roads within the site would be a maximum speed of 25 km/hr.

6.41 The maximum distance that the dump trucks could travel on the site is the dirt road distance of roughly 1 km for a round trip. These doubling distances will be simulated by modelling the line sources twice in the FDM run. The dust source due to dump truck traffic on dirt roads will be identified as a line source. As shown in Figure 6.1 siting of the dirt road is as long as possible and as close as possible to the nearest ASR.

6.42 VKT can be expressed as total vehicle movement per hour. Maximum construction vehicle movement per hour (round trips) has been determined in discussions with civil engineers (4 veh/hr).

6.43 For constructional dust, the wind dependent factor is zero. So the emission factor becomes:

$$E = 0.8\ (1.7)\left(\frac{15}{12}\right)\left(\frac{25}{48}\right)\left(\frac{20}{2.7}\right)^{0.7}\left(\frac{8}{4}\right)^{0.5}\left(\frac{365-p}{365}\right)\ (kg/VKT) \quad \ldots\ldots\ (6.11)$$

i.e. E = 3.7 kg/VKT.

With 4 veh/hr and kg/VKT in terms of g/m/s by a conversion factor of

$$\left(\frac{vehicle\ /\ hour}{3.6\ \times\ 1000}\right),$$

the emission rate for TSP is

$$\left(\frac{3.7}{3.6 \times 1000}\right) \times 4 = 0.004\ g/m/s \quad \ldots\ldots\ldots\ldots \quad (6.12)$$

For RSP, the emission rate is 0.0018 g/m/s.

Wind Erosion of the Whole Exposed Area

6.44 The TSP emission factor of wind erosion of exposed areas (USEPA 1985, Table 8.24-4) is 0.85 Mg/hectare/yr. Given 1 hectare = 10^4 m^2, the emission rate for TSP becomes:

$$\frac{0.85 \times 1000}{10^4 \times 365 \times 24 \times 3.6} = 2.69\ E{-6}\ g/s/m^2 \quad \ldots\ldots\ldots\ldots \quad (6.13)$$

6.45 Since the emission rate of RSP is not available in AP-42, 50% of TSP is assumed to be the emission rate of RSP. Thus the emission rate of wind erosion of the whole exposed area is

for RSP = 1.34×10^{-6} $g/s/m^2$

6.46 The modelled worst case scenario has combined all identified dust emission sources together. FDM was used to predict yearly average, the worst 24-hour average and the worst 1-hour average for TSP and RSP concentrations from the combined sources.

6.47 A second run was undertaken assuming that twice-daily watering of all dirt roads would reduce dust emissions by 50% assuming all the road was thoroughly watered. The emission rate for unpaved road was halved in the second run. The emission factors for loading and unloading, stockpiling and wind erosion remained the same.

Modelling Results

6.48 The results of the FDM are tabulated and illustrated on the following pages. Traffic moving over dirt roads generates most of the dust. It is important to emphasize that the model and its results are very conservative.

6.49 The TSP results are presented in Tables 6.5 to 6.7 and Figures 6.4 to 6.12. They suggest that under the worst case scenario condition it may be necessary to mitigate dust generation from unpaved roads. Theoretically, if enough water is applied to haul routes, the emission rate tends to zero and no dust is generated. In practice, 90% reduction can be achieved by increasing watering frequency to four times per day. Thorough watering of haul routes twice a day reduces dust emission by approximately 50% (Jutze 1974).

Table 6.5 TSP - Yearly Average Concentration ($\mu g/m^3$)

Prediction Points	All Sources (No Mitigation)	All Sources (Some Mitigation)*
Dock 1	65	34
Dock 2	4	2
Dock 3	7	4

* 50% reduction in emission rate for unpaved road

Table 6.6 TSP - Worst 24-Hour Average Concentration ($\mu g/m^3$)

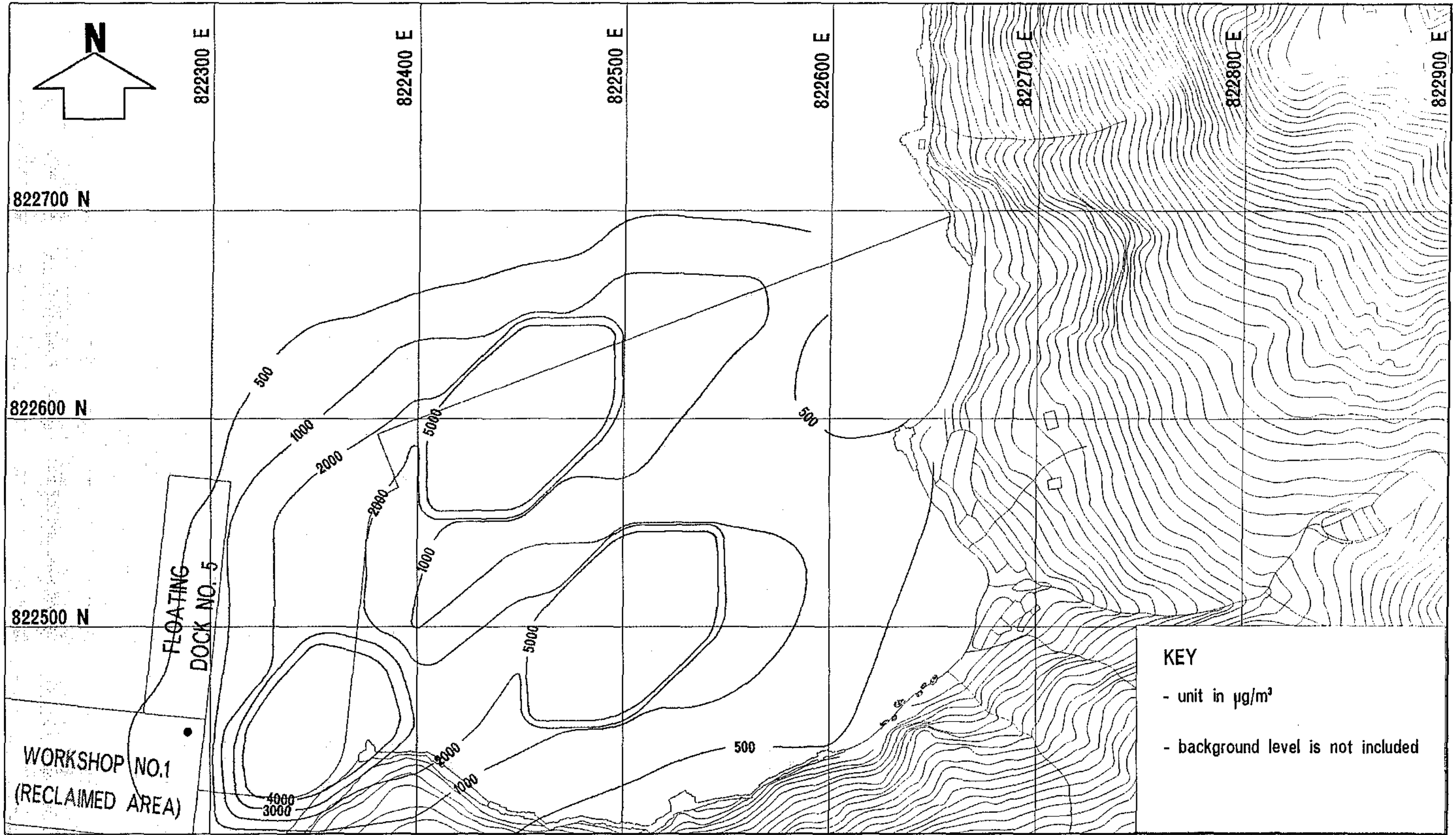
Prediction Points	All Sources (No Mitigation)	All Sources (Some Mitigation)*
Dock 1	291	152
Dock 2	22	12
Dock 3	39	21

* 50% reduction in emission rate for unpaved road

Table 6.7 TSP - Worst 1-Hour Average Concentration ($\mu g/m^3$)

Prediction Points	All Sources (No Mitigation)	All Sources (Some Mitigation)*	Background + All Sources (Some Mitigation)*
Dock 1	586	305	376
Dock 2	42	22	93
Dock 3	76	40	111

* 50% reduction in emission rate for unpaved road



TO KAU WAN OPERATIONAL EIA

FDM - WORST CASE SCENARIO

1 - HOUR TSP GROUND LEVEL (ALL SOURCES COMPLETELY UNMITIGATED)

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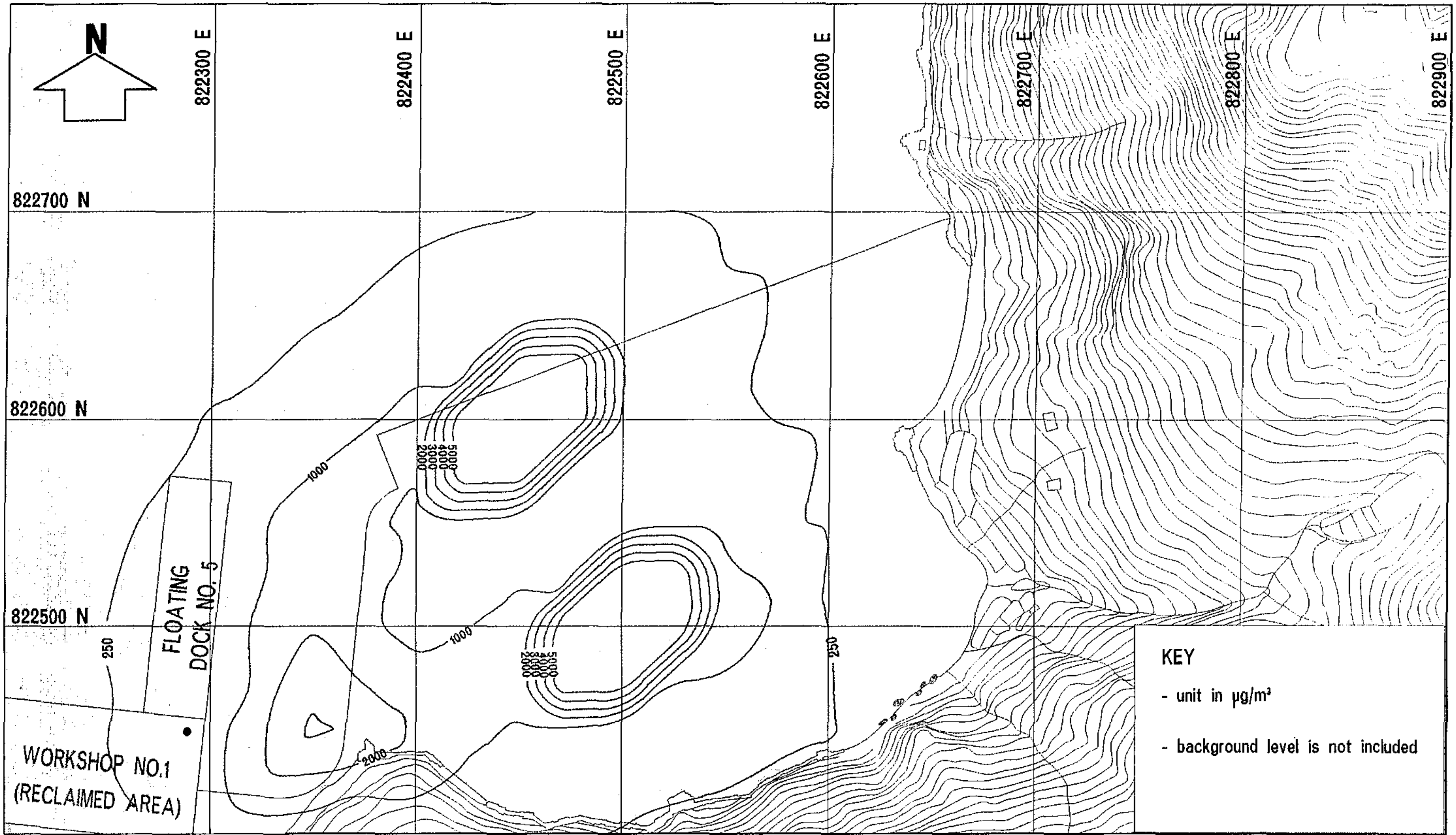

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FDM - WORST CASE SCENARIO

24 - HOUR TSP GROUND LEVEL (ALL SOURCES COMPLETELY UNMITIGATED)

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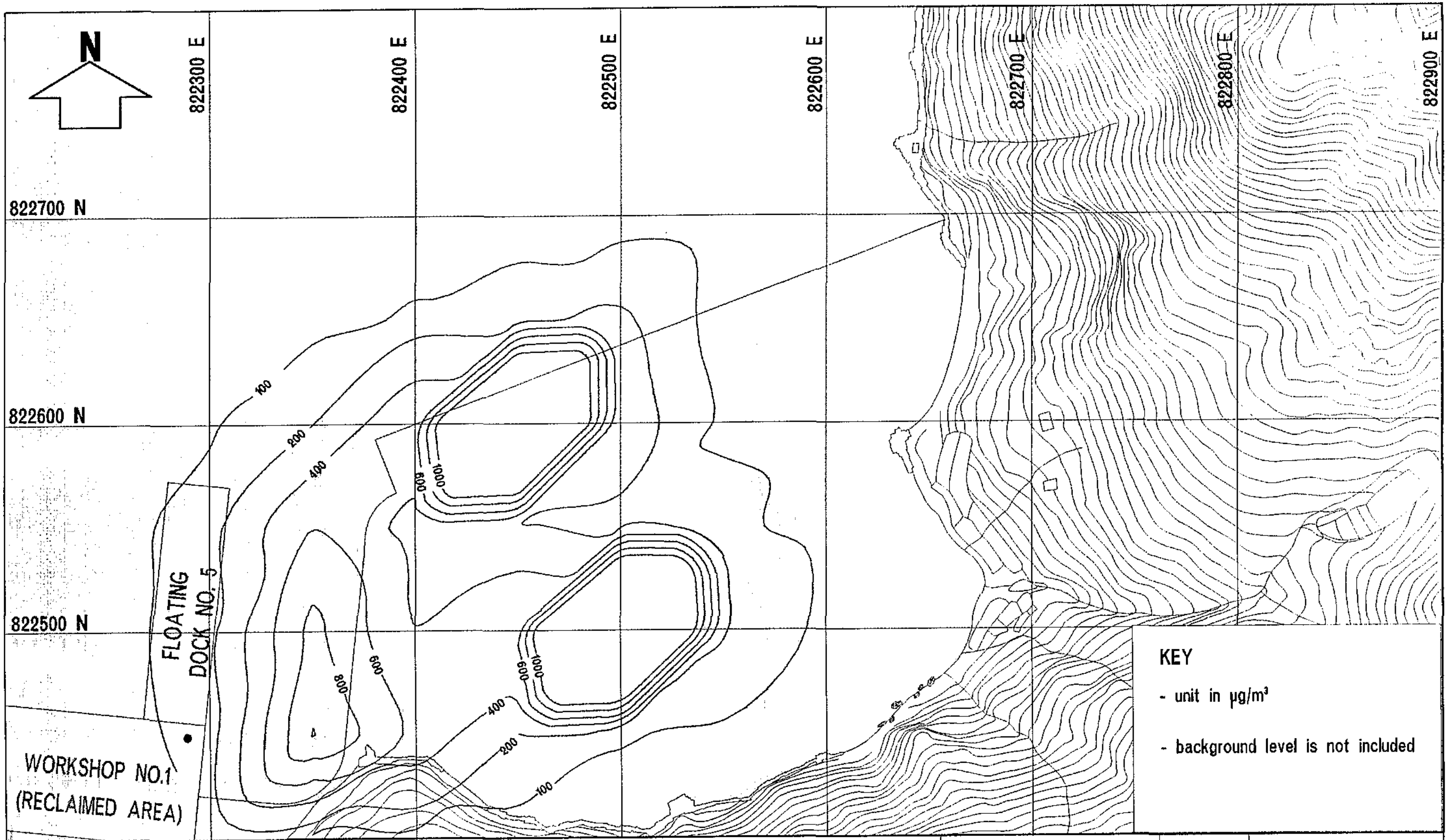
土木工程署 Civil Engineering Department	Initial YPS	Drawing No. FIGURE 6.5



TO KAU WAN OPERATIONAL EIA
FDM - WORST CASE SCENARIO
YEARLY TSP GROUND LEVEL (ALL SOURCES COMPLETELY UNMITIGATED)

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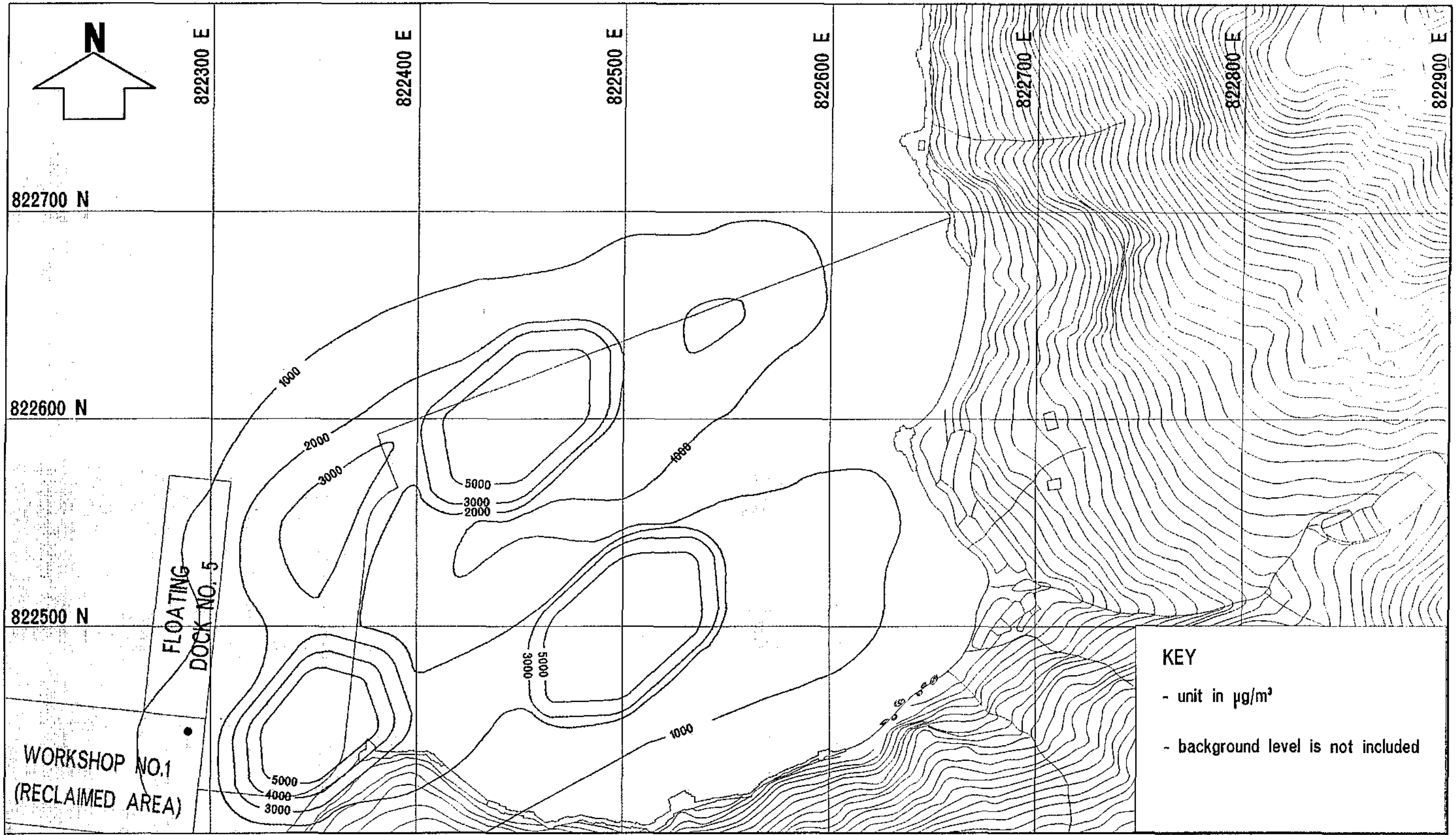
土木工程署 Civil Engineering Department	Initial YPS	Drawing No. FIGURE 6.6



TO KAU WAN OPERATIONAL EIA

FDM - WORST CASE SCENARIO

1 - HOUR RSP GROUND LEVEL (ALL SOURCES COMPLETELY UNMITIGATED)

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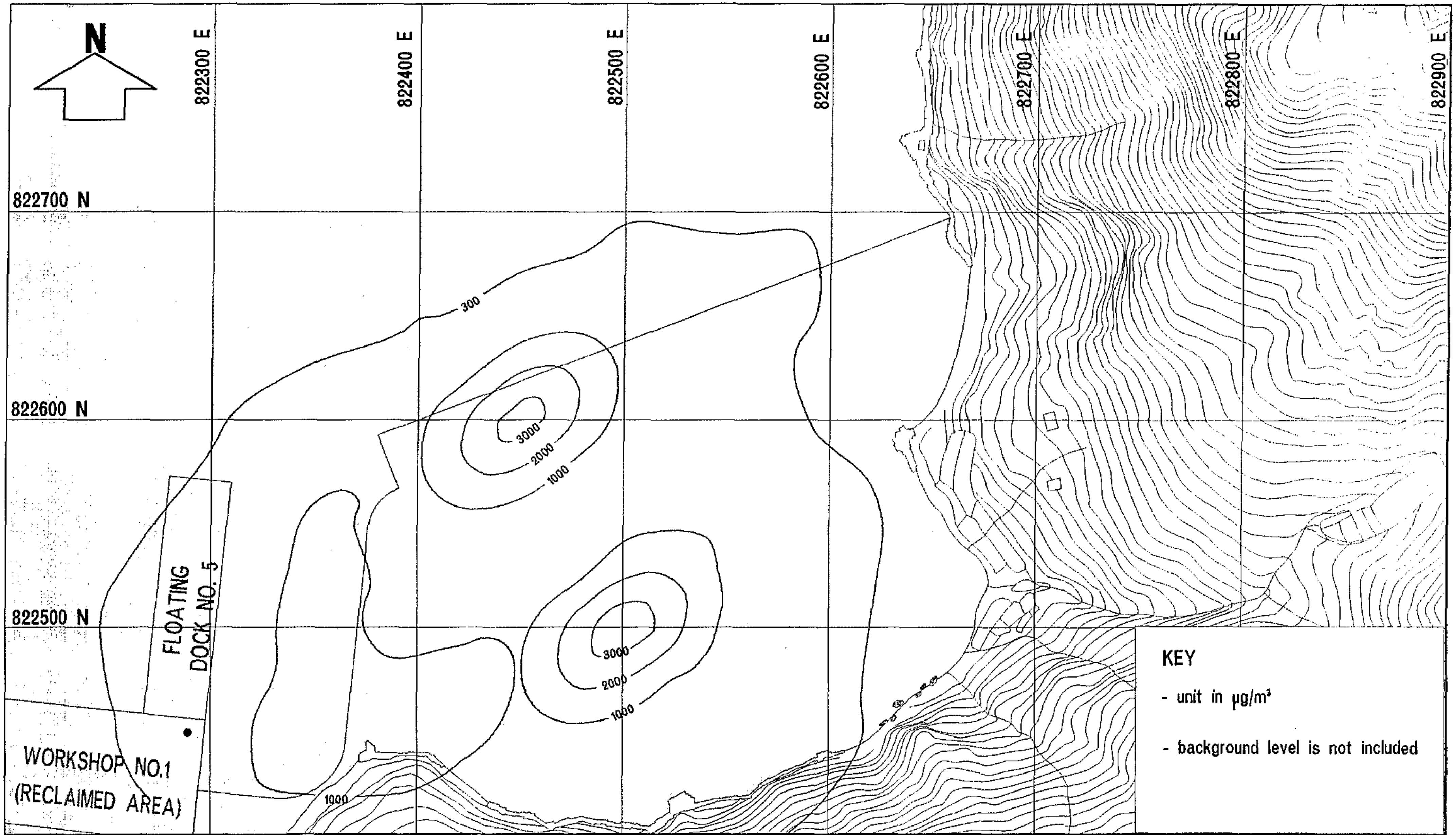
YPS	FIGURE 6.7



TO KAU WAN OPERATIONAL EIA

FDM - WORST CASE SCENARIO

24 - HOUR RSP GROUND LEVEL (ALL SOURCES COMPLETELY UNMITIGATED)

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Engineers and Scientists
賓尼

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Civil Engineering Department

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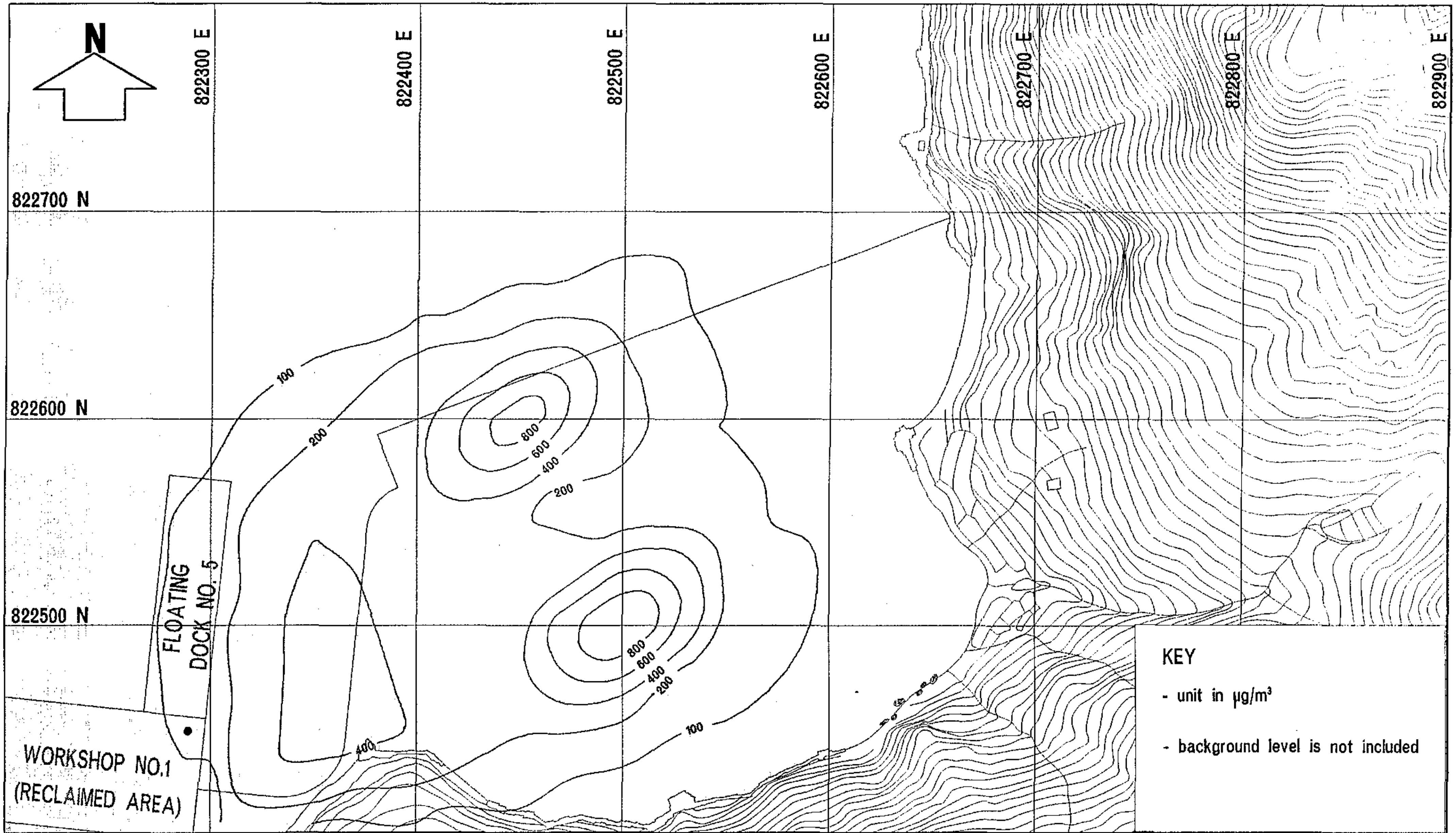
YPS	FIGURE 6.8



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FDM - WORST CASE SCENARIO

YEARLY RSP GROUND LEVEL (ALL SOURCES COMPLETELY UNMITIGATED)

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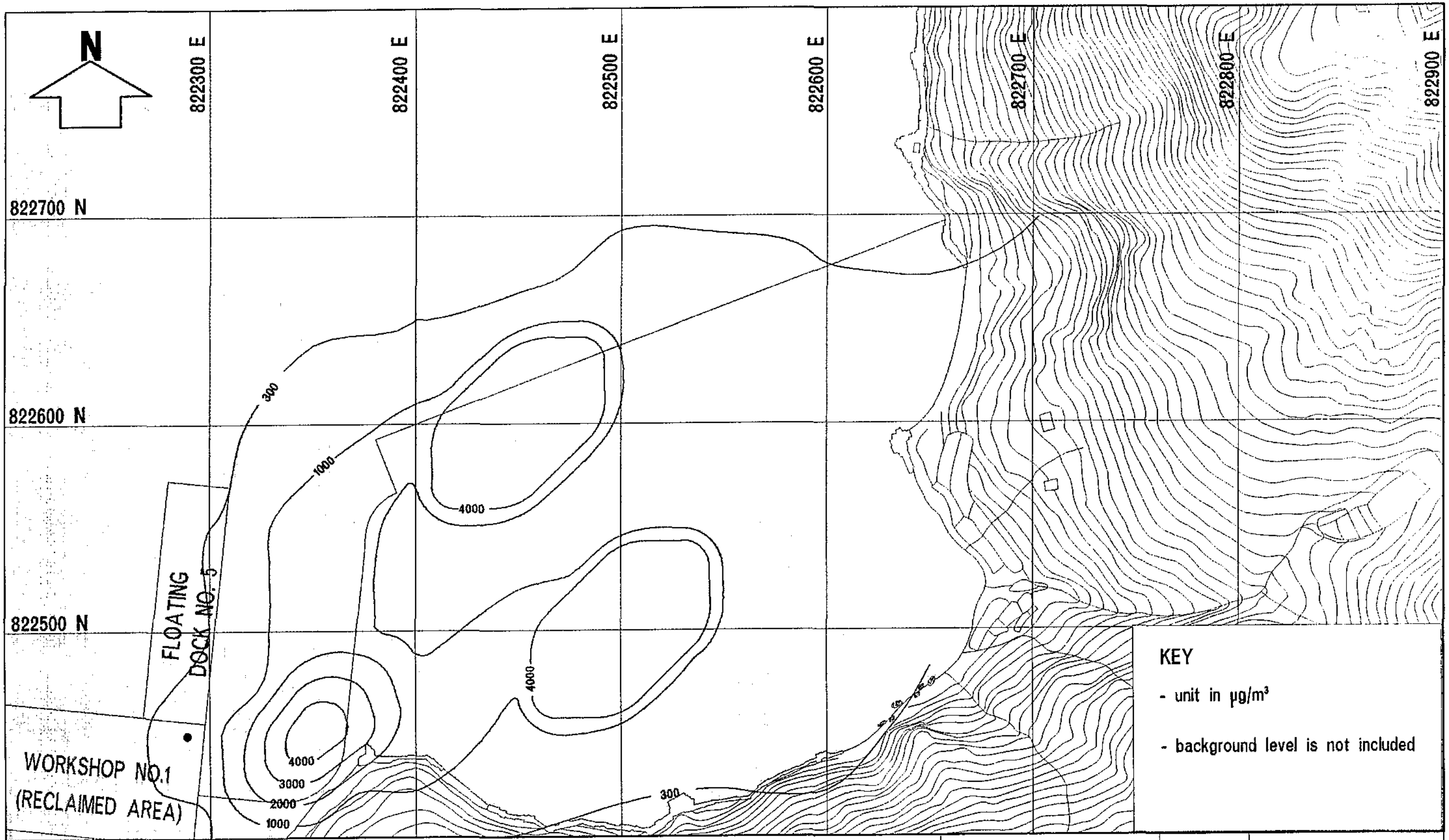
土木工程署 Civil Engineering Department	Initial YPS	Drawing No. FIGURE 6.9



TO KAU WAN OPERATIONAL EIA

FDM - WORST CASE SCENARIO

1 - HOUR TSP GROUND LEVEL

(ALL SOURCES WITH 50% REDUCTION IN DUST FROM DIRT ROAD)

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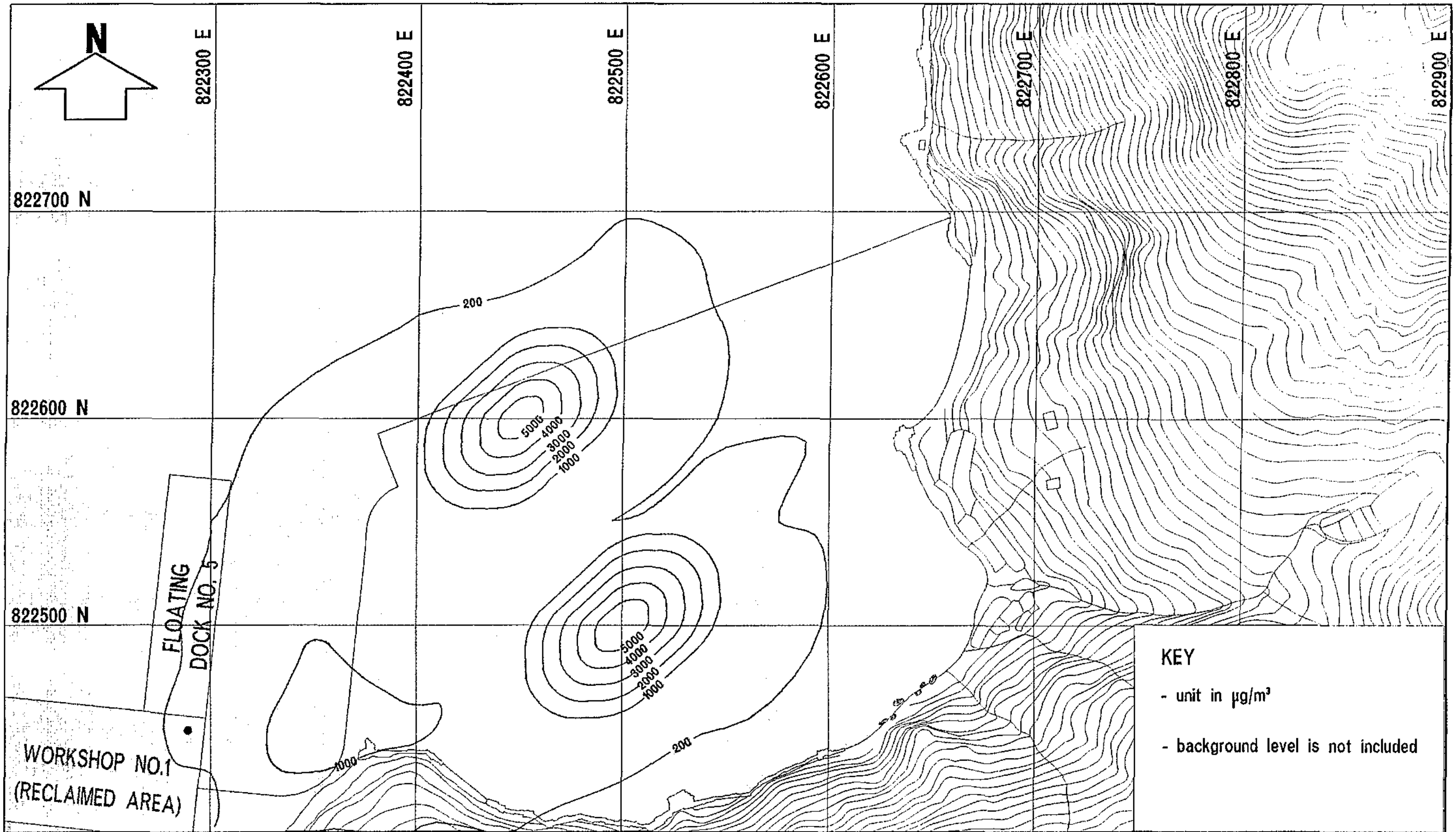
土木工程署 Civil Engineering Department

Date	Scale
FEB 95	1 : 2500
Initial	Drawing No.
YPS	FIGURE 6.10



TO KAU WAN OPERATIONAL EIA

FDM - WORST CASE SCENARIO

24 - HOUR TSP GROUND LEVEL

(ALL SOURCES WITH 50% REDUCTION IN DUST FROM DIRT ROAD)

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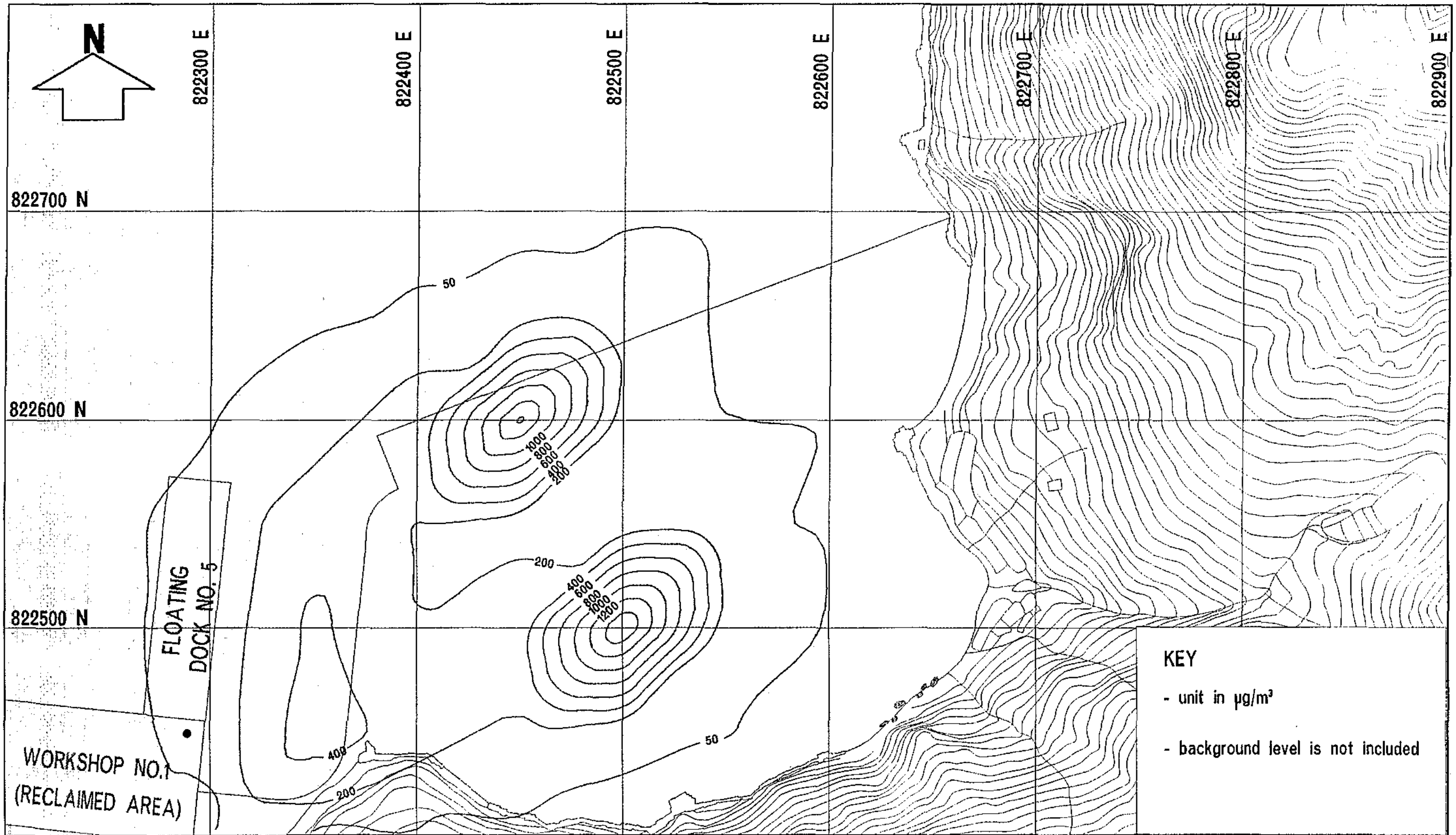
土木工程署 Civil Engineering Department	Initial YPS	Drawing No. FIGURE 6.11



TO KAU WAN OPERATIONAL EIA

FDM - WORST CASE SCENARIO

YEARLY TSP GROUND LEVEL

(ALL SOURCES WITH 50% REDUCTION IN DUST FROM DIRT ROAD)

BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 Engineers and Scientists 賓尼	Date FEB 95	Scale 1 : 2500
土木工程署 Civil Engineering Department	Initial YPS	Drawing No. FIGURE 6.12

6.50 Background 1-hour level was estimated to be 70 $\mu g/m^3$ (geometric mean). It was added to the dust levels with some mitigation, as shown in Table 6.7. Tables 6.5 to 6.7 show the effect of undertaking some mitigation.

6.51 It can be seen from these tables and figures that twice-daily watering of unpaved road would be sufficient to ensure compliance with the Air Quality Objectives for TSP even using the double-layered worst case scenario.

6.52 There should not be any adverse impact on the painting activities of the Yiu Lian dockyards due to the construction of the shipyard facilities at To Kau Wan, if the dust level keeps under the limits set in the Air Quality Objectives.

6.53 Table 6.8 show the modelled RSP results for the To Kau Wan site without any mitigation. Twice daily watering would easily ensure RSP levels fall below the AQO standards of 55 $\mu g/m^3$ (yearly average) or 180 $\mu g/m^3$ (worst 24-hr average).

Table 6.8 RSP - All Sources (No Mitigation)

Prediction Point	Average Concentration ($\mu g/m^3$)	
	Yearly	Worst 24-Hour
Dock 1	64	296
Dock 2	7	39
Dock 3	8	38

6.54 No model exactly mirrors the real situation. The particle size distribution data used in the model was simplistic in the absence of measured data. The modelling of shifting the stockpile to the rest of the site assumes the use of two trucks. It has been assumed for modelling purposes that trucks will move the longest possible route which is as close as possible to the sensitive receivers. This will happen rarely if at all. Trucks are most likely to take the shortest possible routes.

Mitigation Measures

6.55 This study has shown that dust need not cause any adverse environmental impacts on the surrounding environment during the construction of the shipyard facilities at To Kau Wan..

6.56 Travel over dirt roads was found to be the predominant dust source. It can be kept under good control by increasing moisture levels. A twice-daily watering on the dirt road with complete coverage, can reduce dust emissions by up to 50 percent, although it still depends on a number of other factors such as ambient temperature (Jutze 1974).

6.57 Good house keeping procedures are also important to keep the dust levels under good control. To help control dust generated by the transport of soil by dumptrucks, materials with the potential to create dust should not be loaded to a level higher than the side and tail boards, and should be dampened and covered before transport.

6.58 Spoils not transported immediately off site should be stored in an area where wind erosion can be prevented. The dropping heights for excavated materials should be as low as possible so as to minimise fugitive dust due to unloading.

6.59 Other dust suppression measures should also be considered:

- Stockpiles of sand and aggregate greater than 20 m^3 shall be enclosed on three sides, with walls extending above the pile and 2 metres beyond the front of the pile.
- Effective water sprays shall be used during the delivery and handling of all raw sand and aggregate, and other similar materials, when dust is likely to be created and to dampen all stored materials during dry and windy weather.
- Watering of exposed surfaces shall be undertaken at least twice daily.
- Areas within the Site where there is a regular movement of vehicles shall have an approved hard surface and be kept clear of loose surface material.

Operational Air Quality

6.60 This section assesses air quality impact associated with the operation of CLS after its relocation to the new site at To Kau Wan.

6.61 No major operational phase air quality impacts have been identified during our investigations. The purpose of this section is to review potential air quality impacts identifying any areas which may need additional attention at the new site. For example, odour can be detected within the confines of some buildings at Penny's Bay from the use of solvents and thinners during painting and from styrene during fibre-glass moulding. The more confined site at To Kau Wan could potentially lead to higher odour levels. The likelihood of this occurrence is examined.

6.62 Assessment has been undertaken on the basis of the existing legislation in particular the Air Pollution Control Ordinance (Cap 311) and its associated regulations and Technical Memorandum.

6.63 Odour limits are not strictly defined under Cap 311. Nevertheless, EPD generally recommends that:

> "*The predicted odour level at receptor should be less than 5 odour units based on prediction averaging time of 5 seconds. For odour measurement or monitoring, the odour level should not exceed 2 odour units as measured at the site boundary of the plants.*"

Review of Air Quality at the Penny's Bay Site

6.64 Air polluting processes are those processes or activities that emit into the atmosphere substances at a concentration which:

- contravene a technical memorandum;
- have adverse health effects;
- result in the deposit of dust, grit or particles of any kind;
- cause an objectionable odour;
- cause staining, corrosion or other damage to a building, plant, equipment or other material;
- irritate the eye, nose or skin or otherwise cause sensory discomfort;
- disturb normal activities by the colour or opacity of the emission;
- may affect public safety; or
- cause other unreasonable affects to the general public.

6.65 Under Cap 311 licences are required for any process that is a specified process as defined in Cap 311.

6.66 Specific and detailed regulations apply to:

- furnaces, ovens and chimneys;
- associated dust and grit emissions; and
- the control of dark smoke emissions

in addition to the Air Quality Objectives given in Chapter 1.

6.67 A number of organic compounds have been named under the Technical Memorandum and their Health Protection Concentration Levels (HPCL) defined. This does not preclude responsibility for a processor to ensure that no other noxious fumes cause an air pollution nuisance. None of the organic compounds toluene, xylene, butanol, acetone or styrene have their HPCLs listed. All but butanol were named on the EPA Toxic Release Inventory (1987) as common toxic air emission compounds. Toluene is the VOC released in the largest quantities in the USA.

6.68 The following processes are all listed as specified processes according to capacity and application of the specific activity. These activities have all been undertaken by CLS at Penny's Bay.

- aluminium works;
- copper works;
- iron and steel works;
- metal recovery works;
- zinc galvanising works;
- non-ferrous metallurgical works.

6.69 In the past when CLS operated rolling mills and manufactured such items as copper tubing, certain operations, if still undertaken, may now be classified as specified processes.

6.70 Their current operating capacity falls well below the capacities needed for any operation to be classified as a specified process. We do however recommend that CLS check from time to time to ensure that none of their processes require licensing.

6.71 The largest furnace, which is used for iron and steel production is electrically heated and hence not subject to the furnace regulations. The gas-heated crucibles have sufficiently low fuel usage to be exempt.

6.72 Over the years of operation, the inside of the buildings associated with the metallurgical processes have endured a slow build-up of oily dust and grit. This dust probably contains various metal contaminants. There was no evidence of dust or grit buildup outside these buildings. Respirable particles of certain metal can be far more hazardous to human health than substances such as xylene, toluene and styrene. The Occupational Exposure Limits (LD 1992) as the Time Weighted Averages (TWAs) in mg/m^3 of respirable dust are:

- copper fumes - 0.2 mg/m^3
- copper dusts and mists - 1 mg/m^3
- chromium metal - 0.5 mg/m^3
- lead - 0.15 mg/m^3
- tin - 2 mg/m^3

6.73 Of these only copper and tin are smelted on any regular basis. It is of importance to note that quartz respirable dust has a TWA of 0.1 mg/m^3. Most construction dust in Hong Kong contains high percentages of quartz dust. Quartz dust is a far greater health hazard than CLS's metal dusts which in turn are far more toxic than the common organic solvents.

6.74 It is highly unlikely that metal dust or fume levels ever reach the TWA limits even for very short periods of time or in limited areas of any building. Metal smelting involves just melting metals. Fumes are only generated many hundreds of degree hotter, closer to boiling points. Dusts are not usually generated from the surfaces of slowly melting metals. Crucibles are kept covered except for short periods of time when slag is removed or metals poured into moulds.

6.75 Metal dusts and grits can also be generated during cutting, polishing and grinding activities. Tubricating fluids are normally used which mitigate metal dust generation.

6.76 There are a few petrol or diesel driven engines on the Penny's Bay site in addition to ship engines under repair. It is not anticipated that these engines would contribute any significant amounts of particulates, NO_x, SO_2, dark smoke or other fumes to the environment.

6.77 Information on the frequently used organic compounds is given in Table 6.11. Of these styrene and possibly xylene have low odour thresholds. Little odour was detected within the spray-painting areas. Styrene has a very acrid odour and can be readily smelt close to any active fibre-glassing works. No odour was detected by any of the team before entering any building during site visits.

Table 6.11 Data on the Main Organic Chemicals used by CLS

	Chemical	Operation	Characteristics
1	Styrene	GRP	Odour threshold: 0.34 mg/m³ OEL-TWA[1] level: 213 mg/m³ Vapour Pressure: 5.0 mmHg Boiling point: 145°C
2	Acetone	GRP	Odour threshold: 30.8 mg/m³ OEL-TWA[1] level: 1780.0 mg/m³ Vapour Pressure: 181.0 mmHg Boiling point: 56°C
3	Toluene	Paint Shop	Odour threshold: 10.9 mg/m³ OEL-TWA[1] level: 188 mg/m³ Vapour Pressure: 22.0 mmHg Boiling point: 111°C
4	Xylene	Paint Shop	Odour threshold: 0.4 to 8.6 mg/m³ OEL-TWA[1] level: 434 mg/m³ Vapour Pressure: 5.1 mmHg Boiling point: 137°C

1 *OEL-TWA is Hong Kong Occupational Exposure Limits - Time-Weighted Average*

6.78 Currently CLS depends on natural ventilation of the large buildings. However, increasingly, boats built for government must be built under specified conditions of temperature and humidity. It is likely that more of the buildings on the new site will be atmosphere-controlled or air-conditioned.

The To Kau Wan Site

6.79 Based on the activities taking place on the Penny's Bay site, little operational air quality impact is expected at the To Kau Wan site.

6.80 There are a few factors which could potentially increase the impact at the new site as compared to the old. These factors include:

- the more cramped layout of the new site;
- closer sensitive receivers;
- less natural site ventilation as a result of the topography; and
- the use of atmosphere-controlled buildings.

6.81 If any ventilation systems are to be installed it may be necessary to ensure that odours are not collected and then vented towards sensitive receivers. The method for determining the acceptability of the ventilation systems and their "chimneys" is given in the Technical Memorandum for Issuing Air Pollution Abatement Notices to Control Air Pollution From Stationary Polluting Processes. The acceptability will depend on the following physical data:

- the nature of the VOCs,
- mass discharge rate,
- height of discharge point,
- discharge velocity,
- discharge temperature,
- diameter of chimney,
- volume of gas stream,
- site topography,
- location of the nearest receptors.

6.82 It is particularly important that the emission rate at the mouth of any ventilation outlet be controlled so that the hazardous material concentration at the closest sensitive receivers is minimised and below acceptable levels.

6.83 It is considered highly unlikely that VOC concentrations would reach noxious levels because the discharge rate is expected to be low. Also, the site layout indicates that the shortest distance between any work area and the closest sensitive receiver (Yiu Lian Shipyard) is about 150 m. This distance is sufficient to create a buffer zone to aid dispersion and render odour concentrations below the nuisance level of 2 odour units. The Toll Plaza Administration Building to the south is about 300 m from the CLS site. Thus it is not anticiipated that the Toll Plaza Administration Building will experience worsening of air quality associated with the operation of the relocated shipyard.

6.84 The topographical features at the south side of To Kau Wan provide both advantages and disadvantages in terms of air quality for the site area. The advantage is that the mountainous terrain would block most approaching wind, thereby reducing the strength of the wind and reducing the possibility of dispersion of the odorous gases from the work area to the sensitive receivers. However, the terrain may also potentially create a trapping zone where the eddies would be formed at the bottom of the mountain when a strong easterly or northeasterly (wind speed greater than 11.0 m/s) is approaching (Roland, 1988, p602; Calvert and england, 1984, p.866). The disadvantage is that the eddies are the convergent zones where odorous gases will be potentially accumulated or trapped. Base on the information from Royal Observatory, the occurrence of this phenomenon is very rare because only 0.5% of wind in a year is classified as strong wind in this area. This equates to possible formation of a trapping none about once a year.

Mitigation Measures

6.85 Although no significant air quality impacts are anticipated in the operation of CLS at TKW, the following comments are made to ensure that this situation is maintained (Artis 1984):

Ventilation

6.86 Ventilation is the most effective method of reducing the odour levels inside buildings. Due to the toxicity of the odorant, design of these ventilation systems should be undertaken by specialists to ensure that no adverse impacts impinge on the nearby sensitive receptors (Artis 1984).

6.87 Particular attention should be paid to the location and direction of ventilation exhausts. They should not be allowed to face any sensitive receptors directly. Consideration should always be given to the location of windows doors and the direction prevailing winds (Keddie, 1980). At To Kau Wan, the prevailing winds are easterly and southeasterly. Many of the odorous gases are heavier than air, so it is necessary to extract them at a low level of the building.

Minimising Vaporisation of Organics

6.88 All containers for odorous material, should be kept covered as much as possible. Odorous wastes should be sealed in suitable containers and carefully discarded.

6.89 Fibreglassing areas should not have operating air extraction systems during application of resin. This leads to unnecessary and much additional escape of free styrene. As 'free' styrene is removed by extraction, chemical equilibrium moves towards further generation of 'free' styrene instead of the formation of polystyrene. If worker protection is required then positive pressure should be maintained and workers supplied with absorbent masks or if necessary, air from compressed air tanks.

Filtration and Odour Removal Systems

6.90 Many new technologies are being developed. One of the better new technologies for odour control is known as biofiltration.

6.91 This process is based on the principle of aerobic oxidation of the odorous gases by micro-organisms. The advantage of this method is that it produce harmless by-products such as carbon-dioxide and water while achieving a high odour removal efficiencies with less side effects. (Shanahan, 1993).

Conclusions

6.92 The operation of the CLS at To Kau Wan after relocation is not expected to result in any major air quality impacts.

6.93 Currently CLS operations do not fall under the categories of "specified processes" or "furnaces and chimneys".

6.94 Enough activity occurs at CLS to warrant their management remaining vigilant in ensuring that worker health and air quality is protected.

6.95 Odour is not expected to be a problem at the new site. However any new ventilation systems installed have the potential for changing this situation. Thus, while odour levels are expected to be low even with the addition of ventilation systems, the detailed designers will need to check that their design will not result in adverse impacts on air quality.

7. WATER QUALITY ASSESSMENT

Introduction

7.1 The assessment of potential adverse water quality impacts forms one of the more critical areas of the study. Possible pollution of all water bodies (marine, fresh and ground water) have been examined including all potential primary and secondary impacts including physical, chemical and biological impacts both during the construction phase and the operational phase. The marine water body is that with the most chance of being adversely affected by the construction and operation of a shipyard at To Kau Wan. As the To Kau Wan site is a small reclamation the chance of direct adverse impact on the other water bodies is comparatively less.

7.2 The scope of work undertaken for this EIA in regard to marine water quality has been:

- to collect, assess and interpret background information for the existing water systems and their water quality;
- to establish an environmental baseline for the study area;
- to assess the potential marine water quality impacts on the existing environment, nearby sensitive uses and the fish culture zone at Ma Wan as a result of the construction and operation of the shipyard;
- to collect and assess information on the existing operation and waste generating activities of Cheoy Lee's current site comparing this data with future operations;
- to compare the background conditions at To Kau Wan and the present conditions at Penny's Bay to the statutory requirements for effluents and the North Western Water Control Zone Water Quality Objectives;
- to assess any potential impacts due to discharge and/or spillage of chemicals, fuel and contaminated water into the surrounding waters and also the cumulative impacts arising from the operation of the adjacent activities;
- to propose suitable methods for the reduction of any impacts identified to maintain the beneficial uses of the water body and to ensure compliance with Water Pollution Control Ordinance;
- to minimise any negative and/or cumulative impacts upon the nearby environment wherever practicable.

Background Information

Other Projects

7.3 Lantau is currently experiencing a great deal of construction activity associated with the development of the Chek Lap Kok Airport and the Lantau Port and Harbour Development. A number of the contracts affect the background environmental conditions at To Kau Wan, particularly in regard to surface water and marine water quality.

7.4 The North Lantau Expressway (NLE) is one of the major access routes to the new Airport. The Yam O section is that closest to our site. Dredging and reclamation at Tsing Chau Wan is now complete. The marine water monitoring programme for the Yam O section finished in December 1994.

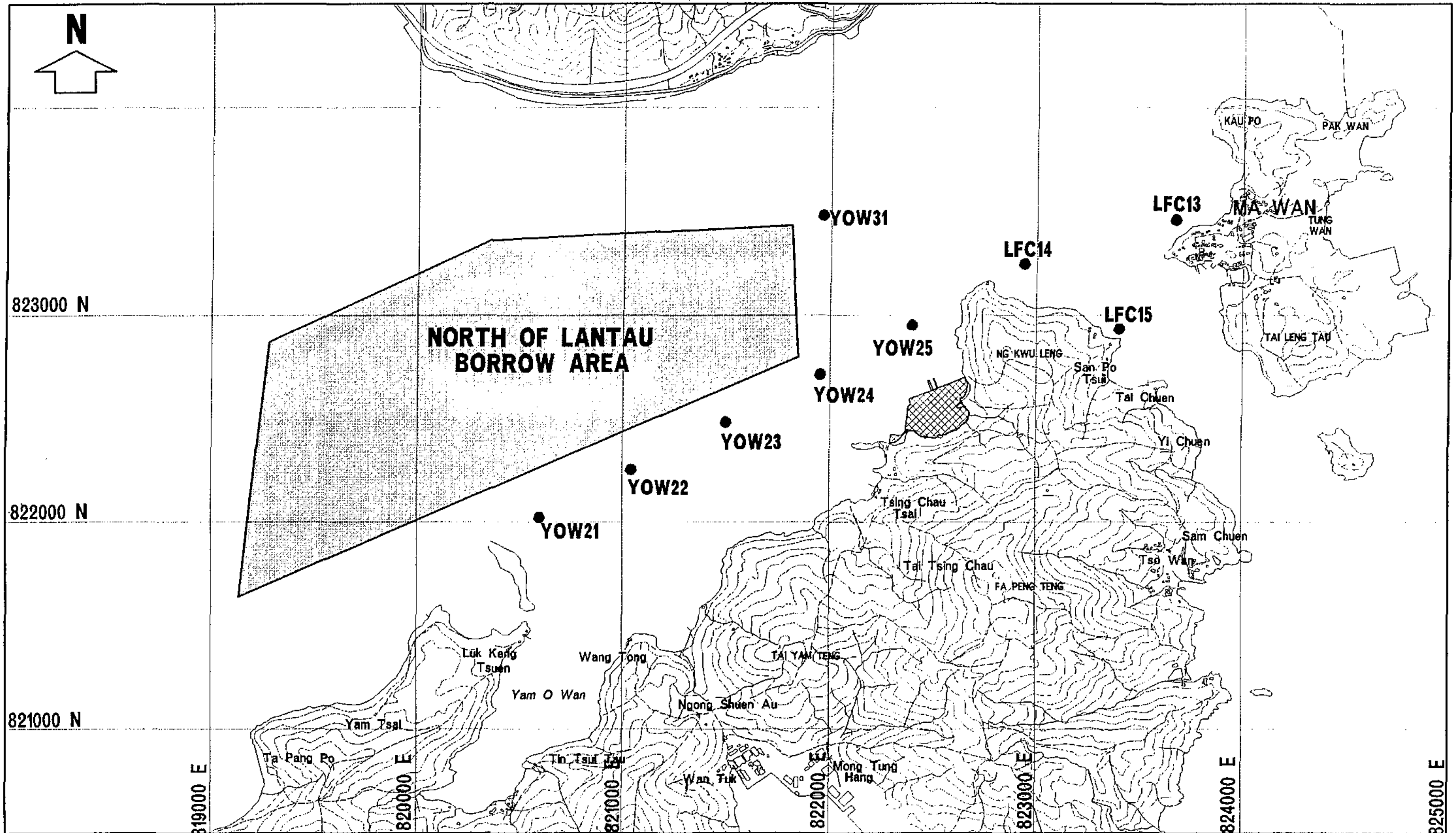
7.5 The construction of the Tai Ho section of the NLE should have little future effect on the To Kau Wan area. The North of Lantau Borrow Area (Figure 7.1) has been dredged for marine fill as close as 800 metres from To Kau Wan. This work has now been completed.

7.6 The construction of the East Lantau tunnels and the Toll Plaza, because of their close proximity, could have a direct effect on the surface water feeding into the To Kau Wan area.

7.7 Construction of the Advanced Works Contract of the Toll Plaza commenced in November 1993 and is virtually complete. The Toll Plaza should be operational by mid 1997. Much of the surface water from the Toll Plaza will be fed into stream channels to the To Kau Wan site. Sewerage from the Toll Plaza, particularly from the Administration Building, was to feed into the surface water drain for the site after treatment. Effluent from the sewerage package plant must meet the TM standards (EPD 1991a). This situation has now changed and the effluent drain will be extended directly to the marine waters between the Yiu Lian and To Kau Wan sites.

7.8 The Shipyard site at To Kau Wan in North Lantau is being established by reclamation. The major water quality impacts were assessed under the EIA of "Agreement No. CE 45/93, Lantau Port Development - Stage 1, Reclamation for Shipyard at To Kau Wan, North Lantau" (BCL 1994a).

7.9 The monitoring and audit programme for this reclamation commenced in mid-January 1995 to ensure that water quality is maintained within an acceptable range as suggested in the Reclamation EIA report (BCL 1994a).



TO KAU WAN OPERATIONAL EIA

BACKGROUND WATER QUALITY MONITORING STATIONS

BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 Engineers and Scientists 賓尼	Date FEB 95	Scale 1 : 25000
土木工程署 Civil Engineering Department	Initial YPS	Drawing No. FIGURE 7.1

Water System

7.10 Water quality near North Lantau is characterised by pollutant loads transported by the influx of fresh water from the Pearl River. The effect is more pronounced during the wet seasons.

7.11 The To Kau Wan site is within the North Western Water Control Zone (NWWCZ) which was declared on 1st April 1992 under the Water Pollution Control Ordinance (Cap. 358) (WPCO). A summary of the Water Quality Objectives (WQO) for the North Western Waters is presented in Chapter 1.

7.12 The WQO relate to the Beneficial Uses (BU) and assimilative capacity of the particular water body or part thereof. The NWWCZ had been identified as having eight beneficial uses as shown in Table 7.1.

Table 7.1 Summary of Beneficial Uses

	Beneficial Use
BU1	A source of food for human consumption
BU2	A resource for commercial exploitation
BU3	A habitat for marine life generally
BU4	Primary contact recreation - bathing
BU5	Secondary contact recreation - diving, sailing, windsurfing etc.
BU6	Domestic and industrial supply
BU7	Navigation and shipping
BU8	Aesthetic enjoyment

7.13 Only some BU's are applicable to our site. These are BU2 (fisheries and fishermen at Ma Wan) and BU3 (habitat for marine life generally). The assessment of this section has focused upon these two BU's relevant to the construction and operation of the shipyard.

Sensitive Receivers

7.14 Sensitive receivers were identified in the Reclamation EIA report (BCL 1994a) using the definitions given in the Hong Kong Planning Standards and Guidelines. The same sensitive receivers are important for this operational phase EIA.

7.15 The fish culture zone at Ma Wan is regarded as the potential sensitive receiver of particular concern. The fisheries and marine life in the study area are also of concern. Chapter 10 discusses these in more detail.

Recent Marine Water Quality near To Kau Wan

7.16 The reclamation EIA (BCL 1994a) presented evaluation of marine water quality data near To Kau Wan for the period between March 1993 and December 1993.

7.17 This collection of data and analyses has been extended until September 1994.

7.18 Two sets of marine water quality monitoring data relevant to the study area have been obtained from two different monitoring and audit programmes in North Lantau:

- "Yam O section of the North Lantau Expressway, Contract No. HY/91/08" (YOW); and

- "Kap Shui Mun Bridge & Ma Wan Viaduct of the Lantau Fixed Crossing, Contract No. HY/93/19" (LFC).

7.19 Data has been evaluated from the following monitoring stations:

- Yam O Section (YOW): Stations YOW21 - YOW25 with the corresponding control station YOW31;

- Lantau Fixed Crossing (LFC): Stations LFC12, LFC13 and LFC14.

The locations of these stations are shown on Figure 7.1.

7.20 The following water quality parameters were measured at the YOW and LFC monitoring stations:

- dissolved oxygen (DO) in mg/l;
- turbidity in NTU;
- suspended solids (SS) in mg/l;
- DO saturation (DOS) in %; and
- water temperature in °C.

The LFC data was collected during both flood and ebb tides, the YOW data just once on each sampling occasion.

7.21 At each monitoring station (Figure 7.1), the water quality impact monitoring was carried out two sampling days per week, except in March 1994 (1 sampling for SS). Measurements were taken at three water depths:

- 1 m below water surface,
- mid-water depth, and
- 1 m above sea bed.

7.22 The marine water quality data analyses presented in this report have examined three parameters in detail:

- suspended solids;
- dissolved oxygen; and
- turbidity.

7.23 Monthly mean depth-averaged values of suspended solids (SS), dissolved oxygen (DO) and turbidity for YOW stations and LFC stations have been calculated and are presented graphically.

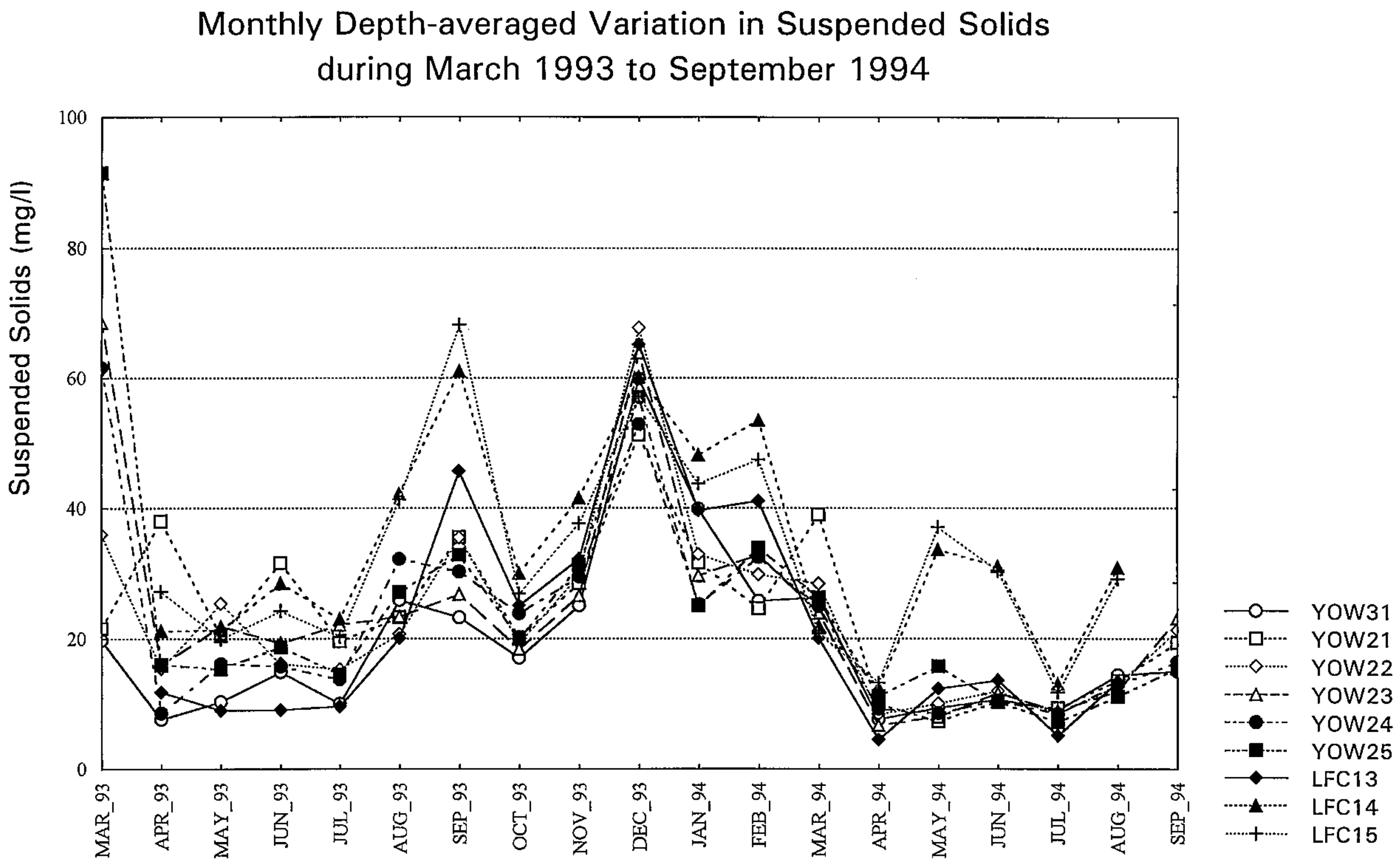
7.24 Individual plots of SS, DO and turbidity levels between surface and bottom water layers at monitoring stations YOW24 and YOW25 are also presented graphically. They are selected because of their close proximity to the core study area.

Suspended Solids

7.25 Monthly depth-averaged variation in suspended solids for the stations YOW21 - YOW25, YOW31 from March 1993 to September 1994 and stations LFC13 - LFC15 from April 1993 to August 1994 are presented graphically in Figure 7.2. There were peaks of SS in September and December 1993. The SS levels showed marked improvement in 1994. These went down from 70 mg/l on December 1993 to less than 40 mg/l from May to September 1994. The SS levels at LFC monitoring stations showed greater variation than the YOW stations.

7.26 The SS and turbidity levels improved in comparison with the levels last year. SS is an indicator of dredging activities and this was reflected in the high SS levels measured near the site in 1993 which improved in 1994 indicating the reduced influence of dredging activities in the area.

7.27 The dredging at Tsing Chau Wan was completed in March 1994 under the Toll Plaza contracts. Reclamation of this dredged area to 5.5 mPD was finished on December 1994 under the same project. The potential water quality impact was lower in comparison with reclamation and dredging activities.



TO KAU WAN OPERATIONAL EIA	BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 CONSULTING ENGINEERS 賓尼	Date DEC 94	Scale
BACKGROUND MARINE WATER QUALITY	土木工程署 Civil Engineering Department	Initial PC	Figure No. 7.2

7.28 Dredging of the closest marine borrow area to To Kau Wan (for the "North Lantau Expressway - Tai Ho Section (HY/91/07)" project) stopped in September 1994 probably resulting in further improvement of water quality in the study area.

7.29 Figure 7.3 is a copy of an aerial photograph taken over northeast Lantau in March 1994. The yellow in the copy along north Lantau is sediment and does not show as clearly as in the original photograph. The relative positions and sizes of the old and new shipyard sites can be seen clearly. Yiu Lian Dockyards can also be seen.

7.30 Individual plots of SS at YOW24 and YOW25 (Figure 7.4 and 7.5) show obvious improvement in SS levels starting from April 1994. Great variation and higher level of SS in the bottom level are observed. Trends are similar for these two stations.

Dissolved Oxygen

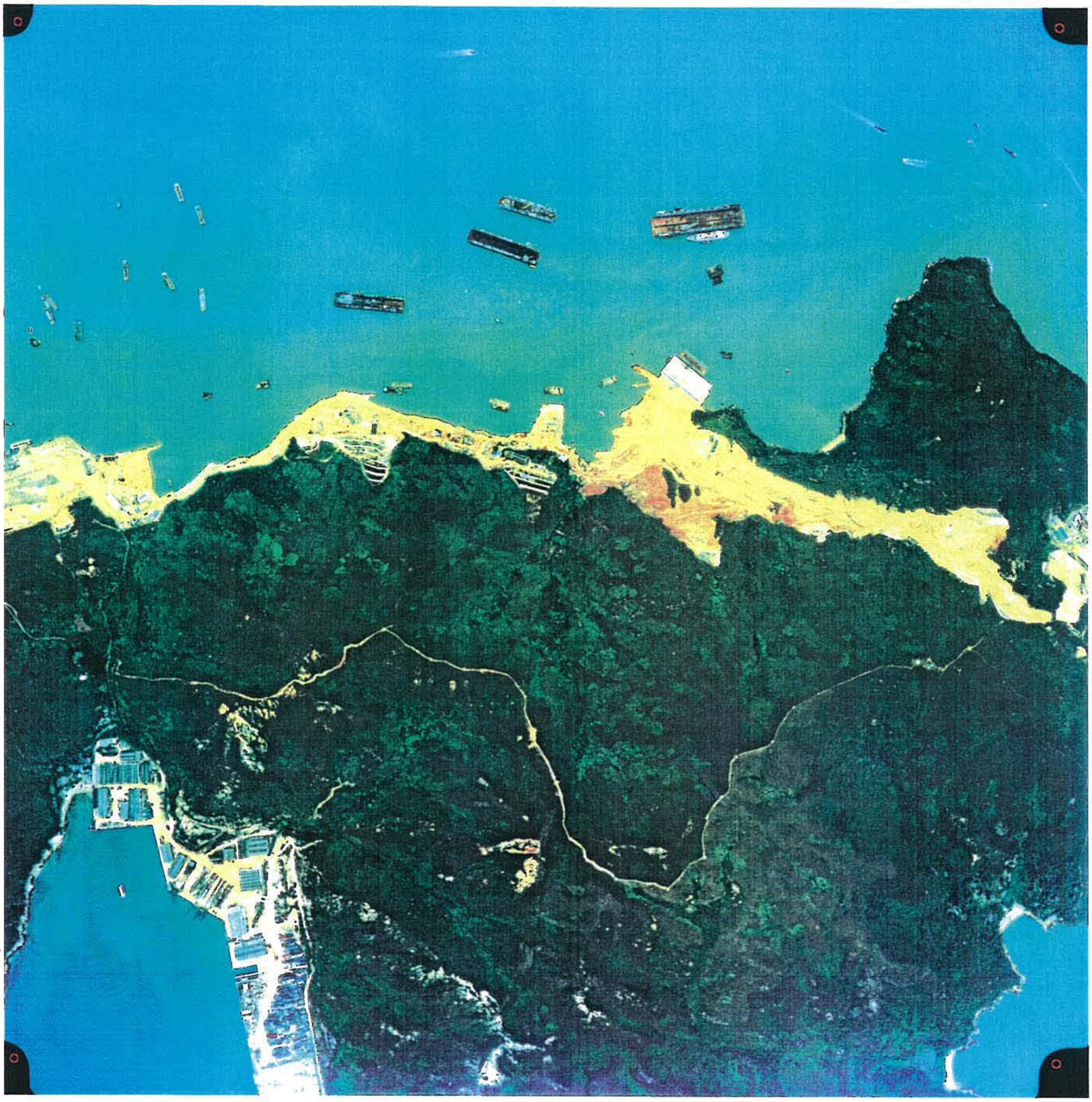
7.31 Monthly depth-averaged variation in dissolved oxygen (DO) indicated compliance with the EPD objectives which were given in detail in Chapter 1. The depth averaged DO levels in fish culture subzones in Western Buffer should not be less than 5 mg/l for 90% of samples.

7.32 The DO levels of the Yam O and Kap Shui Mun marine monitoring stations ranged between 4 mg/l to 9 mg/l (Figure 7.6) indicating well oxygenated conditions in the inshore waters. Not unexpectedly there was little evidence of faecal contamination offshore at To Kau Wan.

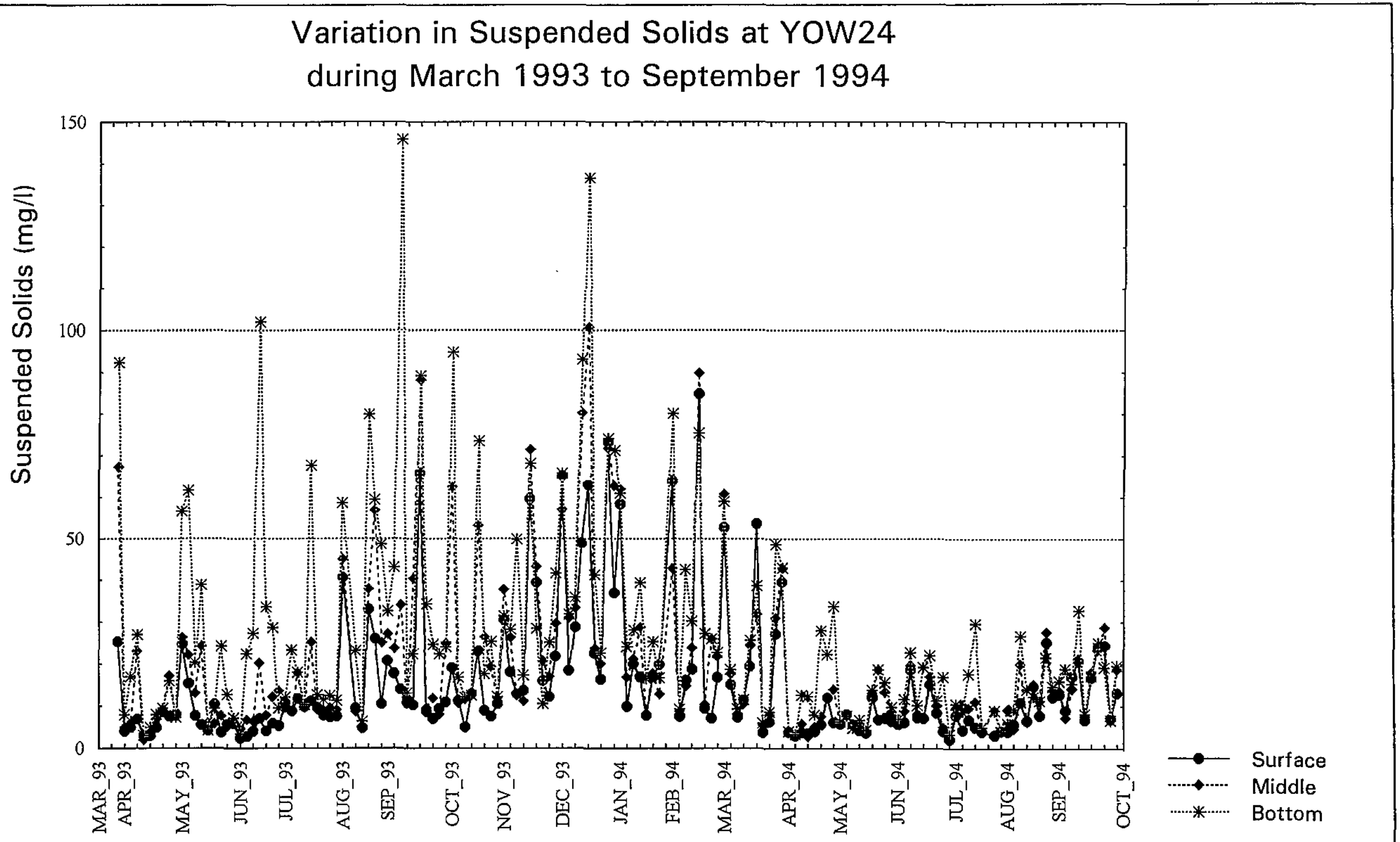
7.33 Although the DO levels of the Kap Shui Mun marine monitoring stations were comparatively lower than the Yam O stations, the lowest DO level at Kap Shui Mun was still higher than 4 mg/l.

7.34 The level of oxygen dissolved in seawater is an indicator of organic pollution. It also varies with changes in temperature, atmospheric pressure, the degree of water turbulence and mixing.

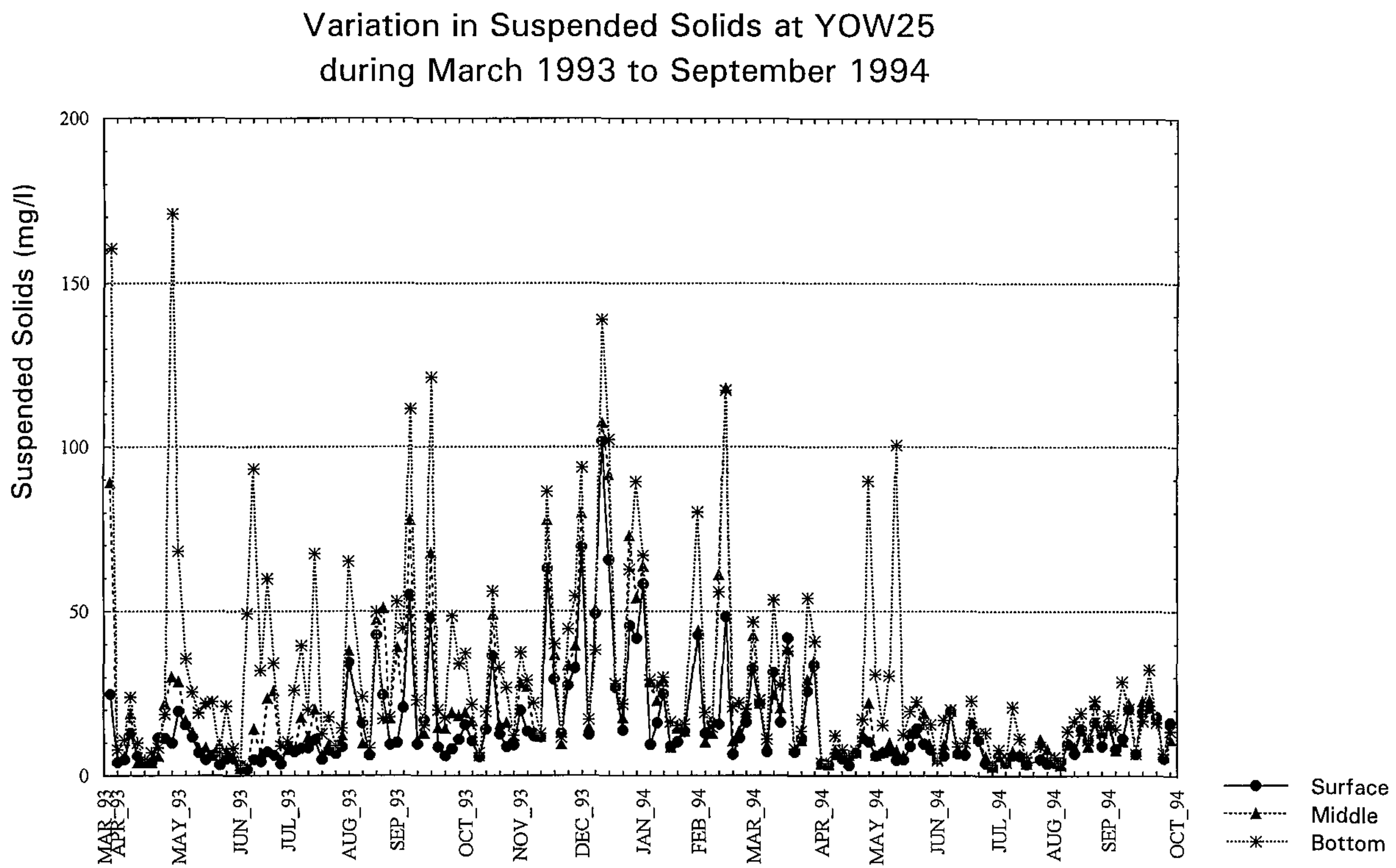
7.35 Low DO levels were in part due to the inverse relationship between oxygen solubility and temperature. This in part explained the low DO levels registered in June and September and the higher levels in the winter season.



TO KAU WAN OPERATIONAL EIA AERIAL PHOTOGRAPH OF MA WAN 28th MARCH, 1994 AT 6,000 FEET SOURCE : REPRODUCTION BY PERMISSION FROM SURVEY & MAPPING OFFICE, HONG KONG GOVERNMENT (CN 6273)	BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 CONSULTING ENGINEERS 賓尼	Date Nov. 94	Scale N.T.S.
	土木工程署 Civil Engineering Department	Initial YPS	Figure No. 7.3



TO KAU WAN OPERATIONAL EIA	BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 CONSULTING ENGINEERS 賓尼	Date DEC 94	Scale
BACKGROUND MARINE WATER QUALITY	土木工程署 Civil Engineering Department	Initial PC	Figure No. 7.4



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BACKGROUND MARINE WATER QUALITY

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Date	Scale
DEC 94	-
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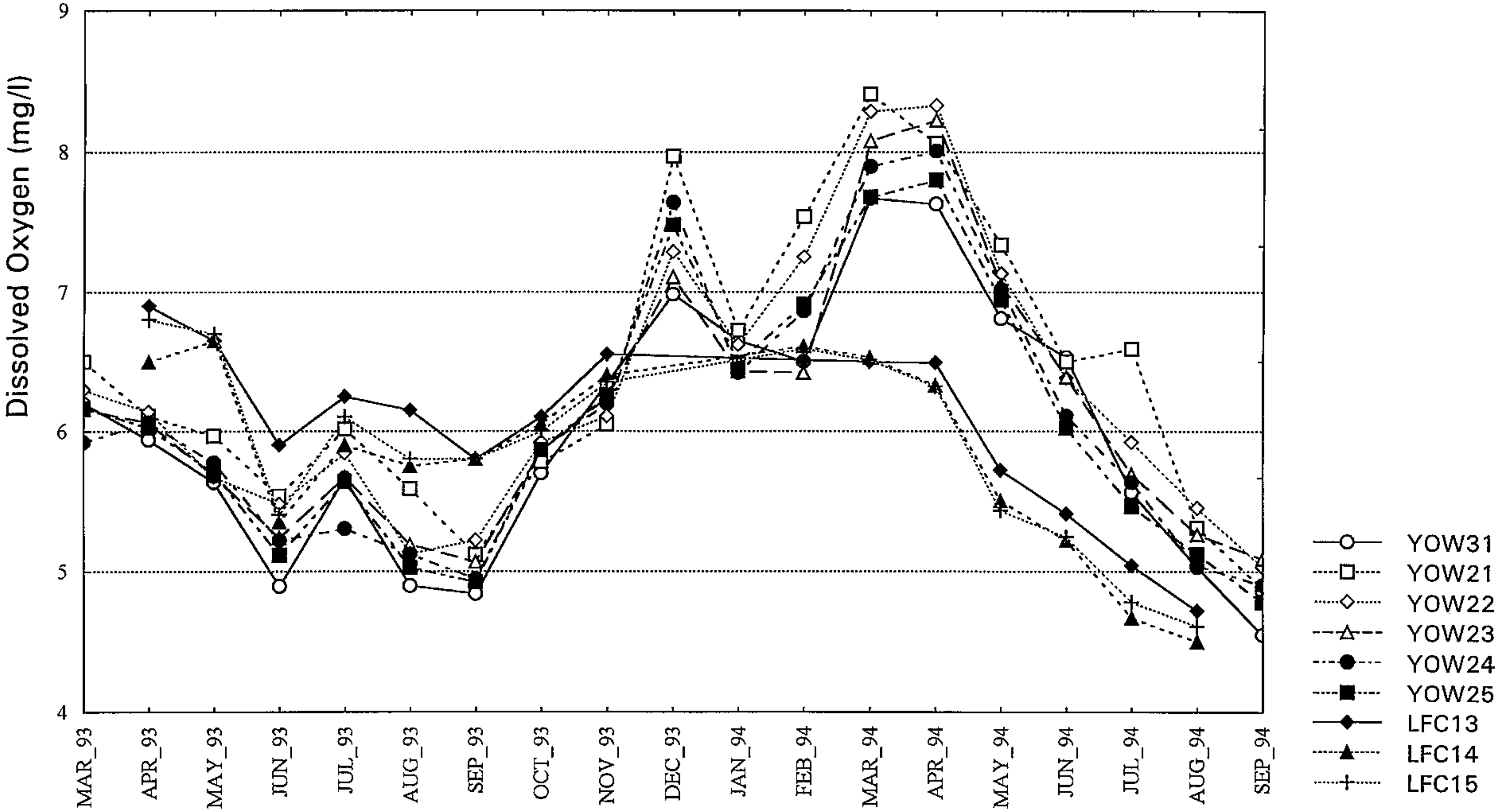
PC	7.5

Monthly Depth-averaged Variation in Dissolved Oxygen during March 1993 to September 1994



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BACKGROUND MARINE WATER QUALITY	土木工程署 Civil Engineering Department	Initial PC	Figure No. 7.6

7.36 The data gathered during this study would suggest that at the Ma Wan fish culture zone, DO levels would not be affected by the construction of shipyard facilities and the operation phase of the shipyard. Indeed it is hard to picture any scenario where the project could have a negative impact on the mariculture zone at Ma Wan. The Ma Wan fish culture zone seems disconnected from happenings on the north coast of Lantau but it sometimes tied to changes occurring at LFC 14 and 15 on the east coast of Lantau. This is comparatively easy to explain in terms of current speeds and directions in Kap Shui Mun.

7.37 Individual plots of YOW24 and YOW25 showed that the DO levels ranged between 4 and 10 mg/l from March 1993 to October 1994 (Figure 7.7 and 7.8). DO levels were observed to be around 3.5 to 4.0 mg/l on August 1994 at YOW24 and September 1994 at YOW25.

Turbidity

7.38 Monthly depth-averaged variation of turbidity at the Yam O and Kap Shui Mun monitoring stations is presented in Figure 7.9. Turbidity values of all monitoring stations ranged between 5 and 50 NTU with two anomalous values greater than 60 NTU in March 1993 at stations YOW21 and 23.

7.39 The turbidity levels in 1994 were nearly half the levels in 1993. The turbidity levels of Yam O monitoring stations were also half the measured values at Kap Shui Mun.

7.40 Individual plots of YOW24 and YOW25 (Figures 7.10 and 7.11) showed obvious improvements in turbidity during 1994. Levels were nearly five times lower in 1994 as compared to 1993.

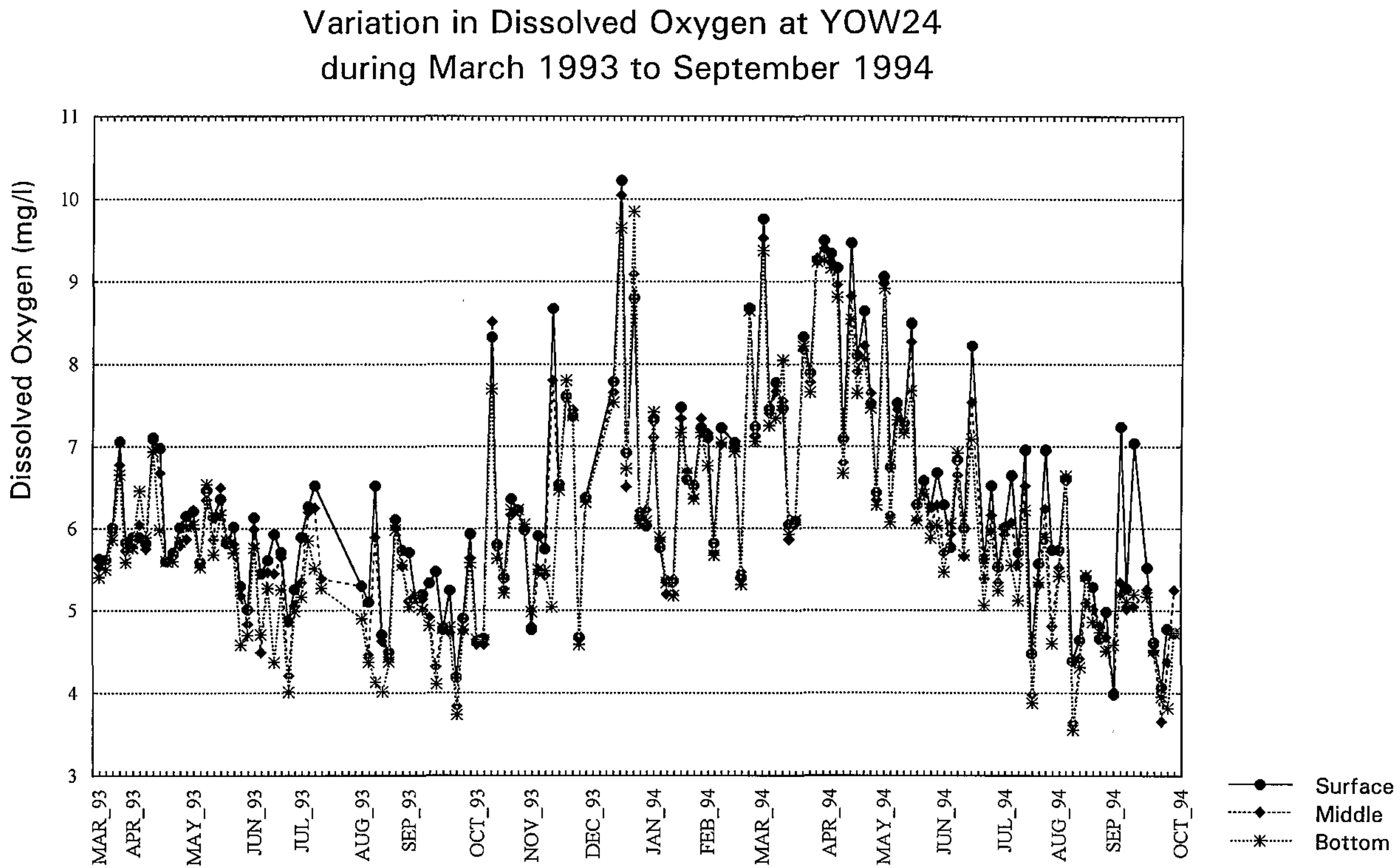
7.41 Similar variation patterns were observed in the suspended solids and turbidity plots. The turbidity peaks nearly always paralleled the SS peaks. As for the SS peaks, high turbidity values lasted only for a short period of time and were localized.

7.42 The comparatively lower turbidity and SS levels in 1994 relate to completion of various works along the north Lantau coast.

Surface and Storm Water

7.43 All the sub-catchments which intersect the site boundary are small, that on the south-east corner of the development being the largest.

7.44 The runoff from the hillsides to the south and east of the site will be intercepted by an open channel which will be constructed at the interface between the new site and the existing ground. One outfall will be provided at the eastern end and the drainage system will be adequately supplied with silt traps.



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BACKGROUND MARINE WATER QUALITY

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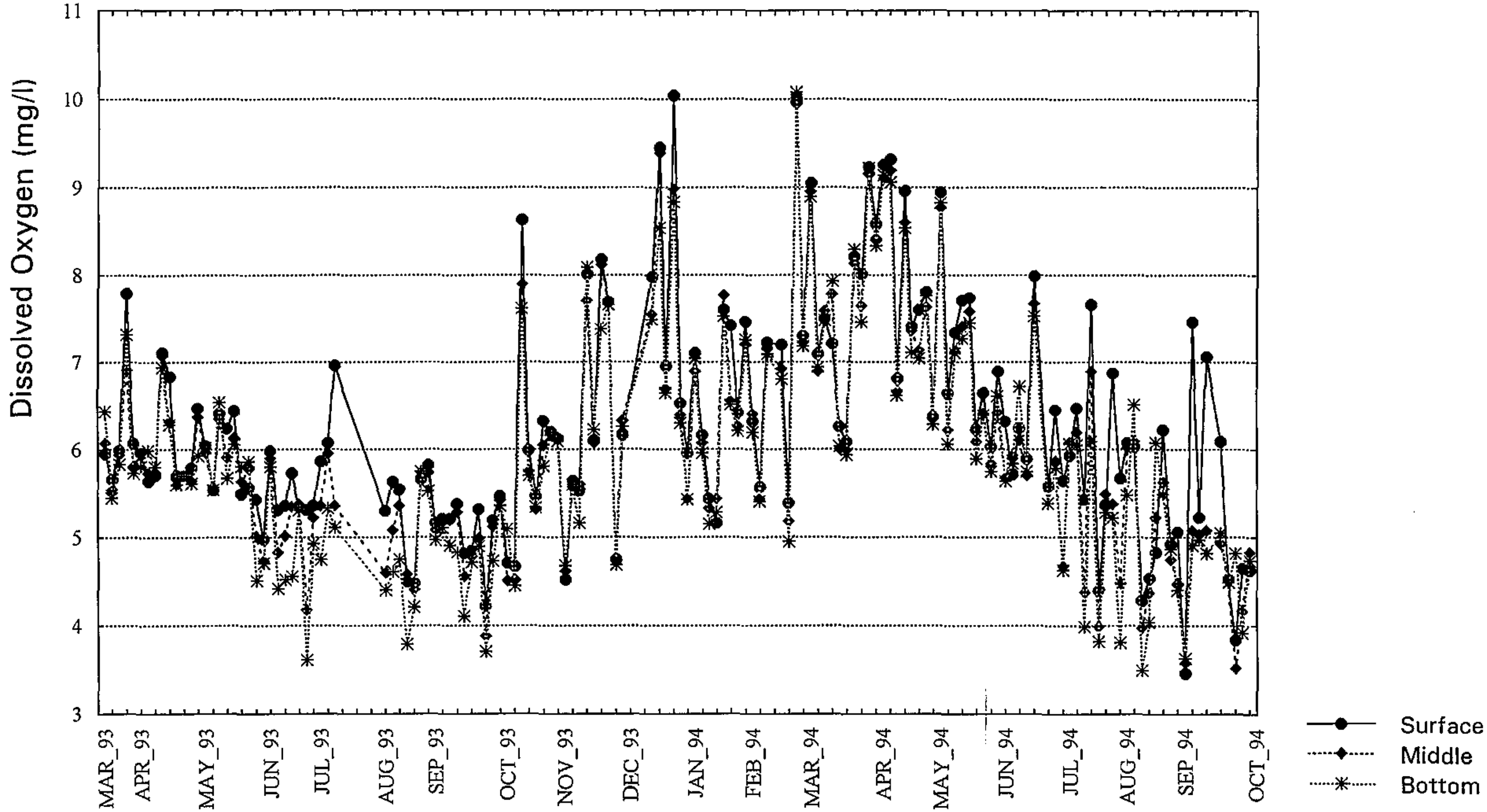
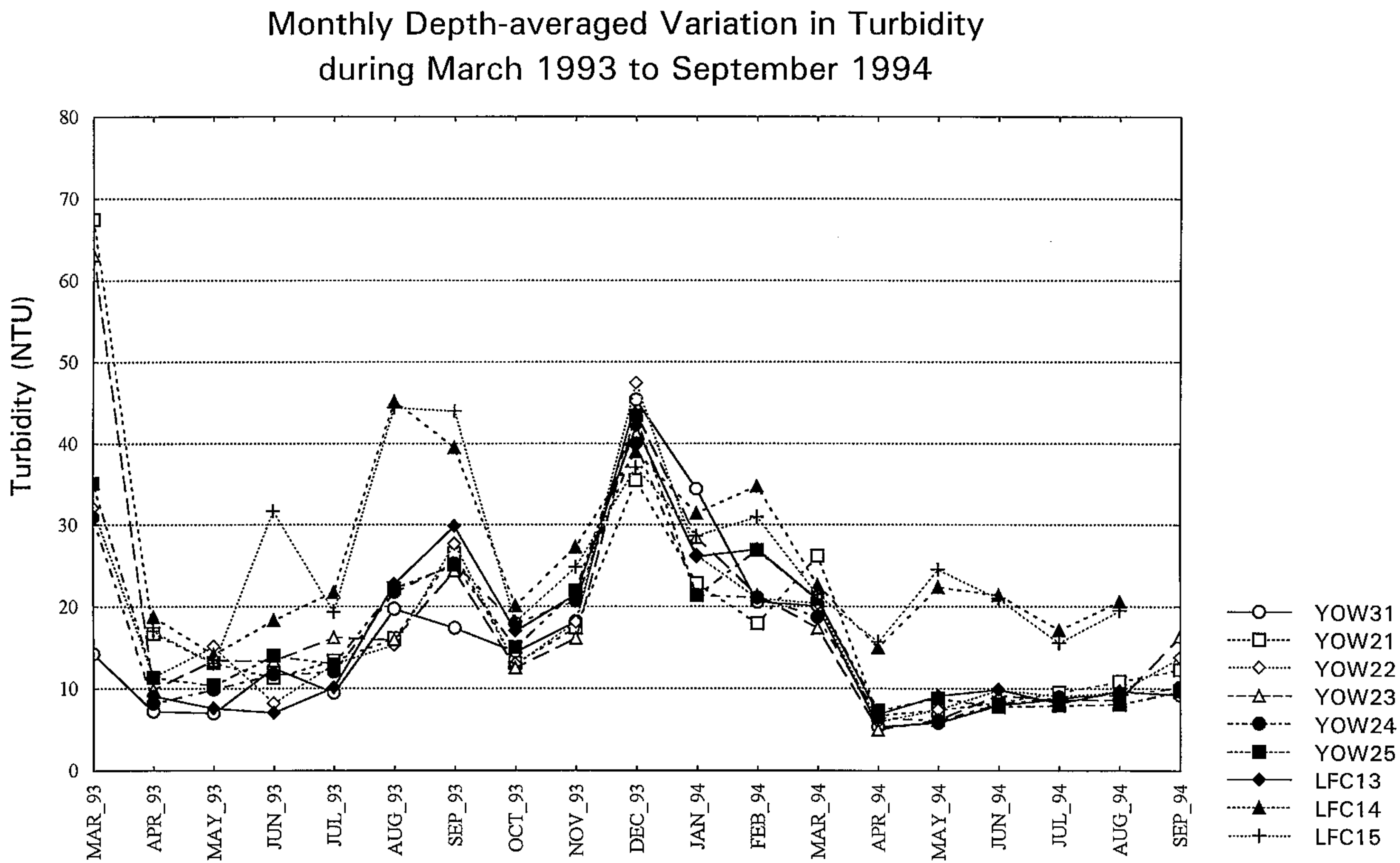
Date	Scale
DEC 94	
Initial	Figure No.
PC	7.7

Variation in Dissolved Oxygen at YOW25
during March 1993 to September 1994



TO KAU WAN OPERATIONAL EIA BACKGROUND MARINE WATER QUALITY	BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 CONSULTING ENGINEERS 賓尼	Date DEC 94	Scale
	土木工程署 Civil Engineering Department	Initial PC	Figure No. 7.8



TO KAU WAN OPERATIONAL EIA

BACKGROUND MARINE WATER QUALITY

BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 CONSULTING ENGINEERS 賓尼	Date DEC 94	Scale
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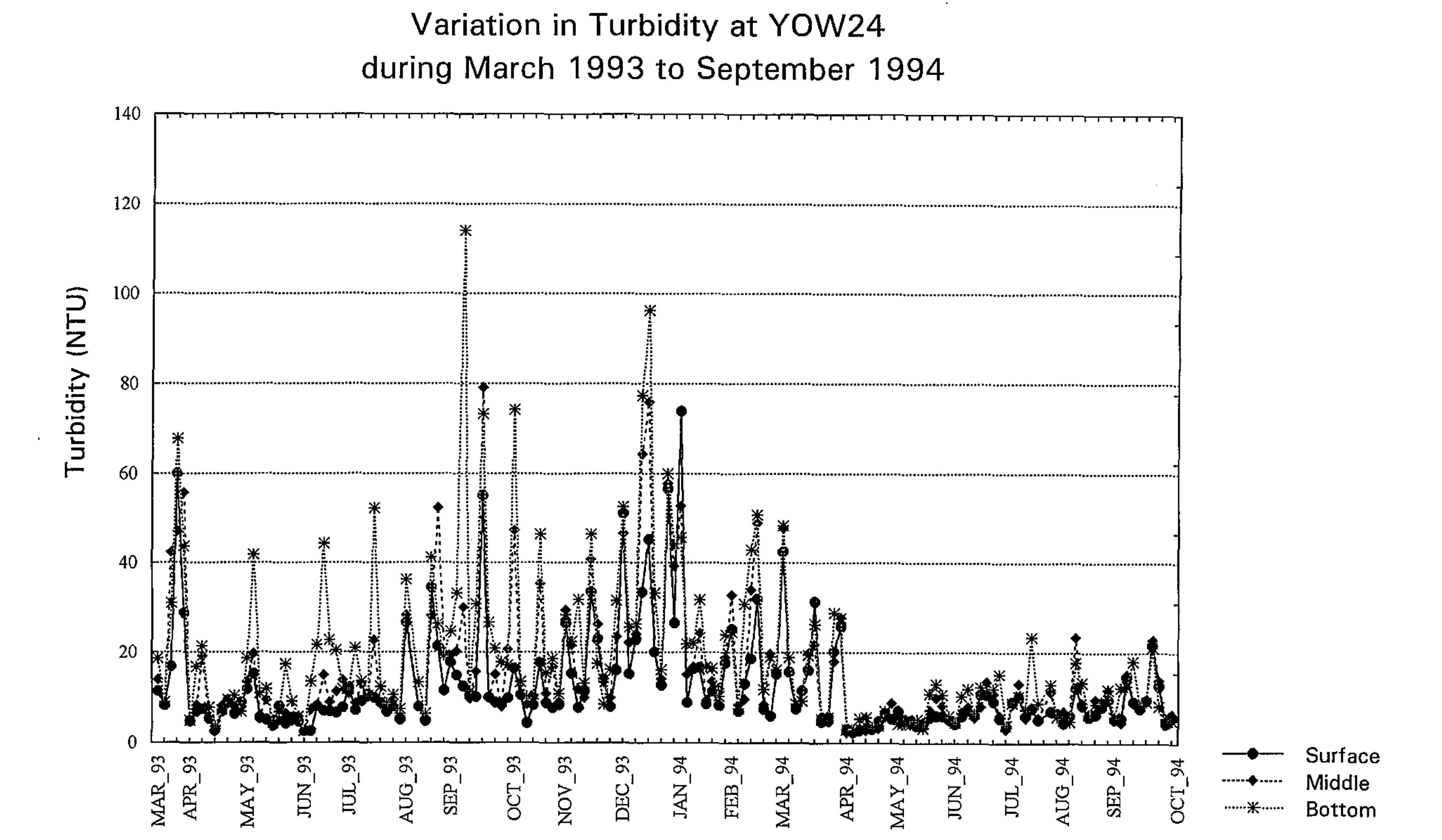

TO KAU WAN OPERATIONAL EIA

BACKGROUND MARINE WATER QUALITY

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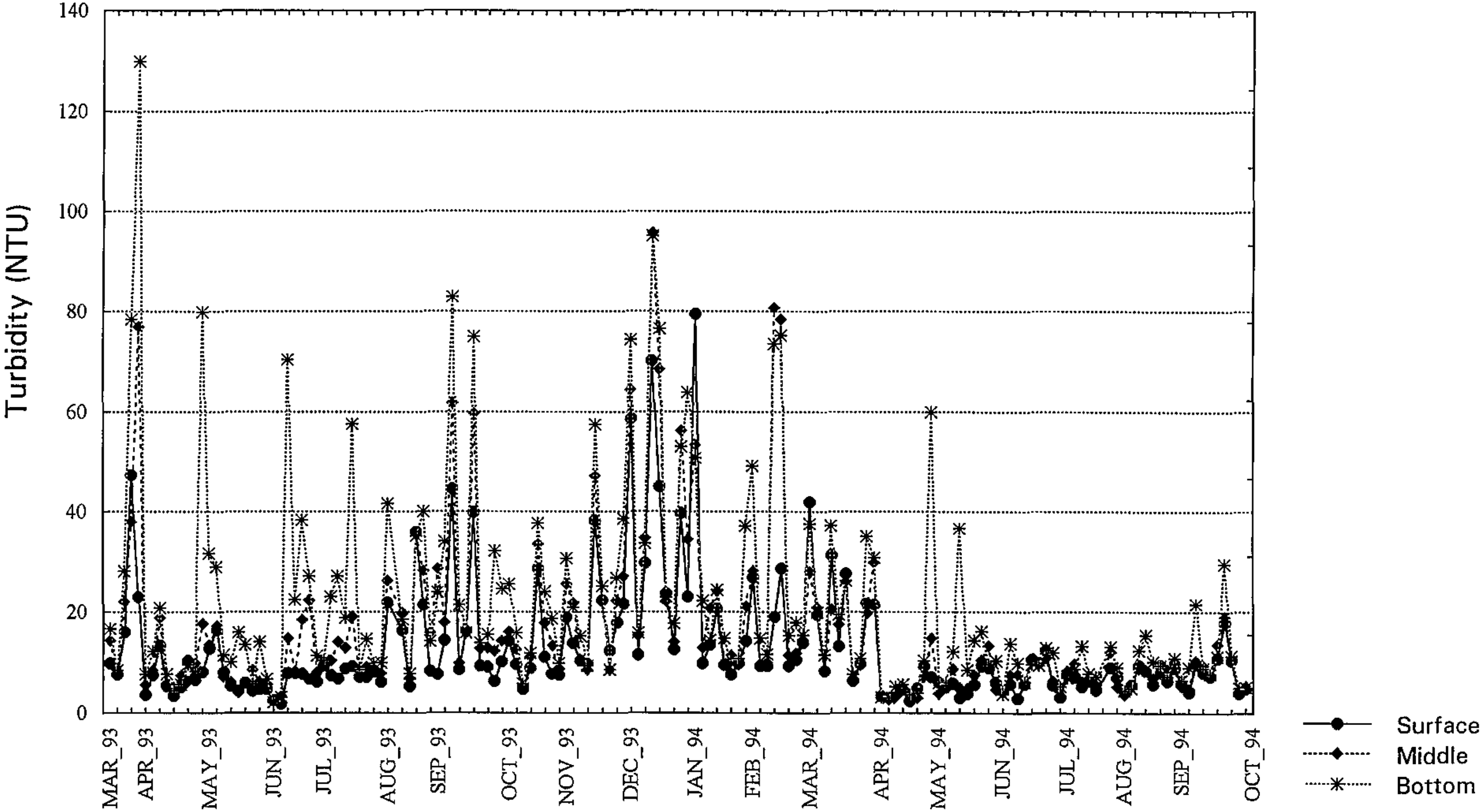
Figure No. 7.10

Variation in Turbidity at YOW25 during March 1993 to September 1994



TO KAU WAN OPERATIONAL EIA BACKGROUND MARINE WATER QUALITY	BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 CONSULTING ENGINEERS 賓尼	Date DEC 94	Scale
	土木工程署 Civil Engineering Department	Initial PC	Figure No. 7.11

The storm water drainage system has been designed to cope with:

- a 50-year rainstorm with a mean high tide water level at the outlet; and
- a 5-year rainstorm with a 50-year storm surge level at the outlet.

7.45 There are a number of natural streams in the study area but only two streams run year round. The larger culvert from the Toll Plaza Project (CH 21265) feeds into the larger of these two streams. The design capacity of the main Toll Plaza culverts directed towards To Kau Wan are given below.

Table 7.2 Design Capacities for the Two Culverts Directed to To Kau Wan by the Toll Plaza Works

	Discharge (cu.m./sec)	Outlet
Culvert (Ch. 20856)	5.2	near Yiu Luen Dockyard
Culvert (Ch. 21265)	7.9	directed to a stream

7.46 The Lantau Toll Plaza administration building was constructed to accommodate staff of the Lantau Fixed Crossing. The construction comprised a 3-storey administration block and a single storey workshop compound at the Lantau Toll Plaza. An adequate sized sewage treatment plant is proposed to be constructed on the sewage treatment works area in between the MTRC reclaimed area and Yiu Lian Shipyard. The treated effluent will either be discharged into the sea. The detail of the outfall from the sewage treatment plant is under review under the Toll Plaza contract. We advised against any treated effluent being discharged into the open stormwater channel, as there is only storm flow in it for part of the year. Insufficient flow could have led to odour problems when there was no dilution of effluent during the dry season.

7.47 Drainage from the East Lantau Tunnels contract also needs treatment before it is discharged into the main stream. The surface water at To Kau Wan would reflect the surface water quality of this project.

Water Quality Assessment of the Construction Phase

7.48 An Environmental Impact Assessment has been undertaken for the reclamation and site formation of the 6 ha site (BCL 1991a).

7.49 The work programme indicates that the site for the new shipyard will be available for construction of buildings 380 days after commencement of the works, which started on 23rd December 1994. There will be no marine access to Penny's Bay by the end of 1996. This means that construction of the shipyard facilities must be finished within a year.

7.50 Waste water due to construction activities is likely to include runoff from dust suppression activities, runoff from soil/spoil and fuel and lubricating oil spillage. This can be prevented by reasonable attention to good site practice such as that given below.

7.51 Temporary arrangements for drainage of the site should be made and should include provision of sedimentation traps and oil interception. Oil interceptors should be provided in works areas compounds as appropriate and regularly emptied to prevent release of oils and grease into the drainage system in the case of accidental spillage. Any long term stockpile of spoil should be treated to reduce erosion of the stockpile and sediment release.

7.52 Fuel and lubricating oil leakage from plant and storage sites should be prevented from contaminating the construction site. A spill action plan should be prepared. Suitable clean-up materials should be kept on site. Layers of sawdust, sand or equivalent material should be laid underneath and around any construction plant and equipment that may possibly leak oil. The pollution clean-up material should be replaced with some clean materials on a regular basis. Any polluted materials should be disposed of in an acceptable and regular manner. Plant and storage sites for fuel and lubricating oil should be formed on bunded and impervious ground.

7.53 Sewage generated from toilets, washing facilities and any temporary canteen provided for staff should be separately collected and suitable treatment should be provided before discharge. Domestic sewage is characterised with relative higher BOD and SS than fresh water and is enriched with nutrients, moreover, the bacterial count would also be elevated and it should not be discharged into the sea. Adequate and suitable temporary arrangements should be implemented such as sufficient chemical toilets and ensuring the waste generated is properly handled. The quantities of domestic waste will be relatively small.

7.54 Surface run-off from the Construction Site will always contain some soil and sand. To protect surface run-off from possible contamination it is important that:

- the use of sediment traps, drainage channels and bunding are required;
- oil interceptors should have a bypass;
- landtake under stockpiles or open working areas should be minimised;
- water should be collected and settled; and
- solids in the sand traps, manholes and streambeds should be cleared out regularly.

7.55 It is not anticipated that there will be any deterioration in water quality caused by the construction of the shipyard facilities provided sensible measures are observed. Any discharges from the Site are controlled under the "Technical Memorandum on Standard for Effluents Discharged into Sewerage Systems, Inland and Coastal Waters".

Water Quality Assessment of the Operational Phase

7.56 This EIA for the Operational Phase of the Shipyard, or more colloquially the Shipyard EIA, examines the operational phase of the shipyard using the existing shipyard as the basis of the EIA study.

7.57 Information on shipyard operation including the materials used and waste treatment practices has been collected and assessed in detail. Some of this information was introduced in Chapters 2 and 3. Further information is highlighted and further elaborated in this chapter.

7.58 A number of methods have been used to assess the Penny's Bay site. These include:

- EPD's previous assessments through the Control Group;
- site visits and discussion with CLS; and
- chemical testing data.

7.59 The original chemical testing programme proposed included testing for the usual seven metals which form part of the sediment classification system. Large quantities of data were made available to us from other sources. This data has been carefully scrutinised.

7.60 The chemical testing programme undertaken within this EIA was formulated to detect pollution from any of the toxic substances used at the Penny's Bay site.

Current WPCO Licences for the Penny's Bay Site

7.61 The Water Pollution Control Ordinance requirements specify that any effluent discharged into the waters of Hong Kong requires licensing. The WPCO licence should be applied for and obtained before any effluent is discharged from a site. The content of effluent discharged into any waters should strictly comply with the limits set in the TM (EPD 1991a) issued under the WPCO. In many cases EPD issues licences with stricter requirements than the TM in order to achieve the Water Quality Objectives.

7.62 Various wastewater generating processes of the CLS operation at Penny's Bay were identified by EPD at Penny's Bay. An effluent discharge licence has been granted to Cheoy Lee Shipyard Limited by the Director of Environmental Protection pursuant to the Water Pollution Control Ordinance (WPCO) Section 23A and for the purpose of Section 8(1) for the discharge or deposit to be made into the waters of Hong Kong. The processes named are:

- electroplating;
- on-site laboratory;
- ship manufacturing; and
- sewage from toilets and canteen.

7.63 Effluent from the rinsing tanks, laboratory, the septic tank and a soakaway system are the principal discharges at the existing site. The septic tank effluent is drained through the soakaway pit into the underground soil. The effluent at the discharge points normally complies with the limitations specified in the WPCO licence. These limitations are reproduced in Table 7.3 and apply to discharge points 2 and 3 (Figure 2.1). These standards are more stringent that the limits set out in the Technical Memorandum on Standards for Effluent Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters (TM) (EPD 1991a).

Table 7.3 Current Discharge Limits into Marine Waters for each of DP2 and DP3 at the Penny's Bay Site

Determinand	Unit	Maximum Limit
Daily Flow Rate	cu.m/day	1.5
pH	pH units	6-9
Temperature	°C	40
Suspended Solid	mg/l	50
5-Day Biochemical Oxygen Demand	mg/l	50
Chemical Oxygen Demand	mg/l	100
Oil & Grease	mg/l	30
Iron	mg/l	0.2
Chromium	mg/l	0.2
Nickel	mg/l	0.2
Copper	mg/l	0.7
Zinc	mg/l	0.5
Total toxic metals	mg/l	2
Cyanide	mg/l	0.2
Total phosphorus	mg/l	6.5
Surfactants (total)	mg/l	20

7.64 The WPCO licences issued under it describe the general prohibitions for the discharge or deposit of certain chemicals and specify the requirement of treatment and disposal facilities. These general prohibitions are:

> *The discharge/deposit shall not contain any other wastes such as polychlorinated biphenyls (PCB), polycyclic aromatic hydrocarbon (PAH), fumigant, pesticide or toxicant, radioactive substance, chlorinated hydrocarbon, flammable or toxic solvent, petroleum oil or tar, calcium carbide, uncontaminated condensing or cooling water, wastes liable to form scum or deposit in any part of the communal sewer or water of Hong Kong, any substance of a nature and quantity likely to damage the sewer or to interfere with any of the treatment processes or to pollute/discolor waters of Hong Kong or to be harmful to the health and safety of any personnel engaged in the operation or maintenance of a sewerage system.*

The septic tank and soakaway pit system must be kept in good operating condition. Failure to do so will result in improper discharge of wastewater from the pretreatment facilities and will render the licence liable to cancellation under Section 24 of the Ordnance.

The grease trap must be kept in good operating condition. Oil and grease retained by the grease trap shall be regularly removed for proper disposal. The removed oil and grease must be disposed of in the same manner as solid wastes. No removed oil and grease shall be discharged into any communal drain, inland waters or waters of Hong Kong.

7.65 Not all sites can be licensed for soakaway systems. Although the current site at Penny's Bay is allowed to use soakaways it is very unlikely that soakaway systems will be permitted at To Kau Wan.

Site Visits

7.66 Two site visits at Penny's Bay were organized to investigate their routine operation activities which are likely to cause water pollution. They were useful to identify the water quality impacts from both the construction stage and operational phase of the new shipyard at To Kau Wan.

Wastewater from Laboratory

7.67 A small on-site laboratory is used to monitor the quality of metals formed in the foundry as well as effluent and solutions for the electroplating and anodising operations. An atomic absorption spectrophotometer (AAS) is used for metal assay and a carbon analyzer for determining the quality of steel. The quantities of chemical used for laboratory testing are very small and should not result in any significant change in the quality of the effluents, nor be regarded as chemical waste. This waste should be treated as chemical waste. It will be added to the spent acidic wastes from the electroplating processes.

Wastewater from Electroplating

7.68 The current electroplating and anodising operations are housed in separate rooms of the same shed. The electroplating process is used for chromium and nickel, whilst aluminium is anodised. These processes were described in Chapter 3.

7.69 Effluent comes only from the rinsing tanks. All other solutions are contained entirely in containers with no outlets. These liquors are used and reused, topped up with more chemicals and reused yet again and again. Finally the solutions are no longer satisfactory. Currently, these spent liquors, in quantities of tens of litres, are allowed to soakaway at the back of the site.

7.70 Routine analysis of electroplating effluents is carried out by an on-site chemist several times a week. As an example, the analytical data for July 1994 is presented in Table 7.4. Most of the data are well within the limits of the site licence. Only the concentration of iron showed greater variation. It ranged between 0.10 mg/l and 0.34 mg/l. Nickel concentration was less than 0.1 mg/l with one anomalous value of 0.23 mg/l. All data was well within the limits of the Technical Memorandum standards for NWWCZ inshore waters for flows under 10 m^3/day. The limits are given for comparison in Table 7.4.

Table 7.4 Analytical Record of Electroplating Effluent on July 1994

Date	Analytical Record (mg/l)						
	pH	Nickel	Copper	Chromium	Iron	Cyanide	Phosphorus
16/7/94	6.5	0.23	0.05	<0.02	0.32	<0.02	0.2
19/7/94	6.2	0.07	0.08	<0.02	0.20	<0.02	<0.02
20/7/94	6.5	0.06	0.03	<0.02	0.10	<0.02	<0.02
27/7/94	6.5	0.06	0.02	<0.02	0.18	-	-
28/7/94	6.5	0.06	0.06	<0.02	0.34	-	-
Licence standards	**6-9**	**0.2**	**0.7**	**0.2**	**0.2**	**0.2**	**6.5**
TM standards	**6-9**	**1**	**1**	**1**	**15**	**0.2**	**10**

Source: Supplied by Cheoy Lee Shipyard

Wastewater from Ship Manufacturing

7.71 Effluents from ship manufacturing could arise from the boat fuelling stations; chemicals involved in fibreglass ship mould production such as styrene, polyester resin and acetone; primers and painting products including paints and paint solvents and thinners such as toluene and xylene.

7.72 Solvents are recycled by passing them through a "solvent recycling apparatus" (see Plate 3.8 in Chapter 3) which is connected to a cooling tower for the condensation of the distilled solvent. The highly dense viscose solvent residues left after distillation are collected in a bin. The residues are handled and disposed of as chemical waste. They are put in a sealed container for disposal. The cooling tower contains only recycled water.

7.73 The current solvent recycling system is used for xylene, toluene and acetone recovery. The recycling system is based on the principle of distillation, separating a mixture of solvents depending upon their individual boiling points, using an electrically heated oil bath. The vaporized solvent is condensed using a circulating water cooler. The distillates are collected at various boiling point temperatures ranges.

7.74 During site visits, the EIA team looked for evidence of spillage and staining. Storm water drains were very clean with little evidence of poor housekeeping practices.

7.75 The areas that showed evidence of spillage were mostly in boat repair area. Protection and clean-up facilities were apparent in the engine repair area but oil and grease contaminated the nearby soil. There was some staining at a couple of marine outlets probably of an oily nature. The staining did not reach right down the seawall but was limited in extent.

7.76 The repair works for boats involves the emptying and cleansing of bilges using household detergent. The bilge wastes contain oil and possible phosphates from the detergent. Currently, all bilge wastes enter the marine environment. The frequency of bilge cleaning is low based on Cheoy Lee's past experience. Repair work is a less important part of the CLS operations.

Sewage from Toilets and Canteen

7.77 The treatment methods used for sewage at Penny's Bay are irrelevant to the new site. Soakaway systems cannot be used at To Kau Wan.

Heavy Metals in Sediment

7.78 By examining metal levels in sediments estimation of possible contamination can be made.

7.79 Three sets of sediment quality measurement data for seven metals, Cadmium (Cd), Chromium (Cr), Copper (Cu), Mercury (Hg), Nickel (Ni), Lead (Pb) and Zinc (Zn) at Penny's Bay have been obtained from two different Lantau Port Development sediment testing programmes in North Lantau:

- "Lantau Port Development (LPD) Container Terminals No. 10 and 11 (Back-Up Areas), Contract No. GE/93/04.032" (Matlab 1994a);

- "Lantau Port Development (LPD) - Stage 1 Container Terminals No. 10 and 11 (Ancillary Works), Contract No. GE/93/04" (Matlab 1994b); and

as well as from the "Contaminated Spoil Management Study" (Mott 1991b).

7.80 The classification criteria for marine sediment contamination levels is specified in the "Classification of Sediment Specified in EPD Technical Circular No. (TC) No. 1-1-92", as shown in Table 7.5.

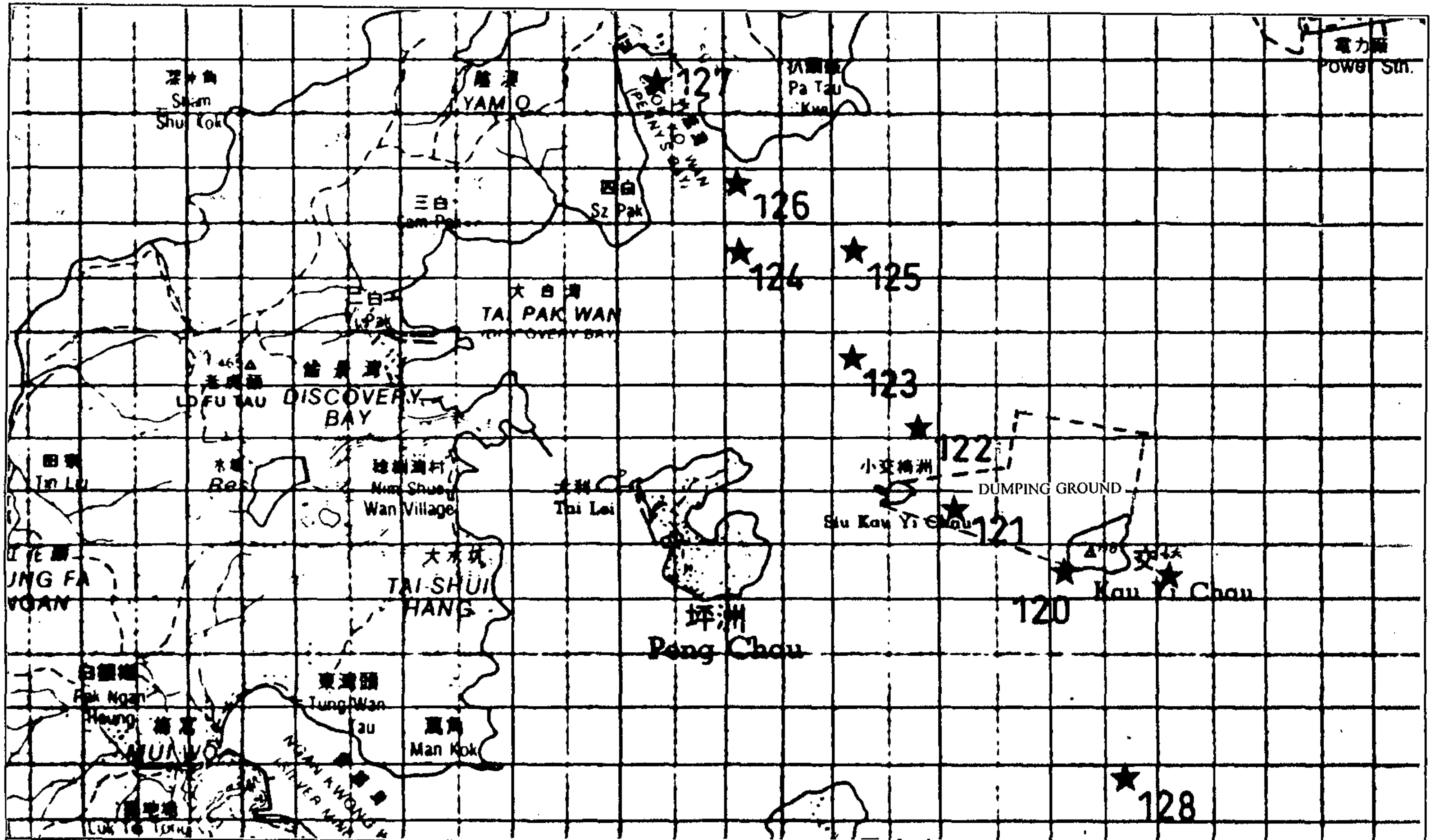
Table 7.5 Classification of Sediments by Metal Content (mg/kg dry weight)

	Cadmium	Chromium	Copper	Mercury	Nickel	Lead	Zinc
Class A	0.0-0.9	0-49	0-54	0.0-0.7	0-34	0-64	0-140
Class B	1.0-1.4	50-79	55-64	0.8-0.9	35-39	65-74	150-190
Class C	1.5 or more	80 or more	65 or more	1.0 or more	40 or more	75 or more	200 or more

Note: *Class A - Uncontaminated;*
Class B - Moderately contaminated; and
Class C - Seriously Contaminated.

7.81 The sampling positions and codes for the sediment data quoted in this section are illustrated in Figures 7.12 and 7.13.

7.82 Maximum, minimum and mean of the metal concentration of surface marine sediment samples (i.e. top 0.5 m) inside Penny's Bay (i.e. data obtained from "LPD - Ancillary Works"), at the mouth of and outside Penny's Bay (i.e. data obtained from "LPD - Back-Up Areas") have been calculated and given in Table 7.6. All heavy metals surface mean levels are within Class A both inside and outside Penny's Bay. Class A suggests that the sediments were uncontaminated.



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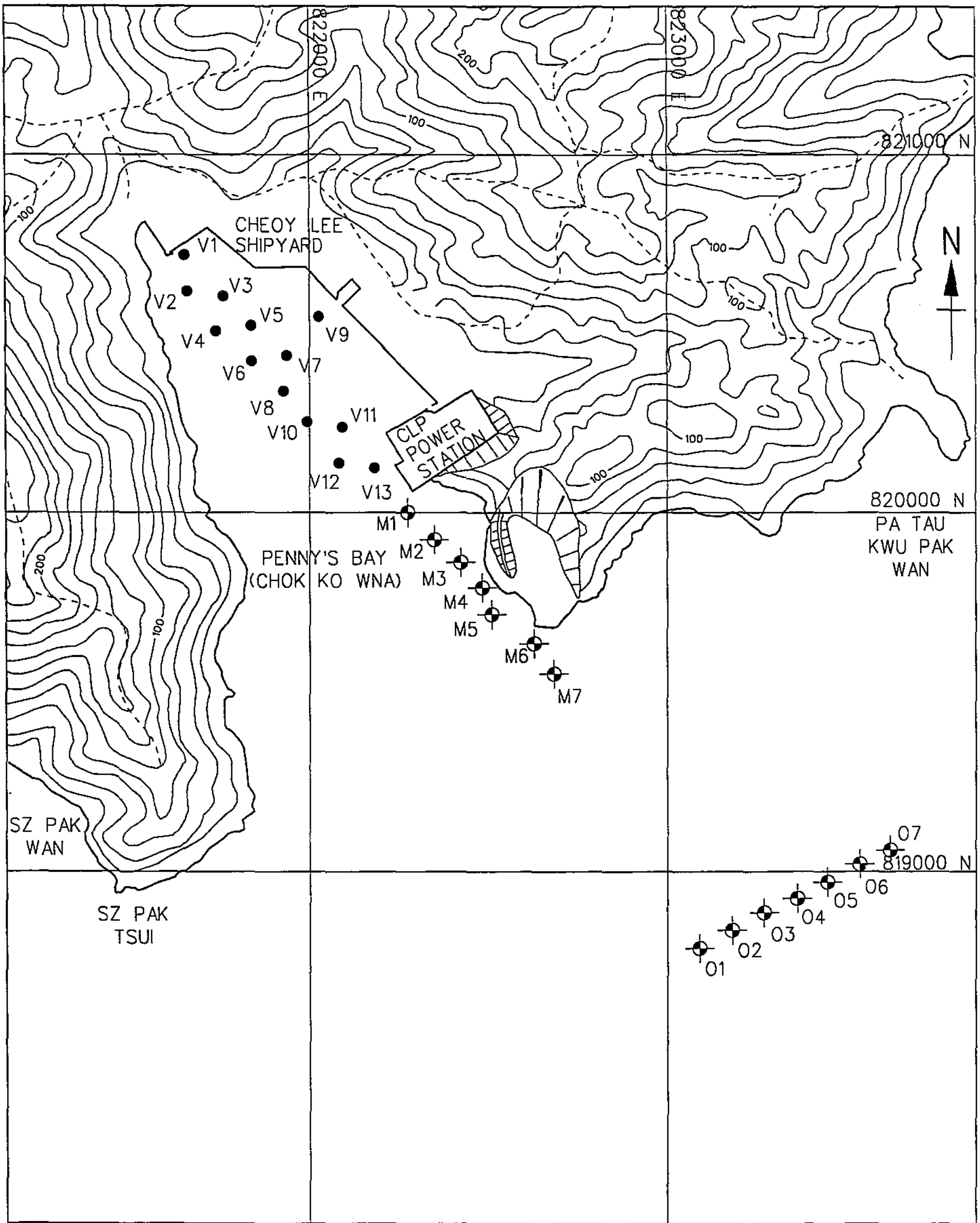
MARINE SEDIMENT SAMPLING STATIONS FOR THE CONTAMINATED SPOIL MANAGEMENT STUDY (MOTT 1991b)

BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 CONSULTING ENGINEERS

土木工程署 Civil Engineering Department

Date	Scale
JAN 95	N.T.S.
Initial	Figure No.
PC	7.12



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MARINE SEDIMENT SAMPLING STATIONS OF THE LANTAU PORT DEVELOPMENT - STAGE 1 PROJECTS	土木工程署 Civil Engineering Department	Initial P.C.	Figure No. 7.13

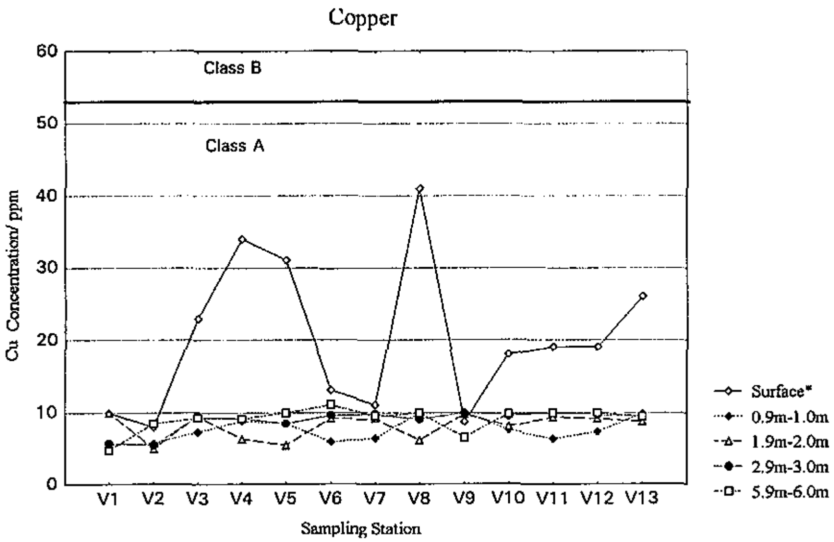
Table 7.6 **Maximum, minimum and mean of the metal concentration of surface sediment inside, at the mouth of and outside Penny's Bay, North Lantau in 1994 (Matlab 1994a, 1994b)**

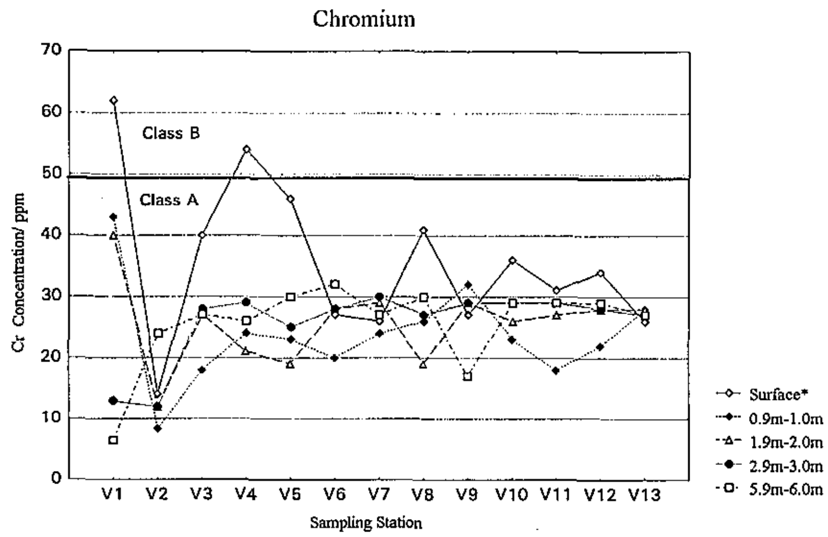
Metal	Metal Concentration (mg/kg)		
	Inside Penny's Bay	Mouth of Penny's Bay	Outside Penny's Bay
Cadmium (Cd)			
Range	-	-	0.02 - 0.11
Mean	0.20*	0.02*	0.05
Chromium (Cr)			
Range	14.0 - 62.0	1.2 - 36.0	25.0 - 49.0
Mean	35.69	20.44	38.00
Copper (Cu)			
Range	7.9 - 41.0	2.1 - 39.0	5.8 - 58.0
Mean	20.12	18.89	37.83
Lead (Pb)			
Range	22.0 - 55.0	22.0 - 125.0	21.0 - 51.0
Mean	38.69	63.00	41.57
Mercury (Hg)			
Range	0.04 - 0.35	0.06 - 0.42	0.07 - 0.38
Mean	0.19	0.21	0.20
Nickel (Ni)			
Range	3.5 - 16.0	0.25 - 17.0	13.0 - 20.0
Mean	12.12	9.94	16.71
Zinc (Zn)			
Range	23.0 - 110.0	21.0 - 106.0	55.0 - 120.0
Mean	75.31	69.14	98.00

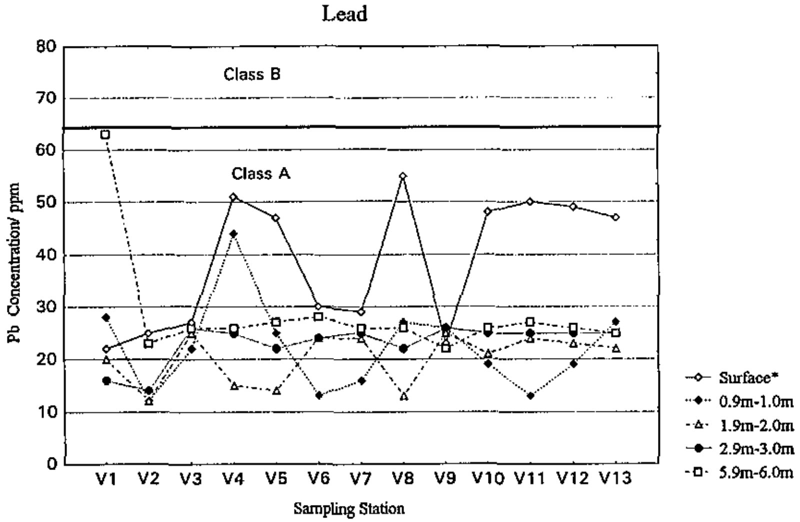
* Materialab often quotes a detection limit of 0.20 mg/kg. These numbers simply suggest that cadmium levels are low.

7.83 Plots of individual metal levels at each sampling site and depth in inner Penny's Bay are given in Figures 7.14 and 7.15. Cadmium has not been plotted. All cadmium levels were as low or lower than commonly quoted detection limits. Cadmium is not likely to be a pollutant of the CLS operations.

7.84 Almost every metal level lies within the Class A limits both inside and outside the bay. Surface values are mostly higher than those for deeper layers as in common throughout the Hong Kong seafloor.

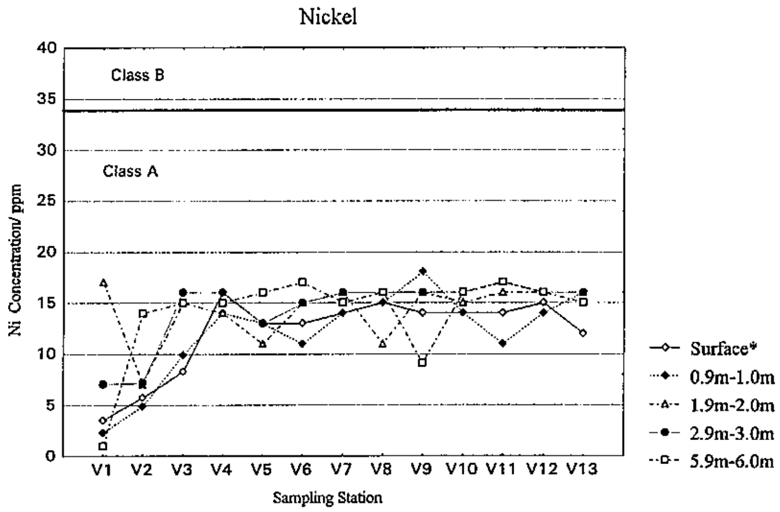


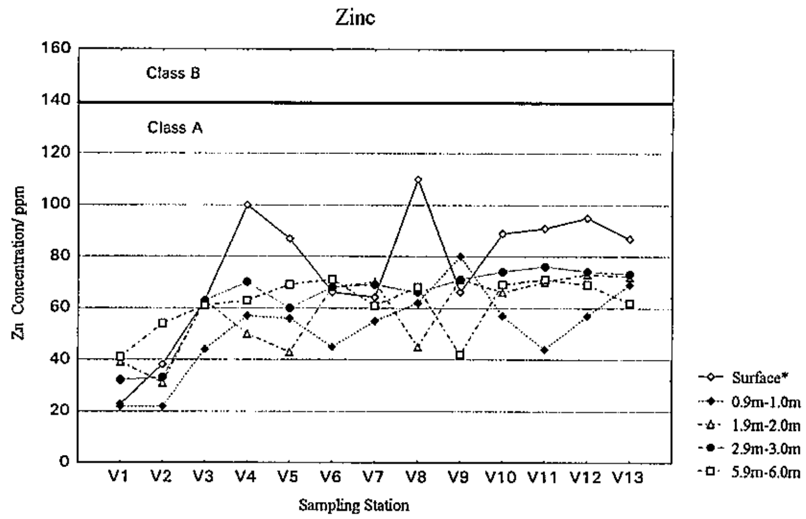


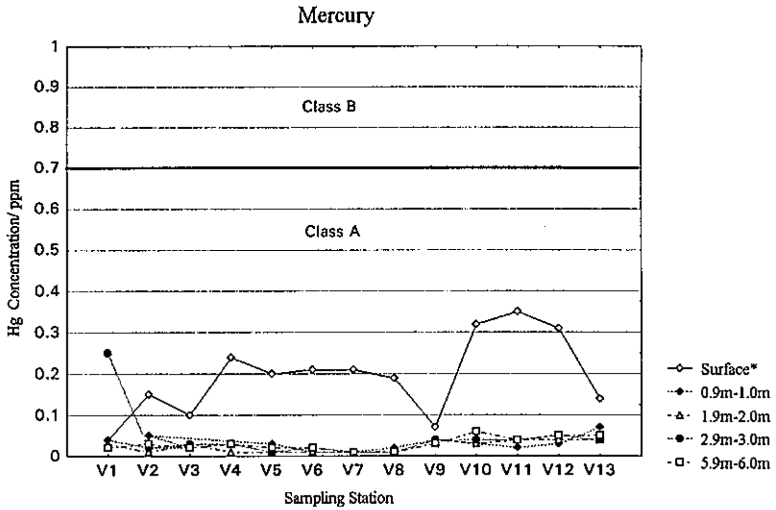


Note: Surface* - 0.0m-0.1m : V2, V6, V9-V13
0.1m-0.2m : V4, V7, V8
0.2m-0.3m : V5
0.3m-0.4m : V1
0.4m-0.5m : V3

TO KAU WAN OPERATIONAL EIA SPATIAL DISTRIBUTION OF METALS IN SEDIMENT AT PENNY'S BAY LPD STUDIES (MATLAB 1994a)	BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 CONSULTING ENGINEERS 賓尼	Date DEC 94	Scale
	土木工程署 Civil Engineering Department	Initial PC	Figure No. 7.14







Note: Surface* - 0.0m-0.1m : V2, V6, V9-V13
0.1m-0.2m : V4, V7, V8
0.2m-0.3m : V5
0.3m-0.4m : V1
0.4m-0.5m : V3

TO KAU WAN OPERATIONAL EIA SPATIAL DISTRIBUTION OF METALS IN SEDIMENT AT PENNY'S BAY LPD STUDIES (MATLAB 1994a)	BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 CONSULTING ENGINEERS 賓尼	Date DEC 94	Scale
	土木工程署 Civil Engineering Department	Initial PC	Figure No. 7.15

7.85 The curves for nickel, zinc and mercury present very little evidence of contamination by CLS. Sediment metal levels are lowest close to CLS's electroplating effluent discharge points. It could be inferred from the graphs that these metal contaminants enter Penny's Bay from outside the Bay.

7.86 The graphs of lead concentrations are harder to interpret. While all sediments at every level are Class A, there is great variation in lead concentrations at many depths. Lead is not expected to be a contaminant of CLS's current or future operations.

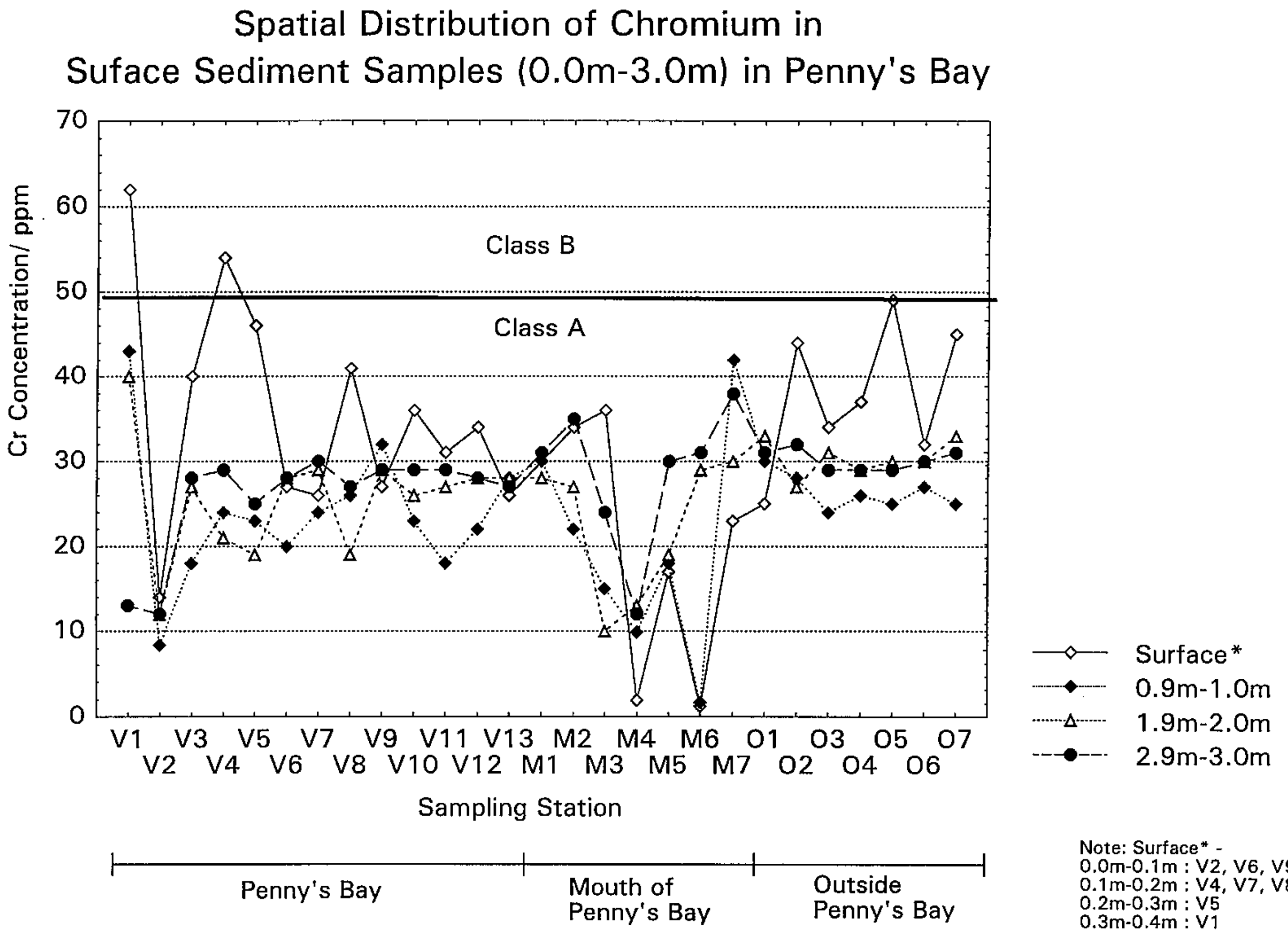
7.87 The graphs for copper and chromium indicate the possibility of minor contamination by these metals. The EIA team has examined these two metal with greater attention. Plots showing Chromium (Cr) and Copper (Cu) levels spatially inside and outside the bay are given in Figures 7.16 and 7.17,

7.88 Figure 7.17 shows Cu levels to be far higher in surface layers outside the bay than inside the bay. This suggests that pollution of surface layers may have originated outside Penny's Bay. There is little evidence of Cu pollution from the CLS operations.

7.89 Figure 7.16 still suggests the possibility of minor Cr contamination by CLS over their 30 years of operation. However, variation in Cr levels in deeper segments make this statistically uncertain.

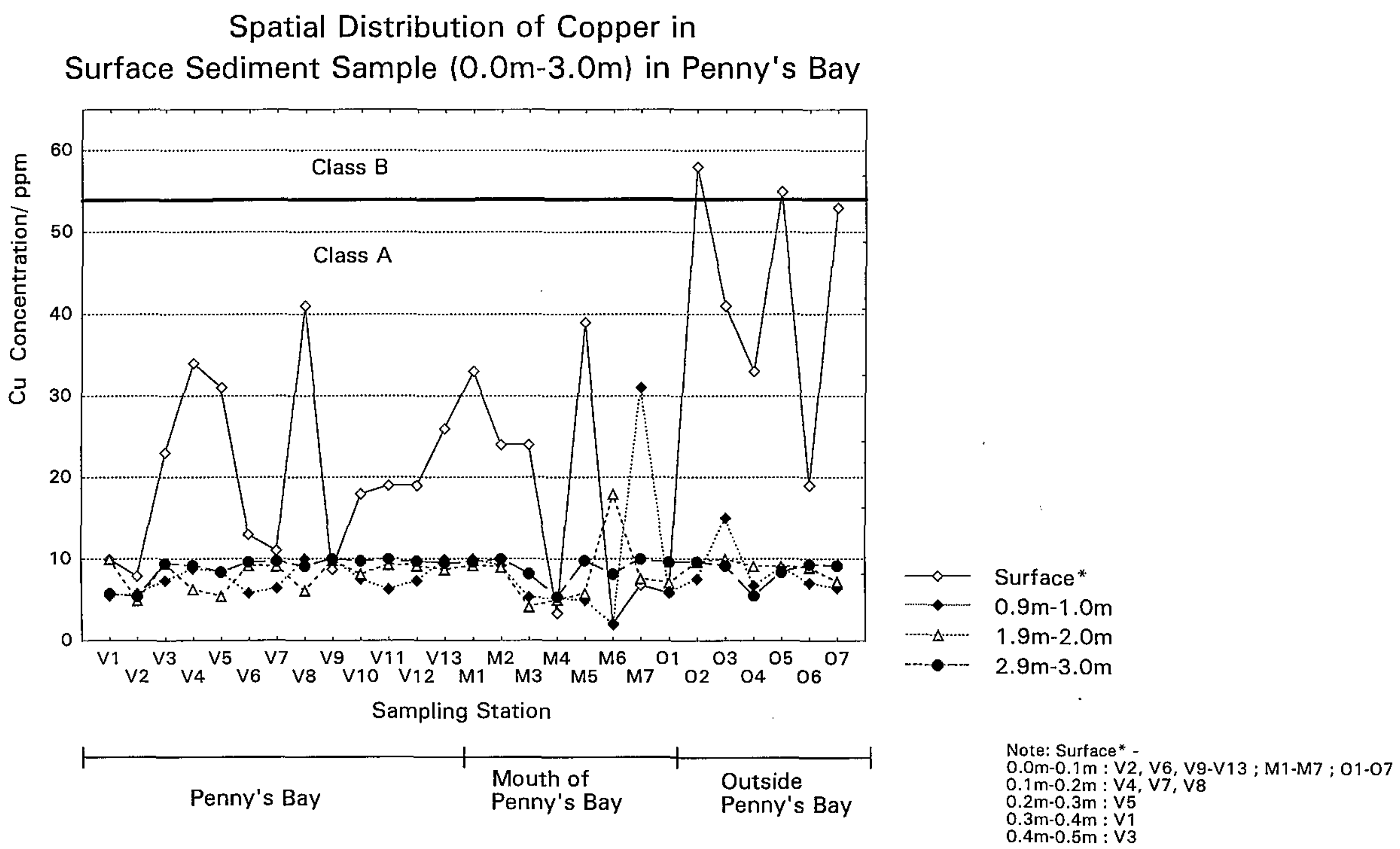
7.90 Figures 7.18 and 7.19 present data from the Contaminated Spoil Management Study undertaken a few years before the LPD studies. This study is the one quoted by APH Consultants (APH 1993) as presenting a high mercury value for sediment near CLS. The study gave two high mercury values in the Study Area (CSMS) one deep inside Penny's Bay and again at sampling sites 120 and 128. Lead was also high at 120.

7.91 Figure 7.12 shows the position of an old disused dumping ground. The EIA team noted the CSMS reported extremely high Hg values to the east of this area. Water movements across the general area of this dumping ground may have carried contaminated sediments in the general direction of Penny's Bay. As in the case for many eastern coves, floating debris is frequently carried into both Penny's Bay and Discovery Bay.



Note: Surface* -
0.0m-0.1m : V2, V6, V9-V13 ; M1-M7 ; O1-O7
0.1m-0.2m : V4, V7, V8
0.2m-0.3m : V5
0.3m-0.4m : V1
0.4m-0.5m : V3

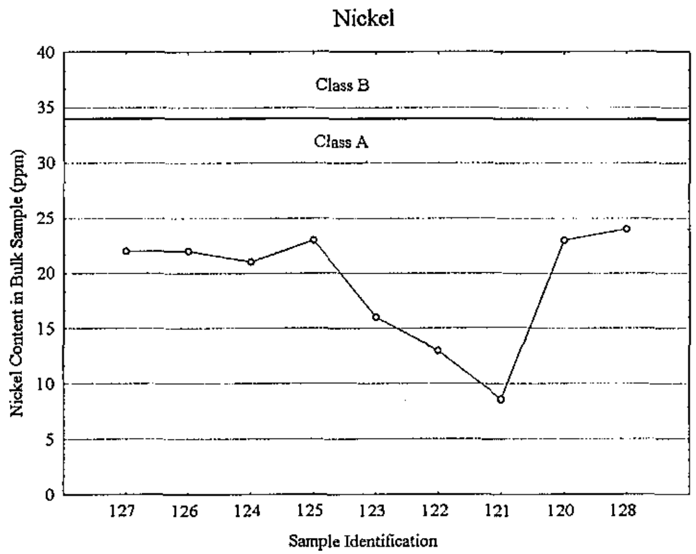
TO KAU WAN OPERATIONAL EIA	BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 CONSULTING ENGINEERS 賓尼	Date DEC 94	Scale
SPATIAL DISTRIBUTION OF CHROMIUM IN SEDIMENT AT PENNY'S BAY LPD STUDIES (MATLAB 1994a, 1994b)	土木工程署 Civil Engineering Department	Initial PC	Figure No. 7.16

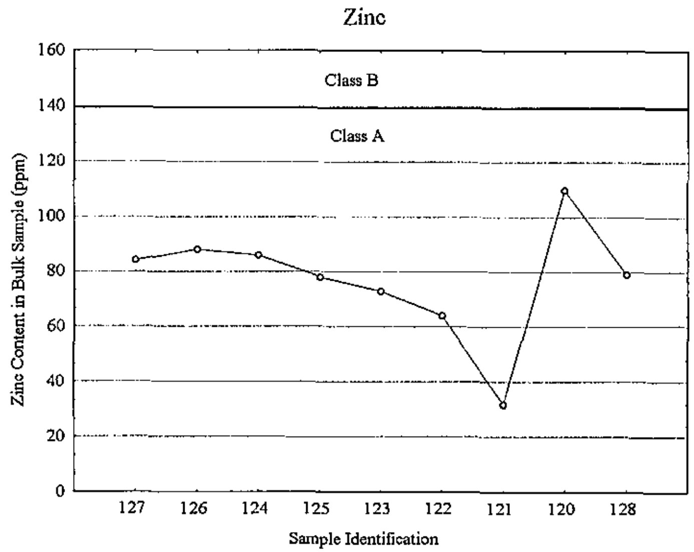


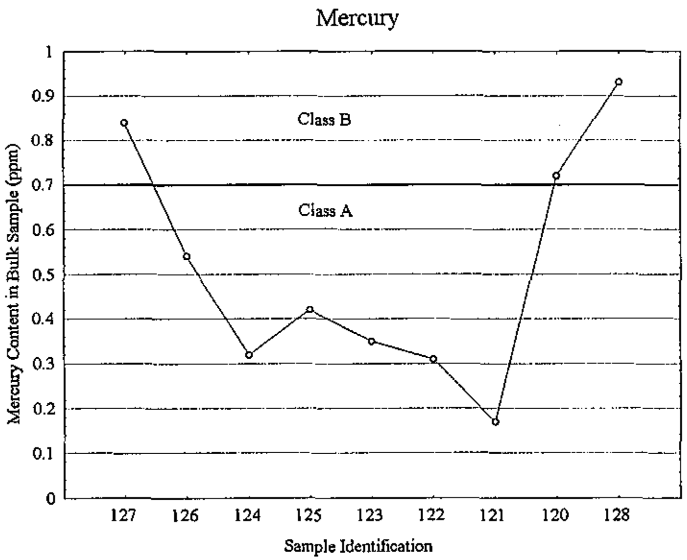
TO KAU WAN OPERATIONAL EIA

SPATIAL DISTRIBUTION OF COPPER IN SEDIMENT AT PENNY'S BAY
LPD STUDIES (MATLAB 1994a, 1994b)

BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 CONSULTING ENGINEERS 賓尼	Date DEC 94	Scale
土木工程署 Civil Engineering Department	Initial PC	Figure No. 7.17



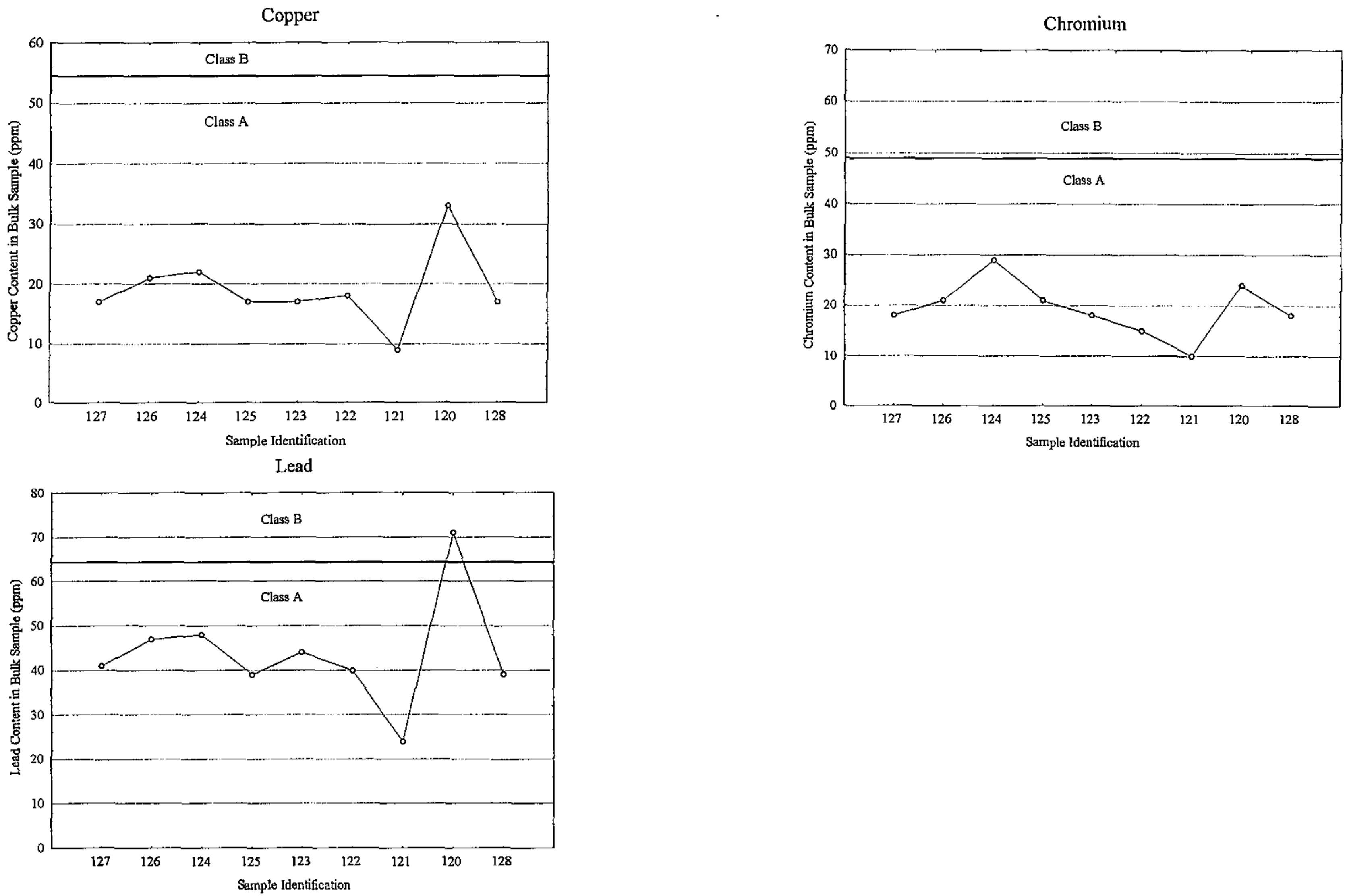




TO KAU WAN OPERATIONAL EIA

SPATIAL DISTRIBUTION OF METALS IN SEDIMENT IN A SOUTH EAST LINE (MOTT 1991b)

BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 CONSULTING ENGINEERS 賓尼	Date DEC 94	Scale
土木工程署 Civil Engineering Department	Initial PC	Figure No. 7.18



TO KAU WAN OPERATIONAL EIA SPATIAL DISTRIBUTION OF METALS IN SEDIMENT IN A SOUTH EAST LINE (MOTT 1991b)	BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 CONSULTING ENGINEERS 賓尼	Date DEC 94	Scale
	土木工程署 Civil Engineering Department	Initial PC	Figure No. 7.19

7.92 On the basis of the available information, the marine sediments in Penny's Bay is not contaminated. Any accumulation of chromium in the sediment close to the shipyard is the result of over 30 years of operation including periods of lesser environmental awareness.

Chemical Testing Programme

7.93 The chemical testing programme was formulated following the site visits. The testing has been on two media, marine water and sediment. Emphasis has been placed on sediment testing as contaminants have more chance of accumulating in this medium. For example, xylene and toluene have short half-lives in seawater.

7.94 Evaluation of impacts has been undertaken by gathering information on the existing operation and waste generating activities of Cheoy Lee's current site and their comparing this data with future operations.

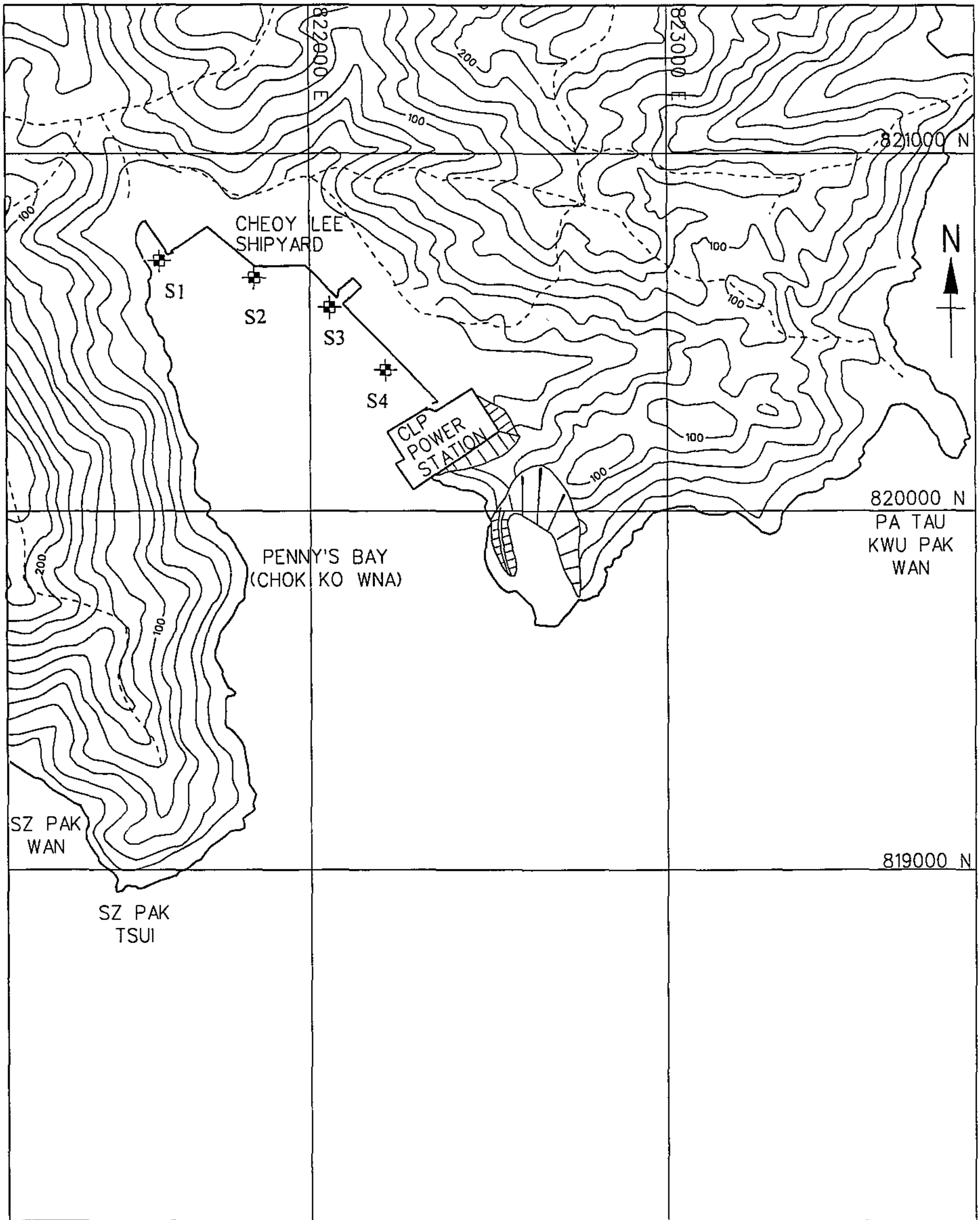
7.95 Water and sediment quality of the existing site has been assessed at strategic points along Cheoy Lee's waterfront and at outfalls to determine if operational activities produce significant amounts of pollutants, such as organics. The range of parameters to be tested for water and sediment has been agreed with EPD.

Marine Water Testing

7.96 Water quality measurements have been conducted at 4 stations in Penny's Bay as shown on Figure 7.20.

- S1 near the beach and chemical storage/plating works;
- S2 near the finishing area/steel hull construction area;
- S3 near the stream outfall/launching basin; and
- S4 near the repair area/engine repair area.

7.97 One sample has been taken from each station at a depth of 1 m below the water surface. Only surface water has been examined as the expected pollutants either float or are present in the upper layers of water. Sampling was conducted on two occasions one week apart.



TO KAU WAN OPERATIONAL EIA	BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 CONSULTING ENGINEERS 賓尼	Date Jan. 95	Scale 1 : 15000
LOCATION OF MARINE WATER AND SEDIMENT MEASUREMENT AT PENNY'S BAY	土木工程署 Civil Engineering Department	Initial P.C.	Figure No. 7.20

7.98 The water samples have been analysed by Materialab, a laboratory accredited to HOKLAS standards for many environmental tests. The oil and grease content of the water samples is given in Table 7.7 below. Oil and grease content was tested as per the APHA 18th Edit 5520B method.

Table 7.7 Oil and Grease Content of Marine Water Samples

Sampling Site	Oil and Grease Content (mg/l)	
	Sampled 17/1/95	24/1/95
S1	8	5
S2	5	4
S3	7	5
S4	14	5

7.99 The results suggest bilge water or similar had been emptied into the sea near the boat repair area not long before the first sampling date. These results indicate that more care is needed. At times, however, floating refuse including oil spills are blown into the bay.

Sediment Quality

7.100 The assessment of sediment quality for Cheoy Lee's current site at Penny's Bay provides evidence of any long term contamination. Sediment analyses provide a good indication of long and short term pollution. They reflect the effect of over 30 years operation including periods of lesser environmental awareness. Sediment samples have been analysed for a range of metals commonly associated with ship building operations other than those in the previous section together with a broad spectrum of organic pollutants including oil and grease. Sediment was sampled at the same stations as used for water quality measurement (Figure 7.20).

7.101 Samples were taken using a small Van Veen grab sampler ensuring that only the surface, and hence the most recent sediment was sampled. The sediment has been analysed for the following parameters:

- Arsenic (As) from metal alloys and boiler tubes
- Cyanide (CN) from electro-plating
- Iron (Fe) from electro-plating and general steel works
- Tin (Sn) from bronze works and antifouling paints
- TOC to indicate general organic pollution
- Oils and Grease
- Organotins to indicate contamination from anti-fouling paints

- Volatile Organics } to identify specific organic pollutants. A list of the compounds included in the scan and quantification is appended.
- Semivolatile Organics }

7.102 The above parameters have been analysed using USEPA Test Methods for Evaluating Solid Waste, SW-846 November 1986, except organotins which will be analysed using USEPA Recommended Protocols for Measuring Metals in Puget Sound Water, Sediment and Tissue Samples, Puget Sound Estuary Program December 1989.

7.103 The full test results are presented in Appendix C. Most compounds were not detected in any sediment sample. Substances which were not detected included arsenic, styrene and xylene.

7.104 Substances detected under the testing programmes are listed in Table 7.8. Where an analyte of interest was detected below the routine reporting limit it has been flagged with an asterisk and the value given should be regarded as an estimate.

Table 7.8 **Substances Detected in Sediment Sampled at Penny's Bay in late January 1995** (U - Undetected, DB - Dry Weight Basis)

Sampling Site / Substance Detected	S1	S2	S3	S4
Cyanide (mg/kg DB)	U	0.51	0.50	0.68
Iron (mg/kg DB)	24000	22000	26000	23000
Oil and grease (mg/kg DB)	380	190	U	270
TOC (%, DB)	1.3	0.9	1.1	1.0
Total Solids (%)	40.5	44.1	46.5	44.6
Tributyltin chloride (μg/kg DB)	30*	86	82	62
Dibutyltin dichloride (μg/kg DB)	U	U	55*	U
Acetone (μg/kg DB)	70	120	130	100
2-Butanone (μg/kg DB)	11	24	19	19
Toluene (μg/kg DB)	4	3	3	9
4-Methyl-2-pentanone (μg/kg DB)	U	12	U	U
Dimethylphthalate (μg/kg DB)	43*	140	99	36*
Phenol	U	U	U	190

7.105 Cyanide was present at levels close to the detection limit. For sediment samples stabilized and analysed promptly these are normal levels. There is no evidence of contamination.

7.106 Iron concentrations in Hong Kong marine sediments are frequently about 2%. The levels measured in sediment at Penny's Bay lie in this normal range.

7.107 EPD's publications on "Marine Water Quality in Hong Kong" commonly report TOC levels in sediments as < 1.5 (% dry solids), 1.5-2, 2-2.5, 2.5 to 3 and > 3. All sites at Penny's Bay had TOC levels below 1.5%. These levels are found in the western waters of Hong Kong or in the open seas.

7.108 Oil and grease levels show a slow accumulation of these substances. As reported elsewhere in this study it is recommended that greater care be taken at the new site to reduce pollution of the site and the nearby marine environment with oils and greases.

7.109 It gave the EIA team confidence in their study that compounds such as TBT, acetone, toluene and cyanide were detected. Acetone and toluene are present at very low levels not expected to be toxic to the marie environment.

7.110 Substances such as toluene and xylene are subject to stage by stage microsomal oxidation by a range of marine organisms including phytoplankton. Compounds such as 2-butanone, 4-methyl-2-pentanone, phthalates and phenols are intermediate metabolites. 2-butanone may also be a metabolite of butanol which is used as a minor solvent in paints.

7.111 TBT and a related compound were detected at levels higher than desired but reasonable in terms of the sediment levels measured in a Hong Kong study undertaken for EPD by Mamie May-ming Lau in 1991. Sediment levels reported in the study are reproduced in Table 7.9. TBT levels in sediment are expected to gradually fall as TBT is now restricted in use. In the past CLS has manufactured large numbers of steel boats painting them all with TBT.

Table 7.9 Tributyltin Concentrations ± S.E. in Sediment Samples from Hong Kong Areas (Lau 1991)

Location	Sediment ng/g+	Sampling date
Marina		
1. Marine Cove	1160 ± 65 930 ± 59	10.10.88 12.4.89
2. Hebe Haven	620 ± 38 217 ± 13	10.10.88 12.4.89
3. Aberdeen	60 ± 4	21.4.89
4. Causeway Bay	800 ± 50 990 ± 61	25.11.88 29.8.89
Typhoon Shelter		
5. Pak Sha Wan Sai Kung	1690 ± 47 81 ± 4	10.10.88 12.4.89
6. Yau Ma Tei	*	26.6.89
7. Yim Tin Tsai	*	26.6.89
8. Causeway Bay	162 ± 10	26.6.89
9. Chai Wan	*	3.7.89
Mariculture Sites in Sai Kung		
10. Leung Shuen Wan	52 ± 4	9.11.88
11. Tui Cham Wan	1100 ± 68	9.11.88
12. Tai Tau Chau	72 ± 5	9.11.88
13. Ka Lung Wan	64 ± 5	9.11.88
14. Kau Sai	140 ± 9	9.11.88
15. Ma Nam Wat	73 ± 4	9.11.88
16. Habe Haven	120 ± 7	9.11.88
Deep Bay		
17. Station 1	*	12.5.89
18. Station 2	*	12.5.89
19. Outer Station	*	29.5.89
Harbour and Coastal Waters		
20. Quarry Bay	400 ± 24	3.4.89
21. Wanchai	*	3.4.89
22. Sai Ying Pun	30 ± 2	21.4.89
23. Tsing Shan Wan	30 ± 2	21.4.89
24. Pillar Point	250 ± 13	21.4.89
25. Aldrich Bay	*	26.6.89
26. Tsuen Wan	400 ± 15	26.6.89
27. Inner Tolo	*	12.4.89
28. Buffer Tolo	*	12.4.89
Kowloon Bay		
29. Station 2	108 ± 5 9 ± 4 *	8.11.88 10.3.89 4.4 & 1.6.89
30. Station 5	189 ± 9 *	10.3.89 4.4 & 1.6.89
31. Station 6	14 ± 2 43 ± 3 *	8.11.88 10.3.89 4.4 & 1.6.89
32. Station 7	150 ± 12 *	10.3.89 4.4 & 1.6.89
33. Station 8	52 ± 3 75 ± 5 *	8.11.88 10.3.89 4.4 & 1.6.89

* Below detection limit.
\+ ng/g is equivalent to μg/kg.

The To Kau Wan Site

7.112 In general, it would be preferable for CLS to carry their basic approach from Penny's Bay to their new site with a few changes. The sediment testing programme indicated that thirty years of operation have resulted in little measurable impact on the marine sediment suggesting that there has been very little long term pollution of the marine water body and very little recent short term pollution. The main exception is oil and grease.

7.113 Due to differences between the sites and in order to ensure that pollution control is always better than acceptable the following measures are recommended.

Sewage from Toilets and Canteen

7.114 Sewage generated from toilets, the canteen and washing facilities should be collected separately from wastewater arising from the laboratory, electroplating and ship manufacturing activities. Cheoy Lee management have advised us that a maximum workforce of 500 people could be employed at the site: although it was evident during the site visit to Penny's Bay that far fewer people were currently employed at the shipyard. Assuming that each employee contributes 50 litres of domestic wastewater each day (in line with the findings of the "Sewage Strategy Study (WH 1989)), then up to 25 m^3 of domestic wastewater would be generated each day. This is in excess of the volumetric limit of 2 x 1.5 m^3/day defined in the existing WPCO licence, although it remains a small volumetric discharge.

7.115 It does not seem likely that septic tanks and leachate fields will be acceptable on the reclaimed land of the new site.

7.116 Relative to typical worldwide values for domestic raw sewage loads, Hong Kong domestic sewage is characterised as being average to weak, with BOD_5 values of about 250 mg/l, SS values of 250 mg/l and total nitrogen levels of about 40 mg/l. (WH 1989). The effluent quality required at the discharge point is defined in the Technical Memorandum of the WPCO (Table 1.6 of Chapter 1): for the anticipated maximum discharge from the To Kau Wan shipyard into the North Western WCZ values of 500 mg/l, 500 mg/l and 100 mg/l for BOD_5, SS and total nitrogen respectively represent the maximum allowable. However, the limits set on *E.coli* bacterial levels mean that direct discharge to sea is not allowable and that the domestic wastewater requires treatment.

7.117 Preferred options could be (i) treatment and disposal via the Toll Plaza sewage treatment plant discussed above; or (ii) using public sewerage and sewage facilities if these are available in the future. If the Toll Plaza plant has sufficient capacity and is to treat wastewater to the required standard, or if public facilities become available, then domestic wastewater from the To Kau Wan Shipyard could be collected to a central location within the Shipyard and then be drained under gravity, or more likely pumped, directly to the facility. Facilities to be provided at the shipyard would probably be limited to a small submersible-pump type pumping station and valve chamber set in a large manhole/chamber. The standards for effluents discharged into foul sewers leading into Government sewage treatment plants are given in Table 1 of the WPCO Technical Memorandum. The CLS facility sewage effluent would easily meet these standards. Other effluents can probably also be discharged via this route. Bilge water may need passing through an oil interceptor first. These questions need addressing at the Detailed Design stage when more information about the site facilities will be known.

7.118 Indications are however that connection with the Toll Plaza treatment plant is not feasible. The Toll Plaza sewage treatment plant is too small and has already been passed by EPD.

7.119 The other alternative is to provide a carefully sized package plant similar to that for the Toll Plaza so as to independently meet the TM standards. CLS's current neighbour, the Penny's Bay Power Station, due to underuse of their package plant have *E.coli* levels in the sewerage effluent better than excellent beach water quality.

7.120 Given the required effluent discharge standard, secondary treatment of the domestic wastewaters should be employed. Extended aeration, contact stabilisation plants or Rotating Biological Contactors (RBC) could be utilised. In all options the plants should be covered with appropriate odour control facilities if found necessary. Plantings would be provided around the unit(s) to create a less intrusive environment.

7.121 It is proposed that the package plant, if required on a permanent basis, be located adjacent to the seawall on the north-eastern corner of the reclamation. This location would be advantageous since it would avoid discharging effluent into the embayment between the reclamation and the Yiu Lian Dockyards; take advantage of the flushing effect of the stormwater culvert outlets and not interfere unduly with shipbuilding activities. This location also assumes that it is unacceptable to continuously discharge effluent into stormwater drainage channels and culverts subject to seasonal flows. Raw domestic wastewaters would be piped to the new plant from contributing locations around the site.

7.122 The sludge generated should be collected and removed by a licensed sludge disposal contractor to be disposed to landfill under arrangement acceptable to EPD.

Bilge Water

7.123 Bilge water containing oil and surfactants should not be discharged directly to any water body.

7.124 It is recommended that this bilge water be discharged to the site sewage system. It is highly likely that the sewage package plant could aid in the treatment of this wastewater. If necessary an oil interceptor should be placed in line.

Surface Water

7.125 The storm drainage system for the site should be separated from any areas where spillage of oil and grease is likely. This occurs in the ship repair area where overhauling at engines takes place. The site has been designed so that surface water runs to the channel at the back of the reclamation and only discharged at the north-east corner. Silt traps will be installed during the reclamation stage and hence will already be in place before facility construction begins. Depending on decisions about the operations to be moved to the new facility provision of oil interceptors should be considered during the Detailed Design Phase.

7.126 Piped water could be available at the new site. Consequently there is potential for the hosing down of concrete areas to replace the current dry sweeping practices. This could result in additional pollution reaching the marine environment. If any areas are to be cleaned in this manner then it will be necessary to install sufficient waste water treatment facilities to cope with any contaminants. These could include paint flakes, bits of metals, floating items, silt, organic solvents, electroplating wastes as well as oils and greases.

7.127 Currently most sheds are surrounded by unsealed reclamation material. This acts as an absorbent. At the new site, particularly due to the compactness of the site it is expected that a greater percentage of the area will probably be sealed. Hence, it is important that any spills are promptly cleaned up.

7.128 Drainage design of the site will strongly influence the cleanliness of surface water runoff. With attention to detail, the new site should be easier to keep clean and should result in less pollutants reaching the marine environment with the possible exception of sewage effluent. *E. coli*, nitrogen and phosphate levels are expected to be a little higher and must be kept within the TM or effluent licence conditions, if these are more stringent.

Spent Electroplating Liquors

7.129 These should not be allowed to soak into the reclamation but should be treated as chemical waste.

8. WASTE DISPOSAL

Introduction

8.1 Solid waste assessment is intended to identify the potential sources of solid wastes and the primary and secondary impacts to the sensitive uses. Careful and intensive waste handling, treatment and disposal methods are given in this chapter. The proposed waste management strategy is incorporated to minimise resource uses in both construction and operation phases. Waste reduction, reuse and recycling are also considered in both phases to achieve environmental conservation practice.

8.2 The source and nature of solid wastes are discussed below and recommendation made for environmentally acceptable means of managing them. In addition, possibilities for reuse of waste material are also considered.

Scope

8.3 The solid waste assessment includes:

- identification of the sources of solid waste with details of the waste generation, waste characterization and waste separation;
- investigation of any secondary impacts such as, odour, gas emission, noxious leachate;
- evaluation of the proposed waste management strategy and waste handling, treatment and disposal methods; and
- incorporation of waste reduction/reuse/recycling by any practical means.

8.4 At the current site, Cheoy Lee Shipyards Ltd recycles many of their waste products. Solid, industrial and hazardous wastes will be identified and suitable handling, treatment, storage and disposal methods suggested. Recycling of the waste products will continue at the new site.

Construction Waste Impact

8.5 The site is a newly reclaimed area. Solid wastes arising from the construction of the shipyard facilities are expected to originate from:

- site preparation;
- excavation for foundation works;
- workforce generated waste;
- residues from construction materials/processes;
- chemical wastes.

Site Preparation and Excavated Material

8.6 The site will be handed over once consolidation of the main 250 metre x 150 metre area is complete and "excess" material used for consolidation is shifted to the other parts of the site and final levelling undertaken.

8.7 It is not envisaged that much site preparation will be needed. However it is inevitable that some excess excavated material will be generated. Foundations are likely to be more substantial for the multi-storey buildings i.e. the administration building and the metal-working/lofting building.

8.8 This excess excavated material is clean. Marine sand is suitable for other reclamations and should be kept separate from all other wastes. The contractor should make suitable arrangements for the reuse of this material.

Workforce Generated Waste

8.9 Workforce generated waste is of two major types:

- municipal waste; and
- domestic-type sewage wastes.

Municipal Waste

8.10 Solid and liquid wastes will be generated by construction crews. The quantity of municipal waste generated is estimated to be 1.29 kg/employee/day by the Environmental Protection Department (EPD 1993).

8.11 A refuse collection station for the temporary collection and storage of waste should be established for collection and temporary storage of municipal waste. Wastes can be delivered in black plastic bags to the nearest Regional Services Department refuse collection point or directly disposed of at Pillar Point Valley Landfill or WENT by private contractors.

Domestic-Type Sewage

8.12 Sewage generated from toilets, washing facilities and any temporary canteen provided for staff should be separately collected and suitable treatment should be provided before discharge. Such domestic sewage is characterised with high BOD, high S.S. and is enriched with nutrients, moreover, the bacterial count would also be elevated. It should not be discharged into the sea. The Contractor should be responsible for supplying adequate, suitable temporary arrangements such as sufficient chemical toilets and ensuring the waste generated is properly handled. The quantities will be relatively small. Connection to the Toll Plaza temporary sewage treatment plant may be advisable.

Building Wastes

8.13 In order to comply with the "New Disposal Arrangement for Construction Waste" which was effective from 1st October 1992, all construction wastes should be sorted on site into inert and non-inert materials.

8.14 Inert materials like soil, rock, sand, concrete debris, rubble, etc. should be sorted out from construction waste before disposal. Pillar Point Valley Landfill still accepts all kinds of construction wastes. No construction waste more than 20% inert material by volume will be disposed of at operational landfills (e.g. Tseung Kwan O Landfill Stage III).

8.15 In the case of reinforced concrete, steel rods and etc. should be separated from concrete rubble by mechanical means, and disposed of separately.

Formwork

8.16 Wood and timbers are used to prepare different forms of concrete structures. All used wooden materials should be sorted from other wastes. Wooden boards can be reused on-site, the reusability and the quantity of final waste depends on the shape and quality of the original boards. Unreusable timber should be sorted out to avoid it mixing with inert waste, and then disposed of at a landfill. On site incineration of wooden waste should be strictly prohibited as this would lead to excessive smoke emissions and cause a fire hazard. A number of private contractors will collect used formwork materials for local reuse or for export to China.

Scaffolding

8.17 Scaffolding is required to provide platforms for workmen. The quantity of bamboo used should be calculated accurately based on the number, area and height of buildings to be built.

8.18 Since the construction of shipyard facilities will be carried out by stages, the bamboo can be reused on-site. It will minimise the disposal rate of used bamboo.

8.19 The remaining bamboo can be removed off-site to other construction sites for reuse. The disposal rate is dependent on the quality of the bamboo and the care taken. Fatigued bamboo which is not suitable for reuse shall be disposed of at a landfill by barges. The nearest operational landfill is that Pillar Point Valley Landfill.

8.20 Construction waste should be properly disposed of at public dumping areas and landfills. Materials should be segregated on site before conveying to dump and landfills.

8.21 Sorting and separate collection of wooden boards, timber, used steel and other ferric metals are very common in Hong Kong construction industries:

- bamboo for scaffolding should be stored appropriately so that the reusability of bamboo can be improved. Generally, bamboo can be reused several times if suitable storage and transportation methods are employed;
- wooden boards and timber from the site fencing and formwork can be collected for local reuse or exported to the PRC;
- used steel can be collected for recycling at local steel furnaces.

8.22 The drainage system should be maintained at all time including removal of solids in sand traps, manholes and stream beds.

8.23 In order to reduce the nuisance to the environment and minimise the wastage of resources, extensive management of construction materials and wastes should be implemented. The general principles to manage construction waste are minimising waste sources and the reuse of materials.

Site Clearance

8.24 Waste will be generated by final site clearance activities upon completion of construction. Such site clearance waste will likely include packaging materials, used wooden blocks and boards, concrete debris, metal scraps, disposed soil and sand, etc. Inert material should be kept separate from other wastes where it can be useful to other construction sites. It is known from private sources that the strategic landfills appreciate reasonable quantities of inert matter for use as daily cover.

Chemical Wastes

8.25 The only foreseen source of chemical waste are oils and greases from plant and equipment used on the site. Regular maintenance and servicing is to be encouraged both for efficiency reasons and to minimise noise and air pollutant emissions. This will generate limited quantities of dirty lubricants and spent air and oil filters. The filters can be disposed at landfill but it is important that any oil, grease, gearbox and hydraulic fluids are collected properly and not allowed to contaminate either the land or groundwater. Contractors who can handle small quantities of these types of chemical wastes for recycling purposes provide the most convenient disposal system. If these companies are not used then the construction contractor should be registered as a chemical waste producer with EPD and the wastes be directed to the Chemical Waste Facility at Tsing Yi.

Conclusion

8.26 Only relatively small amounts of waste should be generated during the construction phase and good recycling practices should keep this quantity to a minimum.

8.27 In the transfer of shipbuilding equipment to the To Kau Wan site care should be taken to avoid bringing any possible contamination from the old site. Equipment or building materials brought from the old site should be cleaned at the old site before removal.

Operational Waste Impact

8.28 Solid wastes generated at the current shipyard operations were identified during two site visits. They can be divided into three main categories based on the general classification of solid wastes suggested by the Environmental Protection Department (EPD):

- chemical and hazardous waste;
- industrial waste; and
- municipal waste.

Chemical and Hazardous Waste

8.29 The Waste Disposal (Chemical Waste) (General) Regulations under the Waste Disposal Ordinance (Cap.354) provides for the control of chemical wastes in Hong Kong.

8.30 All chemical wastes should be collected and labelled with care. Licensed collectors will take the wastes to either Pillar Point, SENT landfill site or the Tsing Yi Chemical Waste Treatment Centre as appropriate. These two landfills are the only landfills normally allowed to accept chemical wastes.

8.31 Any process producing chemical wastes should be registered with EPD. Cheoy Lee Shipyard Ltd has registered with EPD as a Chemical Waste Producer at the existing site at Penny's Bay. A "Registration of Waste Producer" licence was granted to Cheoy Lee by the Director of Environmental Protection.

8.32 Particulars of the waste producer, contract person, types of business and waste were stated in the licence. The major chemical waste types were identified to be the "spent solvents" and "lubricating oil".

Paint and Thinners and Solvents

8.33 Small amounts of Tributyl tin (TBT) antifouling paints have been occasionally used for the repairing of TBT-coated boats. This is not a common procedure. Cheoy Lee Shipyards Ltd register with the Agriculture and Fisheries Department (AFD). Records of all projected use, amounts purchased and amounts used are kept and reported to AFD.

8.34 Copper-based marine paints are bought from the licensed suppliers to be used as TBT substitutes to prevent corrosion and fouling of hull whenever possible. Unfortunately no substitute for TBT has yet been formulated for vessels that must travel world-wide. At this time, much research is being undertaken and substitutes are available for some circumstances.

8.35 All of the paint used to finish the vessels, except for the antifouling paints, are epoxy based. A primer is usually applied before painting. CLS commonly uses zinc based primers. Organic based solvents (i.e. acetone, toluene and xylene) are commonly used as solvents/thinners for painting or in the manufacture of fibre-glass.

8.36 All excess solvent is collected and recycled by the method of distillation using the on-site solvent recycling apparatus. It is used for xylene, toluene and acetone recovery. The highly dense and viscose liquor or solvent residue left after distillation is collected in a bin. This is then placed in a sealed container, labelled and disposed of as chemical waste.

8.37 During ship repairing work, boat hulls are scraped for repainting. Paint flakes are swept up and collected for disposal. The hulls are then repainted with the appropriate antifouling paints. Any dry TBT or copper-based paint is swept up and collected in a labelled container for disposal as chemical waste.

Petroleum and Oil

8.38 There are fuelling stations situated near the launching slipwalls containing marine diesel fuel. During the two site visits there was no evidence of excessive spillage from any of the fuelling stations but there is a possibility that there will be or has been some leakage and spillage of fuel into the environment, especially into the water nearby.

8.39 Waste oil from servicing and maintenance tasks is normally reused in a number of ways. For example, heavy oil is used to fill hollow structures such as rudders helping to prevent corrosion. Waste oil is also used to grease chains and other suitable moving parts of equipment.

8.40 Any surplus waste oil is treated as chemical waste. It may be sent to external waste oil collectors for subsequent recycling or sent to appropriate facilities such as CWTC for disposal.

8.41 Empty oil drums are collected by some oil companies for reuse. In the past Cheoy Lee has recycled oil drums at 1650°C when manufacturing levels of steel boats has been high. Oil drums should not be washed out as this leads to water pollution.

8.42 On past performance it is expected that CLS would apply for a new licence for the new shipyard at To Kau Wan and continue to be aware of *A Guide to the Chemical Waste Control Scheme, A Guide to the Registration of Chemical Waste Producers* and *the Code of Practice on the Packaging Labelling and Storage of Chemical Wastes.*

Industrial Waste

8.43 There are four main sources of industrial waste:

- metal works;
- sawmill;
- painting; and
- fibreglass (GRP) ship mould production.

Metal Works

8.44 Almost all of the metal parts used in Cheoy Lee's ship manufacturing are made from raw materials on site. Currently, three main processes for metal moulding are employed:

- lost wax process;
- sand moulding; and
- die-casting.

8.45 The lost wax process is used for aluminium, copper and bronze moulding whilst the sand moulding is used for iron and steel and die-casting for aluminium. Raw metals (e.g. steel, aluminium, copper & etc.) are either imported or obtained from on-site scrap. All scrap metal is recycled and the final quality of the metal checked by the in-house laboratory. Wax and sand are also recycled where possible, although there is some loss of wax and sand over time. This is very low and does not appear to be a problem.

8.46 Any excess metal which is spilled during sand moulding is collected after cooling and returned to the furnace for recycling. All sand used is recycled for further use. The sand has a very low dust concentration and during the two site visits there was no visible dust from the moulding process. After repeated use the sand may build up high levels of metals but these will be primarily iron and aluminium with some copper and tin. If sand is deemed unsuitable for recycling, it is collected in bins for disposal.

8.47 Metal contaminated soil will be specially collected and disposed of as chemical waste.

8.48 The mould for die-casting is made of metal that can be reused many times. Any split metal is recycled in the same manner as for the other processes and waste slag is collected and sold for recycling.

8.49 The whole foundry area appeared to be very well maintained and clean. All slag from the steel furnace is collected in large steel drums until sufficient quantity has been collected for disposal. Slag from other metals, such as copper, is collected and sold for recycling to China. All spilt sand is swept up and recycled as is the sand used for the moulds. Plate 3.6 in Chapter 3 shows a worker cleaning the sand ready for re-use.

8.50 The floors of the machine shop are all concrete and on the two occasions when site visits were conducted appeared very clean. The areas around each of the lathes or machines was very clean Plate 3.9 and all swarf was swept up, collected and separated depending upon the metal and stored in large drums for recycling due to the cost of the raw material Plate 3.10. The cooling water/cutting liquid used in the lathes is constantly recycled in a closed loop system. No liquid waste is produced as the liquid is continually topped up with water and any metals are filtered out for recycling.

Sawmill

8.51 The sawmill occupies approximately 1,600 m^3 in an open-ended shed and is used to produce timber of various shapes and sizes for ship mould production and joinery.

8.52 There was very little sawdust produced from the joinery work. The floor was swept occasionally to collect any sawdust for later disposal. Sawdust may first be used in areas where oil spillage can occur.

Painting

8.53 Spraypainting is not carried out on a large scale. Any dry paint, except for TBT and copper-based marine paints, will be swept up and collected in a container for disposal as industrial waste. Empty paint cans have in the past been recycled in the main furnace but now principally must be collected as waste.

Fibreglass (GRP) Ship Mould Works

8.54 The GRP mould is originally made by laying fibreglass cloth over a wooden replica of the intended boat hull and applying epoxy resin. The wooden moulds are used once and the wood recycled where possible. The resulting fibreglass mould is fixed within a sturdy wooden frame and can be reused many times. Small amounts of excess resin are cleaned off using acetone solvent and any fibreglass fibres are swept up and stored for disposal.

8.55 The fibreglass (GRP) ship mould works are mostly carried out in open, well ventilated sheds. Only small quantities of chemicals are kept in the working area at any one time. CLS currently use about 32,000 litres of polyester/styrene resin every year, ordering around seventy to eighty 200-litre drums of resin every 6 months which is stored in the special flammable solvent store until needed. They use approximately one drum of acetone every 3-4 months (about 200 litres). Glassfibre matting is also ordered in bulk, one container load every 3-4 months, and stored in the dry goods storage shed.

8.56 Due to the woven nature of the fibreglass, there is very little waste fibre. Any cloth off-cuts were reused and applied on some other part of the mould. The small amount of waste glassfibre fibres produced were swept up and collected in bins for disposal. CLS does not encourage waste. The management ensures that only those quantities of resin that can be applied within the setting time are mixed.

Municipal Waste

Domestic Sewage

8.57 Domestic sewage will be collected from toilets, canteen and watchman quarters. Sewage is characterized by high BOD, low DO and enriched with high nutrient contents. It is not acceptable to discharge sewage into coastal waters directly as it may lead to deterioration of water quality. A foul system will be established to treat the domestic sewage for a maximum of 500 people as has been described in Chapter 7: "*Water Quality*".

8.58 Should any washwater or other wastewaters be discharged into the sea, it is necessary for their composition to comply with the requirements specified by the "Technical Memorandum on Effluent Standards" and the limits stated in the wastewater discharged licence.

8.59 The sludge generated from the sewage treatment plant should be collected and removed by a licensed sludge disposal contractor and be disposed to landfill under arrangement acceptable to EPD.

Domestic Refuse

8.60 Solid waste collected from the watchman quarters and canteen will be domestic refuse. Using a waste generation factor of 1.00 kg per head per day (the upper level at 2001 used by the 1989 Waste Disposal Plan for Hong Kong) yields a waste generation of 500 kg per day. An alternative assessment of the quantity of municipal waste generated by the operation crews is 1.3 kg/person/day.

8.61 A refuse collection station should be established for the collection and temporary storage of municipal waste. All municipal waste should be collected in black refuse bags and barged to the nearest Regional Services Department refuse collection point or directly barged and disposed of at Pillar Point Valley Landfill or WENT by private contractors.

8.62 Floating refuse around the site should be collected and disposed of appropriately. The absence of floating refuse within Penny's Bay was noted by the EIA team during our visits.

Waste Management

8.63 Many recycling practices are on-going in the existing shipyard at Penny's Bay. Even the sands used for the moulding of metal parts are sieved and then re-used.

8.64 Solid waste is currently stored in either large steel drums or in a special waste storage area situated near the solvent waste recycling plant. All used steel drums are stored in various places, depending upon available space, ready for disposal or recycling, either as raw steel for the foundry or as waste containers.

8.65 A spill action plan to prevent fuel and lubricating oil leakage from contaminating the site and suitable clean-up materials (e.g. emulsifier and absorbent) should be prepared at To Kau Wan. Layers of sawdust, sand or equivalent material should be laid underneath and around any construction plant and equipment that may possibly leak oil. The polluted clean-up materials should be disposed of in an acceptable and regular manner.

8.66 Spillage of oil and lubricant will lead to contamination of land, ground water, surface water as well as the coastal water. Care must be taken to prevent serious spillage:

- the storage area for fuel and lubricant should be isolated;
- filling of fuel and lubricant should be carried out with care;
- emulsifier and absorbent should be prepared on-site, as immediate action can be taken when there is minor spillage;
- all fuel and lubricant should be kept away from local surface streams;
- any empty containers should be carefully stored to prevent any spillage of remaining liquid and disposed of carefully.

8.67 All municipal waste should be collected separately and well packed, and delivered to a landfill or nearby RSD refuse collection point.

8.68 Recycling of the waste products are expected to continue at the new site at To Kau Wan. Waste reduction, reuse and recycle will be incorporated into the routine operation practice wherever practical in order to minimise the use of resources and observe the importance of environmental conservation.

8.69 All chemical wastes were properly packaged, labelled and stored before collection. They were collected and transported by a licensed waste collector to a licensed waste disposal facilities in accordance with the regulations and all appropriate licences had been obtained. It is expected that all these practices will continue.

9. ECOLOGICAL IMPACT

9.1 The existing shipyard operations at Penny's Bay have been used as the basis for the assumed operation at To Kau Wan. Therefore, it has been assumed for assessment purposes that any potential impacts, if any, generated from the current shipyard operations will also be produced at the new site. The following section describes the ecology of To Kau Wan and the potential impacts from construction and operation of the shipyard on the surrounding ecosystems.

Terrestrial Ecology

Habitats of To Kau Wan

9.2 The slopes at the southern side of To Kau Wan are very steep (> 45° on average) and are more gentle at the eastern side. On these slopes the dominant vegetation formations are "ferns with grasses and low shrubs" especially on the upper slopes. There are some patches of woodland on the low-land at the western end and southeastern part of the reclaimed area. Discrete patches of woodland are also found in the ravines.

9.3 Faunal and floral surveys were carried out on 19th and 27th January 1994 respectively in the vicinity of the reclamation site for the shipyard at To Kau Wan.

9.4 Birds in a variety of habitats including woodland, scrubland, grassland, sandy beach and rocky shore were observed and counted on site using binoculars.

9.5 Aquatic animals in streams were collected by kick sample method which involved using a net sampler (with 0.5 mm mesh size) facing up-stream and vigorously disturbing an area of substrate.

9.6 A 28 m transect line was run from the exposed upper sandy beach (intertidal) to submerged shallow water (subtidal, 0.3 m depth). Sediments (5 cm in depth) were collected from seven 0.5 m^2 quadrates along the transect and live animals were sorted, numerated and identified.

Results

Birds

9.7 Nine species of birds (Table 9.1) were observed within the site. However, the site is unlikely to be attractive to birds, because the habitats were strongly disturbed by impacts such as noise, visual intrusion, wastes and dust from a number of current human activities which include ships around the dockyard on the western side of the site and the construction of the Toll Plaza.

Stream fauna

9.8 Only two streams at the site contained water and discharge was very small. Faunal composition was poor in terms of number of species (Table 9.2). Only six species (excluding Chironomids) were present in the qualitative samples. No fish were seen in streams during the stream survey.

Table 9.1 Birds recorded at To Kau Wan on 19th January 1994

Common name	Latin name	Number
Woodland birds:		
Magpie	*Pica pica*	3
Black-eared kite	*Milvus migrans*	1
Black-faced laughing thrush	*Garrulax perspicillatus*	5
Crested bulbul	*Pycnonotus jocosus*	2
Warbler (hear sound)	(species undertermined)	2-4
Shore birds:		
Little egret	*Egretta garzetta*	1
Common sandpiper	*Actitis hypoleucos*	2
White wagtail	*Motacilla alba*	1
White-brested kingfisher	*Halcyon smyrnensis*	1
Total number		19

Table 9.2 Stream animals collected from To Kau Wan on 19th January 1994

Common name	Latin name	Abundance
Shrimp	*Neocaridina serata*	++
Mayfly	*Cinygmina* sp.	+
Caddisfly	*Hydropsyche* sp.	+
Water skater	*Gerris* sp.	++
Backswimmers	*Notonecta* sp.	++
Tropical backswimmers	*Anisops* sp.	++
Chironomids	(species undetermined)	++

Note: +, present; ++, common

Coastal Woodlands

9.9 Patches of wooded areas are commonly found along the coast. Those in the study area are shown in Figure 9.1. The most uniform patch of woodland is at the back of the reclaimed area in the eastern side. The trees grow on a seemingly abandoned cultivation field. A quantitative survey of trees in a 10 m x 10 m quadrat was undertaken in this woodland. Inside the quadrat all trees with diameter at breast height (dbh, 1.3 m above ground level) greater than 2 cm were measured and the result is summarised in Table 9.3. There are 23 individuals of 10 tree species in the quadrat. The dominant species are *Microcos paniculata, Mallotus paniculatus, Liquidamber formosana* and *Sterculia lanceolata.* The height of the top canopy species is 12 m and the canopy coverage is 85%. Judging from the pattern of regular spacing between individuals and the uniformity in size, the *Liquidamber formosana* trees in this quadrat and in the vicinity are very likely planted. The woodland is now at its young-mature phase. Only one quadrat was done in the whole study site due to the small extent of the woodlands and the steep topography.

9.10 The physiognomy of the woodland patch at the western end of the reclaimed area is similar to the previously described woodland on Lantau although the species composition is slightly different. The dominant species in this woodland include *Schefflera octophylla, Microcos paniculata, Cerbera manghas,* and *Ficus microcarpa.*

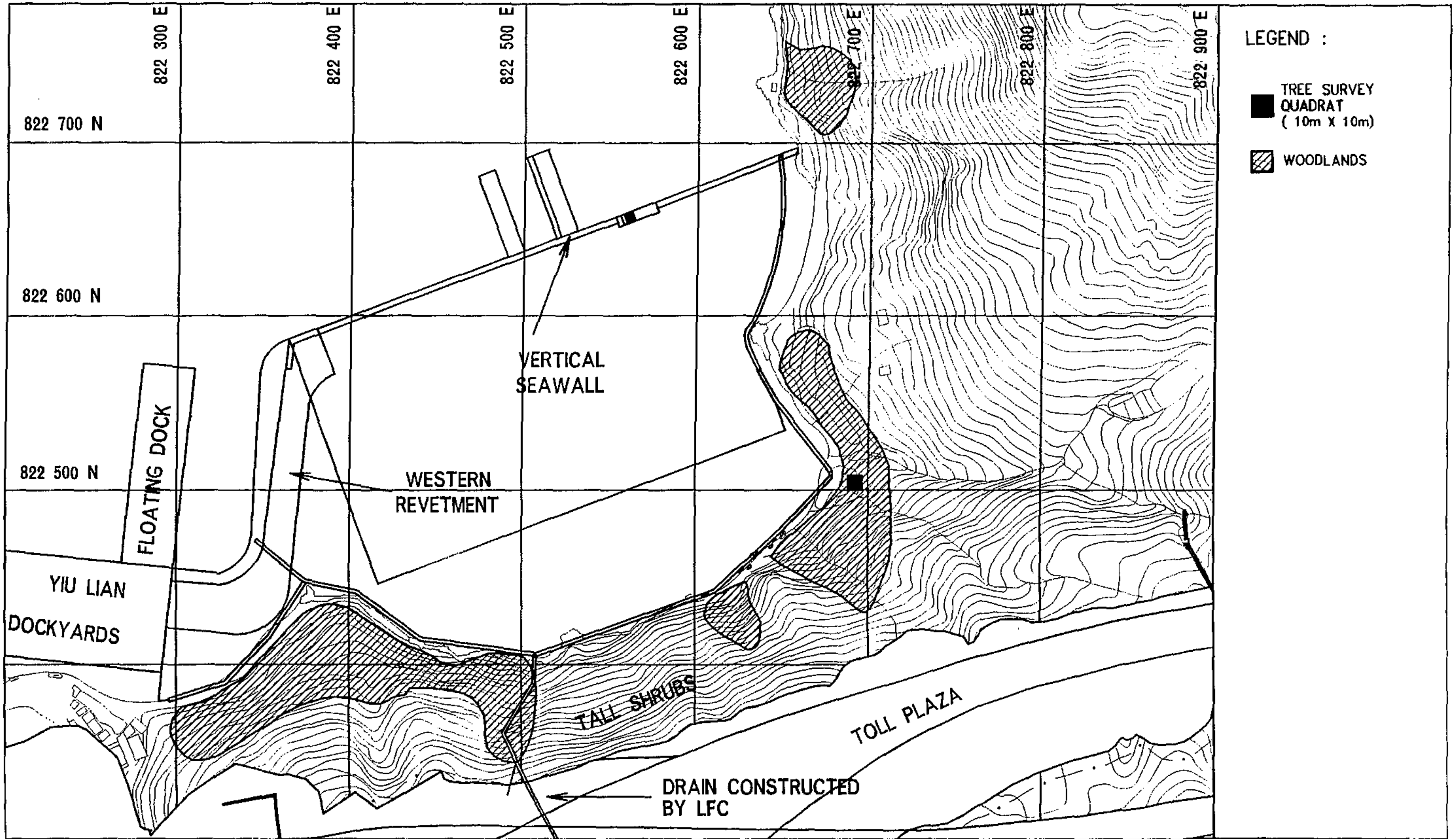
Fernland with Grasses and Shrubs

9.11 Beyond the coastal woodland there are fernlands with grasses and shrubs on the upper slopes. The vegetation is maintained by fire and evidence shows that the fernland was burnt in the last fire season (October 1992 to April 1993). The dominant species in the fernland are the rhizomatous fern *Dicranopteris linearis,* shrubs such as *Rhodomyrtus tomentosa, Litsea rotundifolia* var. *oblongifolia* and *Melastoma* spp., and grasses such as *Miscanthus sinensis* and *Arundinella nepalensis.*

9.12 A list of plants recorded in the study are with relative abundance on site and other information is given in Table 9.4.

Protected or Rare Species

9.13 The major aim of biological conservation is to preserve or enhance species diversity in the ecosystem. Therefore the coastal woodlands are of high conservation value because of their rich bio-diversities. Moreover many of the trees and shrubs in the woodland provide habitat and food (fruit, nectar and leaf) to birds, butterflies and wasps (see Table 9.4).



TO KAU WAN OPERATIONAL EIA

VEGETATION

BINNIE CONSULTANTS LIMITED 賓尼工程顧問有限公司 Engineers and Scientists 賓尼	Date FEB 95	Scale 1 : 3 000
土木工程署 Civil Engineering Department	Initial YPS	Drawing No. FIGURE 9.1

9.14 All orchid species are also protected under the same ordinance. Some grassland orchids such as *Arundina chinensis* and *Spathoglottis pubescens* may occur in the study are but they are virtually undetectable at present since they are not in flower. However, these grassland orchids are widespread in similar habitats in Hong Kong.

9.15 None of the plant species recorded in this study are rare in Hong Kong or in the South China region.

Table 9.3 Results of Tree Survey in the Quadrat (10 m x 10 m) in To Kau Wan, North Lantau

	Plant Species	N	Height (m)	dbh (cm)	Dominance	Relative Abundance	Relative Dominance	Importance Value
*	Microcos paniculata	4	8-12	4.5-19.7	1498.7	17.39	40.58	57.97
	Mallotus paniculatus	4	5-12	6.1-22.6	813.8	17.39	22.03	39.42
	Liquidambar formosana	4	5-12	13.4-19.1	778.4	17.39	21.07	38.47
*	Sterculia lanceolata	5	3-10	2.9-13.4	421.8	21.74	11.42	33.16
*	Bridelia tomentosa	1	5	4.8-7.3	77.9	4.35	2.11	6.46
	Daphniphyllum calycinum	1	5	6.4	31.8	4.35	0.86	5.21
	Phyllanthus emblica	1	6	6.1	28.7	4.35	0.78	5.12
	Rhussuccedanea	1	4	4.5	15.6	4.35	0.42	4.77
	Cratoxylum ligustrinum	1	6	4.1	13.4	4.35	0.36	4.71
	Pithecellobbium lucidum	1	7	4.1	13.4	4.35	0.36	4.71
Total	10 species	23			3693.5			

Remarks:

* = multi-trunk

Dominance = total trunk area at breast height

Dominance, Relative Abundance, Relative Dominance and Importance Value follow Muller-Dombois and Ellenberg (1974).

Table 9.4 **Plant species occurring in To Kau Wan, North Lantau**

Remarks:

BL = Foodplant for Butterfly Larvae
Ntr = Nectar source for Butterflies and Wasps
Frt = Fruit for birds, etc.

Relative Abundance:

A = Abundant
C = Common
F = Frequent
O = Occasional
R = Rare

	Plant Species	Family / (fern group)	On-site relative abundance	Native/Exotic	Remarks
Trees	Acronychia pedunculata	Rutaceae	O	Native	BL
	Aleurites moluccana	Euphorbiaceae	R	Exotic	
	Antidesma ghaesembilla	Euphorbiaceae	O	Native	
	Aporusa dioica (A. chinensis)	Euphorbiaceae	O	Native	Frt
	Aralia chinensis	Araliaceae	F	Native	
	Bambusa sp.	Poaceae	O	Native	
	Bridelia tomentosa	Euphorbiaceae	O	Native	BL Frt
	Celtis sinensis	Ulmaceae	R	Native	BL Frt
	Cerbera manghas	Apocynaceae	C	Native	
	Cratoxylum ligustrinum	Hypericaceae	C	Native	BL Ntr
	Daphniphyllum calycinum	Daphniphyllaceae	F	Native	
	Delonix regia	Caesalpiniaceae	R	Exotic	
	Euphoria longan	Sapindaceae	O	Exotic	
	Ficus hispida	Moraceae	F	Native	
	Ficus microcarpa	Moraceae	F	Native	BL Frt
	Glochidion dasyphyllum	Euphorbiaceae	R	Native	
	Glochidion hongkongense	Euphorbiaceae	O	Native	
	Glochidion macrophyllum	Euphorbiaceae	O	Native	
	Hibiscus tiliaceus	Malvaceae	C	Native	BL

Table 9.4 **Plant species occurring in To Kau Wan, North Lantau** (cont'd)

	Plant Species	Family / (fern group)	On-site relative abundance	Native/Exotic	Remarks		
	Liquidambar formosana	Hamamelidaceae	A	Native			
	Litsea glutinosa	Lauraceae	F	Native	BL		
	Mallotus paniculatus	Euphorbiaceae	A	Native			
	Microcos paniculata	Tiliaceae	A	Native	BL	Ntr	
	Musa sp.	Musaceae	R	Exotic	BL		
	Paliurus ramosissimus	Rhamnaceae	R	Native	BL		
	Pandanus tectorius	Pandanaceae	O	Native			
	Pavetta hongkongensis	Rubiaceae	R	Native. Protected			
	Phoenix hanceana	Arecaceae	O	Native	BL		
	Phyllanthus emblica	Euphorbiaceae	O	Native			
	Pinus massoniana	Pinaceae	O	Native			
	Pithecellobium lucidum	Mimosaceae	F	Native			
	Pongamia pinnata	Papilionaceae	O	Native			
	Psidium guajava	Myrtaceae	O	Exotic			Frt
	Rhus hypoleuca	Anacardiaceae	O	Native	BL		
	Rhus succedanea	Anacardiaceae	A	Native			
	Sapium discolor	Euphorbiaceae	O	Native			
	Sapium sebiferum	Euphorbiaceae	F	Native			Frt
	Schefflera octophylla	Araliaceae	A	Native	BL	Ntr	Frt
	Soolopia chinensis	Flacourtiaceae	O	Native	BL		
	Sideroxylon wightianum	Sapotaceae	R	Native			
	Sterculia lanceolata	Sterculiaceae	A	Native	BL		
	Symplocos sp.	Symplocaceae	O	Native			
	Thespesia populnea	Malvaceae	F	Native			
	Trema orientalis	Ulmaceae	O	Native	BL		Frt
	Zanthoxylum avicennae	Rutaceae	O	Native	BL	Ntr	
Shrubs	Adhaloda vasica	Acanthaceae	R	Exotic			
	Aegiceras corniculatum	Aegicerataceae	R	Native			
	Ardisia crenata	Myrsinaceae	F	Native			

Table 9.4 Plant species occurring in To Kau Wan, North Lantau (cont'd)

	Plant Species	Family / (fern group)	On-site relative abundance	Native/Exotic	Remarks		
	Atalantia buxifolia	Rutaceae	A	Native	BL	Ntr	
	Baeckea frutescens	Myrtaceae	O	Native			
	Breynia fruticosa	Euphorbiaceae	O	Native	BL		
	Clerodendrum inerme	Verbenaceae	O	Native			
	Desmos oochinchinensis	Annonaceae	F	Native	BL		
	Diospyros vaccinioides	Ebenaceae	O	Native			
	Eurya chinensis	Theaceae	O	Native			
	Ficus hirta	Moraceae	F	Native			
	Glochidion eriocarpum	Euphorbiaceae	O	Native	BL		
	Helicteres angustifolia	Sterculiaceae	O	Native			
	Ilex asprella	Aquifoliaceae	O	Native			Frt
	Ilex pubescens	Aquifoliaceae	O	Native			Frt
	Inula cappa	Asteraceae	O	Native			
	Lantana camara	Verbenaceae	C	Exotic		Ntr	
	Litsea rotundifolia var. oblongifolia	Lauraceae	C	Native	BL	Ntr	
	Melastoma candidum	Melastomataceae	F	Native			Frt
	Melastoma sanguineum	Melastomataceae	O	Native			
	Psychotria rubra	Rubiaceae	A	Native		Ntr	Frt
	Rhaphiolepis indica	Rosaceae	F	Native		Ntr	Frt
	Rhodomyrtus tomentosa	Myrtaceae	F	Native			Frt
	Scaevola sericea	Goodeniaceae	F	Native			
	Uvaria microcarpa	Annonaceae	O	Native	BL		
	Vitex rotundifolia	Verbenaceae	R	Native			
	Wikstroemia indica	Thymelaeaceae	O	Native			
Climbers	Alyxia sinensis	Apocynaceae	R	Native			
	Asparagus oochinchinensis	Liliaceae	F	Native			
	Canavalia lineata	Papilionaceae	R	Native	BL		
	Cansjera rheedii	Opiliaceae	R	Native			
	Cassytha filiformis	Lauraceae	O	Native			

Table 9.4 **Plant species occurring in To Kau Wan, North Lantau** (cont'd)

	Plant Species	Family / (fern group)	On-site relative abundance	Native/Exotic	Remarks
	Celastrus hindsii	Celastraceae	R	Native	
	Celastrus orbicufatus	Celastraceae	R	Native	
	Cocculus trilobus	Menispermaceae	O	Native	
	Embelia laeta	Myrsinaceae	F	Native	BL Frt
	Embelia ribes	Myrsinaceae	O	Native	Frt
	Gymnema alterniflorus	Asclepiadaceae	R	Native	
	Hedyotis hedyotidea	Rubiaceae	O	Native	
	Ipomoea brasiliensis	Convolvulaceae	O	Native	
	Ipomoea cairica	Convolvulaceae	F	Exotic	
	Ipomoea sp.	Convolvulaceae	R		
	Melodinus suaveolens	Apocynaceae	R	Native	
	Mikania micrantha	Asteraceae	F	Exotic	Ntr
	Millettia nitida	Papilionaceae	O	Native	BL
	Mussaenda pubescens	Rubiaceae	O	Native	BL Ntr
	Paederia scandens	Rubiaceae	O	Native	Ntr
	Passiflora foetida	Passifloraceae	R	Native	
	Psychotria serpens	Rubiaceae	O	Native	
	Pueraria phaseoloides	Papilionaceae	O	Native	BL
	Rubus reflexus	Rosaceae	O	Native	BL
	Smilax china	Smilacaceae	C	Native	BL Frt
	Smilax glabra	Smilacaceae	O	Native	
	Smilax lanceaefolia	Smilacaceae	R	Native	BL
	Tetracera aslatica	Dilleniaceae	F	Native	
	Zanthoxylum cuspidatum	Rutaceae	F	Native	BL
	Zanthoxylum nitidum	Rutaceae	A	Native	BL
Herbs	Ageratum conyzoides	Asteraceae	O	Native	Ntr
	Commelina communis	Commelinaceae	R	Native	
	Dianella ensifolia	Liliaceae	O	Native	
	Emilia sonchifolia	Asteraceae	R	Native	

Table 9.4 **Plant species occurring in To Kau Wan, North Lantau** (cont'd)

	Plant Species	Family / (fern group)	On-site relative abundance	Native/Exotic	Remarks
	Gynura divaricata	Asteraceae	F	Native	Ntr
	Liriope spicata	Liliaceae	F	Native	
	Melanthera bicolor	Asteraceae	F	Native	Ntr
Grasses & Sedges	Apluda mutica	Poaceae	F	Native	BL
	Arundinaria sinica	Poaceae	C	Native	
	Arundinella nepalensis	Poaceae	F	Native	
	Cyperus cyperoides	Cyperaceae	R	Native	
	Digitaria sanguinalis	Poaceae	R	Native	
	Fimbristylis sp.	Cyperaceae	R		
	Ischaemum aristatum	Poaceae	F	Native	
	Miscanthus sinensis	Poaceae	A	Native	BL
	Neyraudia reynaudiana	Poaceae	F	Native	
	Pennisetum sp.	Poaceae	R		
	Sporobolus virginicus	Poaceae	O	Native	
Ferns	Adiantum flabellulatum	Adiantum Group	O	Native	
	Blechnum orientale	Blechnum Group	F	Native	
	Dicranopteris linearis	Gleicheniaceae	A	Native	
	Lycopodium sp.	Lycopodiaceae	R	Native	
	Lygodium japonicum	Schizaeceae	F	Native	
	Lygodium microphyllum	Schizaeaceae	O	Native	
	Pteris semipinnata	Pteris Group	O	Native	
	Sphenomeris chinensis	Lindsaea Group	R	Native	

Marine Ecology

9.16 The hydrology of North Lantau is under the strong influence of the Pearl River discharge. To Kau Wan, located on north-eastern Lantau, therefore is estuarine in summer and tend to be move oceanic in winter (Chau 1958; Chau 1960; Watts 1971a; Watts 1971b). Locally, the flood tide carries water from Kap Shui Mun into the North Lantau area. The ebb tide carries low salinity water from the Pearl River and dilutes the water column of Kap Shui Mun.

Intertidal Rocky Habitat

9.17 As recorded in the Reclamation EIA (BCL 1994a), the habitats between shoreline and places up to +5.5 mPD will be destroyed during the formation of the site. Replacement of the rocky shore habitats is provided by the Western Revetment. Organisms found on the rocky shore prior to reclamation may be expected to start colonizing the Western Revetment if conditions are favourable. Species recorded on the rocky habitat prior to reclamation were given in Table 9.5.

Table 9.5 Macrobenthic species and density on rocky shore at To Kau Wan. Samples were collected from five quadrats along a transect line on 19th January 1994

Common name	Latin name	quadrate*				
		1	2	3	4	5
Gastropods	*Nodilittorina pyramidalis*		36	230	29	
Gastropods	*Nodilittorina millegrana*		5	31	18	
Gastropids	*Littorina* sp.			15	198	
Gastropods	*Drupa musiva*					3
Limpets	*Patelloida saccharina*					35
Limpets	*Cellana eucosmia*					1
Isopods	*Ligia exotica*	16				
Stalked barnacle	*Pollicipes mitella*					13
Cricket	*Gryllidae*	1				
Cockroach	c.f. *Opisthoplatia orienta*	1				
Total no. of indiv.		18	41	276	245	52
Density (No. of indiv./m^2)		36	82	552	490	104

9.18 In general, the rocky shore of To Kau Wan was impoverished with gastropods belonging to genus *Nodilittorina* and *Littorina* as the dominant species. No further loss of habitat is expected during the construction and operation of the shipyard facilities.

9.19 Many of the typical rocky shores in Hong Kong area dominated by several groups of organisms: barnacles, limpets, shore crabs and gastropods (M&M 1983). The coast to the north-east of the reclaimed area is of rocky habitat. In a mature and stable heterogeneous habitat, a more diversified species structure can be expected. Common fauna of such habitat in Hong Kong is listed in Table 9.6.

9.20 After all constructions have ceased, a more diversified faunal structure of the rocky coast northeast to the reclaimed area is possible.

Subtidal Habitat

Muddy Habitat

9.21 The seafloor to the north and west of the reclaimed area is dredged to -5 mPD and -10.5 mPD respectively for approach channel and docking purposes. Although heavily disturbed during the reclamation work, recovery of organisms will resume during the construction of the shipyard facilities. The affected area and the seafloor further north to the reclamation is muddy habitat. Because of tidal currents and storm effects, the muddy bottom in Hong Kong is continually disrupted, creating new surfaces for colonization by larvae of benthic species. Larvae, which can settle and grow on such habitat, are usually equipped with adaptive mechanisms to suit such environment and these include polychaetes, amphipods and bivalves (Levinton 1982). Surveys conducted on muddy bottom in Hong Kong waters showed that in such habitat, species diversity is generally high and individual abundance is low (Shin 1977; W&R 1981; Shin 1982). This may be true for the infaunal muddy communities. Other studies, conducted on the epifaunal community assemblages of habitats which consist of the muddy environment, show that epifaunal cover of muddy habitat is scarce in Hong Kong waters (BCL 1994b; BCL 1995).

9.22 In principle, the species composition and species abundance are largely determined by the physical and chemical properties of a particular area. Since the whole North Lantau area is subject to the influence of the Pearl River discharge, organisms of similar habitats found elsewhere along the North Lantau coast may also be expected to occur around To Kau Wan. Studies (GM 1991) on the infauna of North Lantau by grab sampling revealed a diverse infauna with 135 taxa along the coast. The high infaunal diversity may have resulted from the heterogenous sediment types along North Lantau.

Table 9.6 Common fauna found on rocky shores in Hong Kong (Morton and Morton, 1983)

Species	
Fauna	**Phylum Echinodermata**
Phylum Annelida	**Class Holothuroidea**
Class Polychaeta	*Holothuria leucospilota*
Hydroides elegans	*Polycheira rufescens*
Pomatoleios kraussic	
Sabellastarte indica	**Phylum Mollusca**
Spirobis foraminosus	**Class Bivalvia**
	Barbatia virescens
Phylum Arthropoda	*Brachiodontese atratus*
Subphylum Crustacea	*Pseudochama retroversa*
Class Cirripedia	*Saccostrea cucullata*
Balanus amphitrite	*Septifer bilocularis*
Pollicipes mitella	*Septifer virgatus*
Tetraclita squamosa	
	Class Gastropoda
Class Malacostraca	*Liophura japonica*
Order Amphipoda	*Littorina brevicula*
Stegocephalus inflatus	*Littorina scabra*
Species A.	*Lunella coronata*
	Monodonta australis
Order Isopoda	*Morula margaritifera*
Ligia exotica	*Morula musiva*
	Nodilittorina millegrana
Order Decapoda	*Nodilittorina pyramidalis*
Cyclograpsus intermedius	*Notoacmea coninna*
Epixanthus frontalis	*Patelloida pygmaea*
Hemigrapsus sanguineus	*Planaxis sulcatus*
Gaëtice depressus	*Siphonaria atra*
Metopograpsus messor	*Thais clavigera*
Parasesarma picta	
Sphaerozius nitidus	**Phylum Cnidaria**
Thalamita picta	**Class Anthozoan**
	Haliplanella luciae
	Phylum Chordata
	Class Pisces
	Species A.

Fishery

9.23 R&W (1985) conducted a monthly study of the inshore fish community in the area of north Lantau Island from December 1978 to December 1979 by using conventional trawls. The dominant species at the station near To Kau Wan showed that *Leiognathus brevirostris* was the most abundant fish followed by *Apogon quadrifasciatus* (46.3% and 7.6% of the total fish collected).

9.24 Other study (GM 1991) also showed that the coast had a considerable high faunal diversity dominated by molluscs and crustaceans. At least 100 species of macroinvertebrates and 26 species of fish were recorded. The area is within that fished by small boats by gill net and line for estuarine species including Yellow Croaker and Japanese Sea Perch (*Lateolabrax japonicus*).

Protected or Rare Species

9.25 The Chinese white Dolphin (*Sousa chinensis*) were recorded frequently in North Lantau especially on the western side. The area north of To Kau Wan is not a popular site for the dolphins and therefore, impacts from the shipyard on the animal are considered minimal.

Potential Impacts from the Shipyard

9.26 Any effluent discharged from the site into Hong Kong waters will require to be licensed as specified in the Water Pollution Control Ordinance. And the content of effluent to be discharged into the waters from the site shall also strictly comply with the limits set in the WPCO.

9.27 During the operational phase of the existing shipyard at Penny's Bay, the potential water quality impact arises comes from electroplating, the on-site laboratory, ship manufacturing as well as sewage from toilets and canteen.

Trace metals

9.28 Anthropogenic enrichment of trace metals in aquatic environments has long been frequently observed (Rand 1985). Studies have shown that sublethal levels of trace metals, whether essential or non-essential, may adversely affect physiological functions as well as the behaviour or organisms without causing death (Abdullah 1986; Hartwell 1991). Such adverse effects may reduce the organism's capacity to adapt to environmental change, thus lowering its survival rate in terms of growth retardation (Reeve 1977a, 1997b; Weis 1986) and reproductive suppression (Buikema 1980; V&H 1988; Ravera 1991).

9.29 The main concern about bioaccumulation is that contaminants which can not be excreted may remain in an unchanged state in the organism and are continually added to during the life of the organism. Predators feeding on these bioaccumulators may have a diet enriched in these contaminants. If, as is commonly the case, these predators are unable to excrete the contaminants or do so only slowly, they, in turn, may face the risk of acquiring an even greater body-burden of the contaminants. The significance of biomagnification is that top predators, which include human, may be exposed to very large concentrations of a contaminant in their food.

9.30 Electroplating and laboratory effluents of the existing shipyard has been routinely analyzed for contaminants with most metal concentration levels well below or within the WPCO limits. Once entering the seawater, the amount of these trace metals will be diluted and some will be absorbed in sediments and be irreversibly bound, thus becoming unavailable.

9.31 Analysis of sediments (Chapter 7) showed that trace metals in the surface sediments of Penny's Bay were within Class A classification, indicating that the sediments were uncontaminated. In 30 years of operation, the analyses indicate that concentrations of trace metals, generated by the operational processes and entering the aquatic environment were low and probably negligible and would not be expected to have any deleterious impacts on the marine environment.

TBT

9.32 Tributyltin (TBT) compounds have been used extensively on large vessels as a biocide in antifouling paint and proven to be extremely effective in preventing growth of marine organisms on hulls of vessels. The compounds are highly toxic to organisms and studies have shown that both fish and shellfish bioaccumulate TBT (Waldock 1983).

9.33 Lau (1991) reviewed the status of TBT in Hong Kong waters and described that growth retardation was evident at 200 ng/l for rainbow trout (Seinen 1981) and that mortality occurred at several thousand ng/l for different species of fresh and salt water fish. In Hong Kong, high levels of TBT are found in mariculture sites, marinas and typhoon shelter. The elevated levels are probably attributed to fishing and pleasure vessels painted with TBT antifoulings as well as the employment of TBT coated fish nets.

9.34 At the existing shipyard, the use of TBT antifouling paints is not commonly practised. On an average the maximum of one to two large vessels per year are painted with TBT paints. Sediment analyses for TBT from the worse possible spots inside Penny's Bay revealed that the levels of TBT inside the bay were well below the levels found elsewhere in Hong Kong waters (Lau 1991) yet CLS had until recently used large quantities of TBT for large steel boat manufacture.

Sewage

9.35 Sewage often contains large quantities of nitrates and phosphates which are plant nutrients. If the input of this nutrient enrichment is large, entrophication results. In Hong Kong, this organic enrichment of the coastal area is partly associated with the development of red tides around Hong Kong waters.

9.36 The chief impact in terms of health risk from sewage discharges to aquatic environment is undoubtedly through the ingestion of contaminated seafood. Filter-feeder such as shellfish may accumulate human pathogens on their tissues and these may be transmitted to the consumer.

9.37 Sewage generated from toilets and canteens at To Kau Wan is proposed to be transferred to treatment before being discharged. The effluent quality will have to meet the standard set in the WPCO.

9.38 With the small volumetric discharge, it is not anticipated that the effluent would have noticeable ecological impact on the surrounding area.

Conclusions

9.39 The coastal woodland at the western end of the bay had been badly disturbed due to the construction works of other projects. There are temporary power lines and telephone lines newly connected running right above the coast at +5 to +10 mPD. Many trees and shrubs were felled for these power lines. However, the percentage loss of woodland due to the above construction is considered small. Vegetation has also recently been lost along the discharge channels built for the Toll Plaza.

9.40 Evidence of past hill fires is observed in the area. Hill fires are the major ecological factor to arrest natural succession of plant communities in Hong Kong. It must be prevented or suppressed effectively to allow ecological succession to occur, which would bring a more stable ecological community with improved species richness. No waste should be burnt at the site.

9.41 Neither the construction nor the operation of shipyard facilities is likely to effect the existing terrestrial habitats.

9.42 To Kau Wan is near the mariculture site at Ma Wan which is one of Hong Kong's demersal fishery resources areas. The quantities and concentrations of contaminants discharged currently at Penny's Bay from the shipyard are small and negligible and pose no significant ecological impact on the local fauna. The same would also be expected to hold true at To Kau Wan. No impact at all is likely as far away as Ma Wan.

9.43 Cheoy Lee Shipyards Ltd at Penny's Bay appears to be ecologically sensitive. During the two site visits, there was no obvious visual signs of contamination. CLS at the current site also recycles many of the waste products and has continually met all of the discharge limits imposed by the Water Pollution Control Ordinance. If the same practice is carried out at To Kau Wan, very little or no significant impact would be expected on the marine ecosystem.

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APPENDIX A

LOG WIND PROFILE

Appendix A: Log Wind Profile

To estimate the mean wind speed as a function of height z, we use a logarithmic relationship (log wind profile) as following:

$$U = U_* \ln \frac{z}{z_o} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (A.1)$$

where	U_*	=	friction velocity,
	k	=	von Karman constant, 0.4 (dimensionless),
	z_0	=	roughness length (10 cm).

The friction velocity can be recalculated from equation (A.1) by substituting U = 5.4 m/s, z = 10 m in equation (A.1). The friction velocity is thus 0.46 m/s.

For example, if the pile height is 5 metres, then the mean velocity is thus 4.49 m/s. Hence, the conversion factor is (4.49/5.4) x 100% = 83%. This conversion factor will be used to convert the percentage provided by Royal Observatory to the value (f) used in pile height.

APPENDIX B

CHEMICAL TESTING PROGRAMME
LIST OF VOLATILES AND SEMIVOLATILES

Appendix B
Chemical Testing Programme
Volatiles and Semivolatiles

GC/MS Semivolatiles

Phenol
Aniline
Bis(2-chloroethyl)ether
2-Chlorophenol
1,3-Dichlorobenzene
1,4-Dichlorobenzene
Benzyl alcohol
1,2-Dichlorobenzene
2-Methylphenol
Bis(2-chloroisopropyl)ether
4-Methylphenol
N-Nitroso-di-n-propylamine
Hexachloroethane
Nitrobenzene
Isophorone
2-Nitrophenol
2,4-Dimethylphenol
Benzoic acid
Bis(2-chloroethoxy)methane
2,4-Dichlorophenol
1,2,4-Trichlorobenzene
Naphthalene
4-Chloroaniline
Hexachlorobutadiene
4-Chloro-3-methylphenol
2-Methylnaphthalene
Hexachlorocyclopentadiene
2,4,6-Trichlorophenol
2,4,5-Trichlorophenol
2-Chloronaphthalene
2-Nitroaniline
Dimethyl phthalate
Acenaphthylene
2,6-Dinitrotoluene
3-Nitroaniline
Acenaphthene
2,4-Dinitrophenol
4-Nitrophenol
Dibenzofuran
2,4-Dinitrotoluene
Diethyl phthalate
4-Chlorophenyl phenylether
Fluorene
4-Nitroaniline
4,6-Dinitro-2-methylphenol
N-Nitrosodiphenylamine
1,2-Diphenylhydrazine
4-Bromophenyl phenylether
Hexachlorobenzene
Pentachlorophenol
Phenanthrene
Anthracene
Di-n-butyl phthalate
Fluoranthene
Pyrene
Benzidine
Butyl benzyl phthalate
3-3'-Dichlorobenzidine
Benzo(a)anthracene
Chrysene
Bis(2-ethylhexyl) phthalate
Di-n-octyl phthalate
Benzo(b)fluoranthene
Benzo(k)fluoranthene
Benzo(a)pyrene
Indeno(1,2,3-cd)pyrene
Dibenzo(a,h)anthracene
Benzo(g,h,i)perylene
Carbazole

GC/MS Volatiles

Dichlorodifluoromethane
Chloromethane
Vinyl chloride
Bromomethane
Chloroethane
Trichlorofluoromethane
Acrolein
1,1-Dichloroethene
Acetone
Carbon disulfide
Methylene chloride
Acrylonitrile
trans-1,2-Dichloroethene
1,1-Dichloroethane
Vinyl acetate
cis-1,2-Dichloroethene
2-Butanone
Chloroform
1,1,1-Trichloroethane
Carbon tetrachloride
Benzene
1,2-Dichloroethane
Trichloroethene
1-2-Dichloropropane
Bromodichlormethane
2-Chloroethyl vinyl ether
cis-1,3-Dichloropropene
4-Methyl-2-pentanone
Toluene
trans-1,3-Dichloropropene
1,1,2-Trichloroethane
Tetrachloroethene
2-Hexanone
Dibromochloromethane
Chlorobenzene
Ethylbenzene
m,p-Xylenes
o-Xylene
Styrene
Bromoform
1,1,2,2-Tetrachloroethane

APPENDIX C

RESULTS OF SEDIMENT TESTING PROGRAMME

Analytical Reports

February Samples

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940 South Harney St., Seattle, WA 98108 (206) 767-5060 FAX (206) 767-5063
Chemistry, Microbiology, and Technical Services

CLIENT: Binnie Consultants, Ltd.
11th Floor, New Town Tower
Pak Mok Ting Street, Shatin
New Territories, Hong Kong
ATTN : Kevin Ward

Certificate of Analysis

Work Order# : 95-01-827
DATE RECEIVED : 01/24/95
DATE OF REPORT: 02/28/95

Work ID : Shipyard
Taken By : Client
Transported by: Fed Exp 40038578315
Type : Sediment

SAMPLE IDENTIFICATION:

	Sample Description		Sample Description
01	S1A	03	S3A
02	S2A	04	S4A

GENERAL COMMENTS ON METHOD 9070 OIL AND GREASE ANALYSIS:

Method 9070 is a liquid-liquid extraction for water samples, employing a gravimetric finish. In a soil sample, for which the analysis was not written, we have modified the method by performing a sonic extraction with a gravimetric finish.

COMMENTS ON BUTYLTIN ANALYSES:

Sample 1-4 in this work order were extracted and analyzed for organotin compounds (mono-, di-, tri-, and tetrabutyltin) as described in "A method for the Analysis of Butyltin Species and Measurement of Butyltin Species in Sediment and English Sole Livers from Puget Sound" (Marine Environmental Research, Vol. 27, 1989, pp. 1-18 authored by Krone, Brown, et al.

The method utilized extraction of the butyltins with a mixture of dichloromethane/tropolone, derivatization with hexylmagnesium bromide, and clean-up via silica gel/alumina column chromatography prior to analysis by GC/MS. In order to achieve reasonable detection limits, the published method was modified. The amount of sample was increased to 20 grams from 10 grams. The sediment samples were also extracted using EPA Method 3550 (sonication

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extraction) instead of the roller bottles described in the method. The final volume of the extracts was also reduced from 1000 uL to 500 uL.

The recovery of monobutyltin trichloride in the MS/MSD samples was below the minimum control limit. It is known that the monobutyltin tends to break down during the extraction process leading to low recoveries of this analyte (as is described in the published method). No corrective action is required for low MS/MSD recovery for this analyte.

COMMENTS ON SEMIVOLATILE (METHOD 8270) ANALYSES:

The method blank associated with these samples was contaminated with phenol and 4-methylphenol at levels which exceeded the laboratory control limits. The source of the contamination was most likely carry over from a sample which was GPC cleaned immediately before this blank was GPC cleaned. No 4-methylphenol was detected in any of the samples, however low levels of phenol were detected in all samples associated with this blank. For corrective action, the samples were re-extracted and reanalyzed. The method blank associated with the re-extracted samples was lost due to a mechanical failure in the GPC clean-up equipment. No further re-extractions could be performed as there was no remaining sample. The re-extracted samples were analyzed and results consistent with the first analyses were obtained, however, the levels of phenol in the re-extracted samples were lower than in the original sample analyses indicating that the phenol in the original sample analyses was most likely due to contamination. The original sample results have been reported as they were extracted within holding time.

COMMENTS ON METALS QC ANALYSIS:

Arsenic, tin and iron were inadvertently not added to the matrix spike samples. Since there were no remaining samples for re-analysis, the digestates were spiked with arsenic and tin after the digestion step. Recoveries of these post-digestion spikes are reported below. The samples contained too much iron to be reliably spiked, so duplicate analyses were reported as QC.

	Post-digestion Spike Recovery	Control Limits
Arsenic	89 %	50% - 150%
Tin	15%	50% - 150%

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Certificate of Analysis

Work Order# : 95-01-827

Whereas the recoveries for Arsenic indicated that sample results were reliable, Tin recoveries imply that there was matrix interference and that sample results may be biased low. Since there were no remaining samples, no further action could be taken.

Unless otherwise instructed all samples will be discarded on 04/29/95

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E : The flagged value was reported from an analysis which exceeded the linear range of the instrument. See additional comments for further discussion of the circumstances. Values so flagged should be considered estimates.

D : The value reported derives from analysis of a diluted sample or sample extract.

P : When a dual column GC technique is employed, this flag indicates that test results from the two columns differ by more than 25%. Generally, we report the lower value.

C : The flagged analyte has been confirmed by GC/MS analysis. The value reported may be derived from either the initial or confirmatory (GC/MS) analysis. See specific report comments for details.

SDL : Sample Detection Limit. The SDL can vary from sample to sample, depending on sample size, matrix interferences, moisture content and other sample-specific conditions.

PQL : Practical Quantitation Limit. This limit is drawn from the test method and usually represents the SDL multiplied by a matrix-specific factor.

CRQL : Client Requested Quantitation Limit, usually the limit of detection specified at your request. Might also be referred to as Contract Required Quantitation Limit.

DB : Dry Basis. The value reported has been back-calculated to normalize for the moisture content of the sample.

AR : As-Received. The value has NOT been normalized for moisture.

Other abbreviations, used in special applications, are defined where they appear.

DISPOSAL DATE - Our reports now include the date on which we will dispose of your samples. (In limited instances, we may require that the samples be returned to your custody.) If you wish to have the samples back, or would like to have them stored for a longer period, please notify us before the disposal date.

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USING OUR REPORTS

Laucks uses an electronic Laboratory Information Management System that produces both our reports and invoices. The following information and definitions will help you understand our reports, and we encourage you to call us if your questions are not answered here.

SAMPLE IDENTIFICATION - Sample IDs are recorded as they appear on your sample containers or chain-of-custody documents.

TEST RESULTS - Analyses that result in a single data point are shown in alphabetical order in the body of the report. Tests that yield multiple results are generally reported on separate pages, on a sample-by-sample basis.

MEASUREMENT UNITS - The reporting units are shown to the right of the analyte name. In the event that a different unit was more appropriate to a specific sample, that exception is shown immediately beneath the test result. Units commonly employed are mg/kg (solids) or mg/L (liquids), comparable to parts per million; ug/kg (solids) or ug/L (liquids), comparable to parts per billion; and percent (%).

METHODS OF ANALYSIS - The EPA or Standard Methods method number is shown in parentheses after the analyte name when field size allows; or, for analyses that yield multiple data points, in the header information on the individual report page.

ABBREVIATIONS - Several abbreviations can appear in our reports. The most commonly employed abbreviations are:

U : The analyte of interest was not detected, to the limit of detection indicated.

B : The analyte of interest was detected in the method blank associated with the sample, as well as in the sample itself. The B flag is applied without regard to the relative concentrations detected in the blank and sample.

J : The analyte of interest was detected below the routine reporting limit. This value should be regarded as an estimate.

T : The flagged values represent the SUM of two co-eluting compounds. The SUM of these two values is shown as though it were a result for each of them. The two figures should not be added together.

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Chemistry, Microbiology, and Technical Services

CLIENT : Binnie Consultants, Ltd.

Certificate of Analysis

Work Order # 95-01-827

TESTS PERFORMED AND RESULTS:

Analyte	Units	01	02	03	04
Arsenic (Method 6010)	mg/kg DB	3.4 U	2.8 U	2.8 U	3.2 U
Cyanide (Method 9012)	mg/kg DB	0.59 U	0.51	0.50	0.68
Iron (Method 6010)	mg/kg DB	24000.	22000.	26000.	23000.
Oil & Grease (SW 9070)	mg/kg DB	380.	190.	50. U	270.
Tin (Method 7870)	mg/kg DB	16. U	12. U	12. U	15. U
Total Organic Carbon	%, dry basis	1.3	0.9	1.1	1.0
Total Solids	%	40.5	44.1	46.5	44.6

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REPORT ON SAMPLE: 9501827-01D
Client Sample ID: S1A

Collection Date	: N/A	Test Code	: MSTINS
Date Received	: 01/31/95	Test Method	: SW 8270
Date Analyzed	: 02/13/95	Extraction Method	: Roller Bottle
Date Confirmed	: 02/14/95	Report Units	: ug/kg DB

Analyte	Result		SDL	PQL
Monobutyltin trichloride	140	U	140	140
Dibutyltin dichloride	69	U	69	69
Tributyltin chloride	30	J	54	54
Tetrabutyltin	54	U	54	54

Surrogate recovery report for sample 9501827-01D

Surrogate	Percent Recovery	Limits: Min.	Max.
Tripropyltin chloride	87	20	160

* = Indicates that recovery is outside control limits

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REPORT ON SAMPLE: 9501827-02B
Client Sample ID: S2A

Collection Date	: N/A	Test Code	: MSTINS
Date Received	: 01/31/95	Test Method	: SW 8270
Date Analyzed	: 02/13/95	Extraction Method	: Roller Bottle
Date Confirmed	: 02/14/95	Report Units	: ug/kg DB

Analyte	Result		SDL	PQL
Monobutyltin trichloride	130	U	130	130
Dibutyltin dichloride	63	U	63	63
Tributyltin chloride	86		50	50
Tetrabutyltin	50	U	50	50

Surrogate recovery report for sample 9501827-02B

Surrogate	Percent Recovery	Limits: Min.	Max.
Tripropyltin chloride	92	20	160

* = Indicates that recovery is outside control limits

REPORT ON SAMPLE: 9501827-03B
Client Sample ID: S3A

Collection Date : N/A
Date Received : 01/31/95
Date Analyzed : 02/13/95
Date Confirmed : 02/14/95

Test Code : MSTINS
Test Method : SW 8270
Extraction Method : Roller Bottle
Report Units : ug/kg DB

Analyte	Result		SDL	PQL
Monobutyltin trichloride	120	U	120	120
Dibutyltin dichloride	55	J	60	60
Tributyltin chloride	82		47	47
Tetrabutyltin	47	U	47	47

Surrogate recovery report for sample 9501827-03B

Surrogate	Percent Recovery	Limits: Min.	Max.
Tripropyltin chloride	86	20	160

* = Indicates that recovery is outside control limits

REPORT ON SAMPLE: 9501827-04B
Client Sample ID: S4A

Collection Date	: N/A	Test Code	: MSTINS
Date Received	: 01/31/95	Test Method	: SW 8270
Date Analyzed	: 02/13/95	Extraction Method	: Roller Bottle
Date Confirmed	: 02/14/95	Report Units	: ug/kg DB

Analyte	Result		SDL	PQL
Monobutyltin trichloride	130	U	130	130
Dibutyltin dichloride	63	U	63	63
Tributyltin chloride	62		49	49
Tetrabutyltin	49	U	49	49

Surrogate recovery report for sample 9501827-04B

Surrogate	Percent Recovery	Limits: Min.	Max.
Tripropyltin chloride	79	20	160

* = Indicates that recovery is outside control limits

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REPORT ON SAMPLE: 9501827-01A
Client Sample ID: S1A

Collection Date	: N/A	Test Code	: 8240_S
Date Received	: 01/24/95	Test Method	: SW 8240
Date Analyzed	: 01/31/95	Report Units	: ug/kg DB
Date Confirmed	: 02/22/95		

Analyte	Result	SDL	Analyte	Result	SDL
Dichlorodifluoromethane ...	2 U	2	Benzene	2 U	2
Chloromethane	2 U	2	1,2-Dichloroethane.........	2 U	2
Vinyl chloride	2 U	2	Trichloroethene	2 U	2
Bromomethane	2 U	2	1,2-Dichloropropane	2 U	2
Chloroethane	5 U	5	Bromodichloromethane	2 U	2
Trichlorofluoromethane	12 U	12	2-Chloroethyl vinyl ether .	12 U	12
Acrolein	5 U	5	cis-1,3-Dichloropropene ...	2 U	2
1,1-Dichloroethene	2 U	2	4-Methyl-2-pentanone	5 U	5
Acetone	70	15	Toluene	4	2
Carbon disulfide	7 U	7	trans-1,3-Dichloropropene .	2 U	2
Methylene chloride	22 B	5	1,1,2-Trichloroethane	2 U	2
Acrylonitrile	2 U	2	Tetrachloroethene	2 U	2
trans-1,2-Dichloroethene ..	2 U	2	2-Hexanone	2 U	2
1,1-Dichloroethane	2 U	2	Dibromochloromethane	2 U	2
Vinyl acetate	2 U	2	Chlorobenzene	2 U	2
cis-1,2-Dichloroethene	2 U	2	Ethylbenzene	2 U	2
2-Butanone	11	5	m,p-Xylenes	2 U	2
Chloroform	2 U	2	o-Xylene	2 U	2
1,1,1-Trichloroethane	2 U	2	Styrene	2 U	2
Carbon tetrachloride	2 U	2	Bromoform	2 U	2
			1,1,2,2-Tetrachloroethane .	2 U	2

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Surrogate recovery report for sample 9501827-01A

Surrogate	Percent Recovery	Limits: Min.	Max.
d4-1,2-Dichloroethane	98	76	121
d8-Toluene	101	74	128
p-Bromofluorobenzene	94	72	118

* = Indicates that recovery is outside control limits

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REPORT ON SAMPLE: 9501827-02A
Client Sample ID: S2A

Collection Date	: N/A	Test Code	: 8240_S
Date Received	: 01/24/95	Test Method	: SW 8240
Date Analyzed	: 01/31/95	Report Units	: ug/kg DB
Date Confirmed	: 02/22/95		

Analyte	Result	SDL	Analyte	Result	SDL
Dichlorodifluoromethane ...	2 U	2	Benzene	2 U	2
Chloromethane	2 U	2	1,2-Dichloroethane.........	2 U	2
Vinyl chloride	2 U	2	Trichloroethene	2 U	2
Bromomethane	2 U	2	1,2-Dichloropropane	2 U	2
Chloroethane	5 U	5	Bromodichloromethane	2 U	2
Trichlorofluoromethane	11 U	11	2-Chloroethyl vinyl ether .	11 U	11
Acrolein	5 U	5	cis-1,3-Dichloropropene ...	2 U	2
1,1-Dichloroethene	2 U	2	4-Methyl-2-pentanone	12	5
Acetone	120	14	Toluene	3	2
Carbon disulfide	7 U	7	trans-1,3-Dichloropropene .	2 U	2
Methylene chloride	23 B	5	1,1,2-Trichloroethane	2 U	2
Acrylonitrile	2 U	2	Tetrachloroethene	2 U	2
trans-1,2-Dichloroethene ..	2 U	2	2-Hexanone	2 U	2
1,1-Dichloroethane	2 U	2	Dibromochloromethane	2 U	2
Vinyl acetate	2 U	2	Chlorobenzene	2 U	2
cis-1,2-Dichloroethene	2 U	2	Ethylbenzene	2 U	2
2-Butanone	24	5	m,p-Xylenes	2 J	2
Chloroform	2 U	2	o-Xylene	2 U	2
1,1,1-Trichloroethane	2 U	2	Styrene	2 U	2
Carbon tetrachloride	2 U	2	Bromoform	2 U	2
			1,1,2,2-Tetrachloroethane .	2 U	2

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Surrogate recovery report for sample 9501827-02A

Surrogate	Percent Recovery	Limits: Min.	Max.
d4-1,2-Dichloroethane	97	76	121
d8-Toluene	102	74	128
p-Bromofluorobenzene	101	72	118

* = Indicates that recovery is outside control limits

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REPORT ON SAMPLE: 9501827-03A
Client Sample ID: S3A

Collection Date	: N/A	Test Code	: 8240_S
Date Received	: 01/24/95	Test Method	: SW 8240
Date Analyzed	: 01/31/95	Report Units	: ug/kg DB
Date Confirmed	: 02/22/95		

Analyte	Result	SDL	Analyte	Result	SDL
Dichlorodifluoromethane ...	2 U	2	Benzene	2 U	2
Chloromethane	2 U	2	1,2-Dichloroethane.........	2 U	2
Vinyl chloride	2 U	2	Trichloroethene	2 U	2
Bromomethane	2 U	2	1,2-Dichloropropane	2 U	2
Chloroethane	4 U	4	Bromodichloromethane	2 U	2
Trichlorofluoromethane	11 U	11	2-Chloroethyl vinyl ether .	11 U	11
Acrolein	4 U	4	cis-1,3-Dichloropropene ...	2 U	2
1,1-Dichloroethene	2 U	2	4-Methyl-2-pentanone	4 U	4
Acetone	130	13	Toluene	3	2
Carbon disulfide	6 U	6	trans-1,3-Dichloropropene .	2 U	2
Methylene chloride	22 B	4	1,1,2-Trichloroethane	2 U	2
Acrylonitrile	2 U	2	Tetrachloroethene	2 U	2
trans-1,2-Dichloroethene ..	2 U	2	2-Hexanone	2 U	2
1,1-Dichloroethane	2 U	2	Dibromochloromethane	2 U	2
Vinyl acetate	2 U	2	Chlorobenzene	2 U	2
cis-1,2-Dichloroethene	2 U	2	Ethylbenzene	2 U	2
2-Butanone	19	4	m,p-Xylenes	2 U	2
Chloroform	2 U	2	o-Xylene	2 U	2
1,1,1-Trichloroethane	2 U	2	Styrene	2 U	2
Carbon tetrachloride	2 U	2	Bromoform	2 U	2
			1,1,2,2-Tetrachloroethane .	2 U	2

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Surrogate recovery report for sample 9501827-03A

Surrogate	Percent Recovery	Limits: Min.	Max.
d4-1,2-Dichloroethane	97	76	121
d8-Toluene	105	74	128
p-Bromofluorobenzene	94	72	118

* = Indicates that recovery is outside control limits

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REPORT ON SAMPLE: 9501827-04A
Client Sample ID: S4A

Collection Date	: N/A		Test Code	: 8240_S
Date Received	: 01/24/95		Test Method	: SW 8240
Date Analyzed	: 01/31/95		Report Units	: ug/kg DB
Date Confirmed	: 02/22/95			

Analyte	Result	SDL	Analyte	Result	SDL
Dichlorodifluoromethane ...	2 U	2	Benzene	2 U	2
Chloromethane	2 U	2	1,2-Dichloroethane.........	2 U	2
Vinyl chloride	2 U	2	Trichloroethene	2 U	2
Bromomethane	2 U	2	1,2-Dichloropropane	2 U	2
Chloroethane	4 U	4	Bromodichloromethane	2 U	2
Trichlorofluoromethane	11 U	11	2-Chloroethyl vinyl ether .	11 U	11
Acrolein	4 U	4	cis-1,3-Dichloropropene ...	2 U	2
1,1-Dichloroethene	2 U	2	4-Methyl-2-pentanone	4 U	4
Acetone	100	13	Toluene	9	2
Carbon disulfide	7 U	7	trans-1,3-Dichloropropene .	2 U	2
Methylene chloride	24 B	4	1,1,2-Trichloroethane	2 U	2
Acrylonitrile	2 U	2	Tetrachloroethene	2 U	2
trans-1,2-Dichloroethene ..	2 U	2	2-Hexanone	2 U	2
1,1-Dichloroethane	2 U	2	Dibromochloromethane	2 U	2
Vinyl acetate	2 U	2	Chlorobenzene	2 U	2
cis-1,2-Dichloroethene	2 U	2	Ethylbenzene	2 U	2
2-Butanone	19	4	m,p-Xylenes	2 U	2
Chloroform	2 U	2	o-Xylene	2 U	2
1,1,1-Trichloroethane	2 U	2	Styrene	2 U	2
Carbon tetrachloride	2 U	2	Bromoform	2 U	2
			1,1,2,2-Tetrachloroethane .	2 U	2

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Surrogate recovery report for sample 9501827-04A

Surrogate	Percent Recovery	Limits: Min.	Max.
d4-1,2-Dichloroethane	97	76	121
d8-Toluene	102	74	128
p-Bromofluorobenzene	99	72	118

* = Indicates that recovery is outside control limits

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REPORT ON SAMPLE: 9501827-01A
Client Sample ID: S1A
Collection Date : N/A
Date Received : 01/24/95
Date Extracted : 02/07/95
Date Analyzed : 02/15/95

Test Code : LXTCSS
Test Method : SW8270
Extraction Method : SW3550

Analyte	Result (ug/kg DB)	SDL (ug/kg DB)	Analyte	Result (ug/kg DB)	SDL (ug/kg DB)
Phenol	220 B	82	3-Nitroaniline	410 U	410
Aniline	410 U	410	Acenaphthene	82 U	82
Bis(2-chloroethyl)ether	82 U	82	2,4-Dinitrophenol	820 U	820
2-Chlorophenol	82 U	82	4-Nitrophenol	820 U	820
1,3-Dichlorobenzene	82 U	82	Dibenzofuran	82 U	82
1,4-Dichlorobenzene	82 U	82	2,4-Dinitrotoluene	160 U	160
Benzyl alcohol	82 U	82	Diethyl phthalate	82 U	82
1,2-Dichlorobenzene	82 U	82	4-Chlorophenyl phenylether	82 U	82
2-Methylphenol	82 U	82	Fluorene	82 U	82
Bis(2-chloroisopropyl)ether	82 U	82	4-Nitroaniline	160 U	160
4-Methylphenol	82 U	82	4,6-Dinitro-2-methylphenol	820 U	820
N-Nitroso-di-n-propylamine	82 U	82	N-Nitrosodiphenylamine	82 U	82
Hexachloroethane	160 U	160	1,2-Diphenylhydrazine	160 U	160
Nitrobenzene	82 U	82	4-Bromophenyl phenylether ..	160 U	160
Isophorone	82 U	82	Hexachlorobenzene	160 U	160
2-Nitrophenol	160 U	160	Pentachlorophenol	820 U	820
2,4-Dimethylphenol	82 U	82	Phenanthrene	82 U	82
Benzoic acid	2000 U	2000	Anthracene	82 U	82
Bis(2-chloroethoxy)methane	82 U	82	Carbazole	82 U	82
2,4-Dichlorophenol	160 U	160	Di-n-butyl phthalate	82 U	82
1,2,4-Trichlorobenzene	82 U	82	Fluoranthene	29 J	82
Naphthalene	82 U	82	Pyrene	35 J	82
4-Chloroaniline	82 U	82	Benzidine	2000 U	2000
Hexachlorobutadiene	82 U	82	Butylbenzylphthalate	82 U	82
4-Chloro-3-methylphenol	160 U	160	3,3'-Dichlorobenzidine	820 U	820
2-Methylnaphthalene	82 U	82	Benzo(a)anthracene	82 U	82
Hexachlorocyclopentadiene ..	160 U	160	Chrysene	36 J	82
2,4,6-Trichlorophenol	160 U	160	Bis(2-ethylhexyl)phthalate	760 B	82
2,4,5-Trichlorophenol	160 U	160	Di-n-octyl phthalate	82 U	82
2-Chloronaphthalene	82 U	82	Benzo(b)fluoranthene	81 JT	82
2-Nitroaniline	160 U	160	Benzo(k)fluoranthene	81 JT	82
Dimethyl phthalate	43 J	82	Benzo(a)pyrene	57 J	82
Acenaphthylene	82 U	82	Indeno(1,2,3-cd)pyrene	48 J	82
2,6-Dinitrotoluene	160 U	160	Dibenzo(a,h)anthracene	82 U	82
			Benzo(g,h,i)perylene	56 J	82

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GC/MS ABN surrogate recovery report for sample 9501827-01A

Surrogate	Percent Recovery	Limits: Min.	Max.
2-Fluorophenol	72	33	115
d5-Phenol	80	45	112
d4-2-Chlorophenol ...	83	41	110
d5-Nitrobenzene	78	38	117
2-Fluorobiphenyl	80	47	124
d4-1,2-Dichlorobenzene	76	43	118
2,4,6-Tribromophenol	99	30	136
d14-p-Terphenyl	100	51	135

* = Surrogate recovery outside control limits

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REPORT ON SAMPLE: 9501827-02A
Client Sample ID: S2A
Collection Date : N/A
Date Received : 01/24/95
Date Extracted : 02/07/95
Date Analyzed : 02/15/95

Test Code : LXTCSS
Test Method : SW8270
Extraction Method : SW3550

Analyte	Result (ug/kg DB)	SDL (ug/kg DB)	Analyte	Result (ug/kg DB)	SDL (ug/kg DB)
Phenol	200 B	75	3-Nitroaniline	380 U	380
Aniline	380 U	380	Acenaphthene	75 U	75
Bis(2-chloroethyl)ether	75 U	75	2,4-Dinitrophenol	750 U	750
2-Chlorophenol	75 U	75	4-Nitrophenol	750 U	750
1,3-Dichlorobenzene	75 U	75	Dibenzofuran	75 U	75
1,4-Dichlorobenzene	75 U	75	2,4-Dinitrotoluene	150 U	150
Benzyl alcohol	75 U	75	Diethyl phthalate	75 U	75
1,2-Dichlorobenzene	75 U	75	4-Chlorophenyl phenylether	75 U	75
2-Methylphenol	75 U	75	Fluorene	75 U	75
Bis(2-chloroisopropyl)ether	75 U	75	4-Nitroaniline	150 U	150
4-Methylphenol	75 U	75	4,6-Dinitro-2-methylphenol	750 U	750
N-Nitroso-di-n-propylamine	75 U	75	N-Nitrosodiphenylamine	75 U	75
Hexachloroethane	150 U	150	1,2-Diphenylhydrazine	150 U	150
Nitrobenzene	75 U	75	4-Bromophenyl phenylether ..	150 U	150
Isophorone	75 U	75	Hexachlorobenzene	150 U	150
2-Nitrophenol	150 U	150	Pentachlorophenol	750 U	750
2,4-Dimethylphenol	75 U	75	Phenanthrene	51 J	75
Benzoic acid	1900 U	1900	Anthracene	75 U	75
Bis(2-chloroethoxy)methane	75 U	75	Carbazole	75 U	75
2,4-Dichlorophenol	150 U	150	Di-n-butyl phthalate	49 JB	75
1,2,4-Trichlorobenzene	75 U	75	Fluoranthene	59 J	75
Naphthalene	75 U	75	Pyrene	64 J	75
4-Chloroaniline	75 U	75	Benzidine	1900 U	1900
Hexachlorobutadiene	75 U	75	Butylbenzylphthalate	75 U	75
4-Chloro-3-methylphenol	150 U	150	3,3'-Dichlorobenzidine	750 U	750
2-Methylnaphthalene	75 U	75	Benzo(a)anthracene	48 J	75
Hexachlorocyclopentadiene ..	150 U	150	Chrysene	61 J	75
2,4,6-Trichlorophenol	150 U	150	Bis(2-ethylhexyl)phthalate	730 B	75
2,4,5-Trichlorophenol	150 U	150	Di-n-octyl phthalate	75 U	75
2-Chloronaphthalene	75 U	75	Benzo(b)fluoranthene	88 T	75
2-Nitroaniline	150 U	150	Benzo(k)fluoranthene	88 T	75
Dimethyl phthalate	140	75	Benzo(a)pyrene	63 J	75
Acenaphthylene	75 U	75	Indeno(1,2,3-cd)pyrene	51 J	75
2,6-Dinitrotoluene	150 U	150	Dibenzo(a,h)anthracene	75 U	75
			Benzo(g,h,i)perylene	51 J	75

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GC/MS ABN surrogate recovery report for sample 9501827-02A

Surrogate	Percent Recovery	Limits: Min.	Max.
2-Fluorophenol	72	33	115
d5-Phenol	77	45	112
d4-2-Chlorophenol ...	79	41	110
d5-Nitrobenzene	80	38	117
2-Fluorobiphenyl	75	47	124
d4-1,2-Dichlorobenzene	77	43	118
2,4,6-Tribromophenol	94	30	136
d14-p-Terphenyl	89	51	135

* = Surrogate recovery outside control limits

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REPORT ON SAMPLE: 9501827-03A
Client Sample ID: S3A
Collection Date : N/A
Date Received : 01/24/95
Date Extracted : 02/07/95
Date Analyzed : 02/15/95

Test Code : LXTCSS
Test Method : SW8270
Extraction Method : SW3550

Analyte	Result (ug/kg DB)	SDL (ug/kg DB)
Phenol	350 B	72
Aniline	360 U	360
Bis(2-chloroethyl)ether	72 U	72
2-Chlorophenol	72 U	72
1,3-Dichlorobenzene	72 U	72
1,4-Dichlorobenzene	72 U	72
Benzyl alcohol	72 U	72
1,2-Dichlorobenzene	72 U	72
2-Methylphenol	72 U	72
Bis(2-chloroisopropyl)ether	72 U	72
4-Methylphenol	72 U	72
N-Nitroso-di-n-propylamine	72 U	72
Hexachloroethane	140 U	140
Nitrobenzene	72 U	72
Isophorone	72 U	72
2-Nitrophenol	140 U	140
2,4-Dimethylphenol	72 U	72
Benzoic acid	1800 U	1800
Bis(2-chloroethoxy)methane	72 U	72
2,4-Dichlorophenol	140 U	140
1,2,4-Trichlorobenzene	72 U	72
Naphthalene	72 U	72
4-Chloroaniline	72 U	72
Hexachlorobutadiene	72 U	72
4-Chloro-3-methylphenol	140 U	140
2-Methylnaphthalene	72 U	72
Hexachlorocyclopentadiene	140 U	140
2,4,6-Trichlorophenol	140 U	140
2,4,5-Trichlorophenol	140 U	140
2-Chloronaphthalene	72 U	72
2-Nitroaniline	140 U	140
Dimethyl phthalate	99	72
Acenaphthylene	72 U	72
2,6-Dinitrotoluene	140 U	140
3-Nitroaniline	360 U	360
Acenaphthene	72 U	72
2,4-Dinitrophenol	720 U	720
4-Nitrophenol	720 U	720
Dibenzofuran	72 U	72
2,4-Dinitrotoluene	140 U	140
Diethyl phthalate	72 U	72
4-Chlorophenyl phenylether	72 U	72
Fluorene	72 U	72
4-Nitroaniline	140 U	140
4,6-Dinitro-2-methylphenol	720 U	720
N-Nitrosodiphenylamine	72 U	72
1,2-Diphenylhydrazine	140 U	140
4-Bromophenyl phenylether	140 U	140
Hexachlorobenzene	140 U	140
Pentachlorophenol	720 U	720
Phenanthrene	72 U	72
Anthracene	72 U	72
Carbazole	72 U	72
Di-n-butyl phthalate	36 JB	72
Fluoranthene	28 J	72
Pyrene	26 J	72
Benzidine	1800 U	1800
Butylbenzylphthalate	72 U	72
3,3'-Dichlorobenzidine	720 U	720
Benzo(a)anthracene	72 U	72
Chrysene	72 U	72
Bis(2-ethylhexyl)phthalate	950 B	72
Di-n-octyl phthalate	72 U	72
Benzo(b)fluoranthene	44 JT	72
Benzo(k)fluoranthene	44 JT	72
Benzo(a)pyrene	23 J	72
Indeno(1,2,3-cd)pyrene	72 U	72
Dibenzo(a,h)anthracene	72 U	72
Benzo(g,h,i)perylene	72 U	72

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GC/MS ABN surrogate recovery report for sample 9501827-03A

Surrogate	Percent Recovery	Limits: Min.	Max.
2-Fluorophenol	74	33	115
d5-Phenol	79	45	112
d4-2-Chlorophenol ...	81	41	110
d5-Nitrobenzene	76	38	117
2-Fluorobiphenyl	79	47	124
d4-1,2-Dichlorobenzene	77	43	118
2,4,6-Tribromophenol	98	30	136
d14-p-Terphenyl	85	51	135

* = Surrogate recovery outside control limits

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REPORT ON SAMPLE: 9501827-04A
Client Sample ID: S4A
Collection Date : N/A
Date Received : 01/24/95
Date Extracted : 02/07/95
Date Analyzed : 02/15/95

Test Code : LXTCSS
Test Method : SW8270
Extraction Method : SW3550

Analyte	Result (ug/kg DB)	SDL (ug/kg DB)
Phenol	190	76
Aniline	380 U	380
Bis(2-chloroethyl)ether	76 U	76
2-Chlorophenol	76 U	76
1,3-Dichlorobenzene	76 U	76
1,4-Dichlorobenzene	76 U	76
Benzyl alcohol	76 U	76
1,2-Dichlorobenzene	76 U	76
2-Methylphenol	76 U	76
Bis(2-chloroisopropyl)ether	76 U	76
4-Methylphenol	76 U	76
N-Nitroso-di-n-propylamine	76 U	76
Hexachloroethane	150 U	150
Nitrobenzene	76 U	76
Isophorone	76 U	76
2-Nitrophenol	150 U	150
2,4-Dimethylphenol	76 U	76
Benzoic acid	1900 U	1900
Bis(2-chloroethoxy)methane	76 U	76
2,4-Dichlorophenol	150 U	150
1,2,4-Trichlorobenzene	76 U	76
Naphthalene	76 U	76
4-Chloroaniline	76 U	76
Hexachlorobutadiene	76 U	76
4-Chloro-3-methylphenol	150 U	150
2-Methylnaphthalene	76 U	76
Hexachlorocyclopentadiene	150 U	150
2,4,6-Trichlorophenol	150 U	150
2,4,5-Trichlorophenol	150 U	150
2-Chloronaphthalene	76 U	76
2-Nitroaniline	150 U	150
Dimethyl phthalate	36 J	76
Acenaphthylene	76 U	76
2,6-Dinitrotoluene	150 U	150

Analyte	Result (ug/kg DB)	SDL (ug/kg DB)
3-Nitroaniline	380 U	380
Acenaphthene	76 U	76
2,4-Dinitrophenol	760 U	760
4-Nitrophenol	760 U	760
Dibenzofuran	76 U	76
2,4-Dinitrotoluene	150 U	150
Diethyl phthalate	76 U	76
4-Chlorophenyl phenylether	76 U	76
Fluorene	76 U	76
4-Nitroaniline	150 U	150
4,6-Dinitro-2-methylphenol	760 U	760
N-Nitrosodiphenylamine	76 U	76
1,2-Diphenylhydrazine	150 U	150
4-Bromophenyl phenylether	150 U	150
Hexachlorobenzene	150 U	150
Pentachlorophenol	760 U	760
Phenanthrene	76 U	76
Anthracene	76 U	76
Carbazole	76 U	76
Di-n-butyl phthalate	76 U	76
Fluoranthene	76 U	76
Pyrene	14 J	76
Benzidine	1900 U	1900
Butylbenzylphthalate	76 U	76
3,3'-Dichlorobenzidine	760 U	760
Benzo(a)anthracene	76 U	76
Chrysene	76 U	76
Bis(2-ethylhexyl)phthalate	770 B	76
Di-n-octyl phthalate	76 U	76
Benzo(b)fluoranthene	76 U	76
Benzo(k)fluoranthene	76 U	76
Benzo(a)pyrene	76 U	76
Indeno(1,2,3-cd)pyrene	76 U	76
Dibenzo(a,h)anthracene	76 U	76
Benzo(g,h,i)perylene	76 U	76

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GC/MS ABN surrogate recovery report for sample 9501827-04A

Surrogate	Percent Recovery	Limits: Min.	Max.
2-Fluorophenol	78	33	115
d5-Phenol	83	45	112
d4-2-Chlorophenol ...	86	41	110
d5-Nitrobenzene	78	38	117
2-Fluorobiphenyl	79	47	124
d4-1,2-Dichlorobenzene	81	43	118
2,4,6-Tribromophenol	102	30	136
d14-p-Terphenyl	77	51	135

* = Surrogate recovery outside control limits

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APPENDIX A

Method Blanks & Surrogate Recoveries Reports

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Quality Control Report
Method Blanks for Work Order 9501827

Blank Name	Samples Verified	Test Description	Result	Units	Control Limit
B020395_CN_S01	1-4	Total cyanide	0.25 U	mg/kg DB	0.50
B020695_CN_S01	1-4	Total cyanide	0.25 U	mg/kg DB	0.50
B020795_TOC_S02	1-4	Total Organic Carbon	0.10 U	percent	0.50
B022395_FAA_S01	1-4	Tin by FAA	10 U	mg/kg DB	20
B022395_ICP_S01	1-4	Arsenic by ICP	1.1 U	mg/kg DB	2.3
		Iron by ICP	1.8		1.8
B013195_MVO_S01	1-4	Dichlorodifluoromethane	1.0 U	ug/kg	1.0
		Chloromethane	1.0 U		1.0
		Vinyl chloride	1.0 U		1.0
		Bromomethane	1.0 U		1.0
		Chloroethane	2.0 U		2.0
		Trichlorofluoromethane	5.0 U		5.0
		Acrolein	2.0 U		2.0
		1,1-Dichloroethene	1.0 U		1.0
		Acetone	6.0 U		30
		Carbon disulfide	3.0 U		3.0
		Methylene chloride	1.0 J		20
		Acrylonitrile	1.0 U		1.0
		trans-1,2-Dichloroethene	1.0 U		1.0
		1,1-Dichloroethane	1.0 U		1.0
		Vinyl acetate	1.0 U		1.0
		cis-1,2-Dichloroethene	1.0 U		1.0
		2-Butanone	2.0 U		2.0
		Chloroform	1.0 U		1.0
		1,1,1-Trichloroethane	1.0 U		1.0
		Carbon tetrachloride	1.0 U		1.0
		Benzene	1.0 U		1.0
		1,2-Dichloroethane	1.0 U		1.0
		Trichloroethene	1.0 U		1.0
		1,2-Dichloropropane	1.0 U		1.0

A method blank can validate more than one analyte on more than one work order. The method blanks in this report may validate analytes not determined on this work order, but nonetheless determined in the associated blank.

Because they validate more than one work order, method blank results are not always reported in the same concentration units or to the same detection limits that are used for sample results.

* = blank exceeds control limit

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Quality Control Report
Method Blanks for Work Order 9501827

Blank Name	Samples Verified	Test Description	Result		Units	Control Limit
		Bromodichlormethane	1.0 U			[illegible]
		2-Chloroethyl vinyl ether	5.0 U			[illegible]
		cis-1,3-Dichloropropene	1.0 U			1.0
		4-Methyl-2-pentanone	2.0 U			2.0
		Toluene	1.0 U			[illegible]
		trans-1,3-Dichloropropene	1.0 U			[illegible]
		1,1,2-Trichloroethane	1.0 U			1.0
		Tetrachloroethene	1.0 U			[illegible]
		2-Hexanone	1.0 U			[illegible]
		Dibromochloromethane	1.0 U			1.0
		Chlorobenzene	1.0 U			[illegible]
		Ethylbenzene	1.0 U			[illegible]
		m,p-Xylenes	1.0 U			1.0
		o-Xylene	1.0 U			1.0
		Styrene	1.0 U			[illegible]
		Bromoform	1.0 U			[illegible]
		1,1,2,2-Tetrachloroethane	1.0 U			1.0
B020795_MSV_S01	1-4	Monobutyltin trichloride	56 U		ug/kg	[illegible]
		Dibutyltin dichloride	28 U			[illegible]
		Tributyltin chloride	22 U			22
		Tetrabutyltin	22 U			22
B020795_MSV_S03	1-4	Phenol	40	*	ug/kg	[illegible]
		Aniline	170 U			170
		Bis(2-chloroethyl)ether	33 U			33
		2-Chlorophenol	33 U			[illegible]
		1,3-Dichlorobenzene	33 U			[illegible]
		1,4-Dichlorobenzene	33 U			33
		Benzyl Alcohol	33 U			[illegible]
		1,2-Dichlorobenzene	33 U			[illegible]
		2-Methylphenol	33 U			33

A method blank can validate more than one analyte on more than one work order. The method blanks in this report may validate analytes not determined on this work order, but nonetheless determined in the associated blank.

Because they validate more than one work order, method blank results are not always reported in the same concentration units or to the same detection limits that are used for sample results.

* = blank exceeds control limit

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Quality Control Report
Method Blanks for Work Order 9501827

Blank Name	Samples Verified	Test Description	Result	Units	Control Limit
		Bis(2-chloroisopropyl)ether	33 U		33
		4-Methylphenol	160	*	33
		N-Nitroso-di-n-propylamine	33 U		33
		Hexachloroethane	67 U		67
		Nitrobenzene	33 U		33
		Isophorone	33 U		33
		2-Nitrophenol	33 U		33
		2,4-Dimethylphenol	33 U		33
		Benzoic Acid	830 U		830
		Bis(2-chloroethoxy)methane	33 U		33
		2,4-Dichlorophenol	67 U		67
		1,2,4-Trichlorobenzene	33 U		33
		Naphthalene	33 U		33
		4-Chloroaniline	33 U		33
		Hexachlorobutadiene	33 U		33
		4-Chloro-3-Methylphenol	67 U		67
		2-Methylnaphthalene	33 U		33
		Hexachlorocyclopentadiene	67 U		67
		2,4,6-Trichlorophenol	67 U		67
		2,4,5-Trichlorophenol	67 U		67
		2-Chloronaphthalene	33 U		33
		2-Nitroaniline	67 U		67
		Dimethyl phthalate	33 U		170
		Acenaphthylene	33 U		33
		2,6-Dinitrotoluene	67 U		67
		3-Nitroaniline	170 U		170
		Acenaphthene	33 U		33
		2,4-Dinitrophenol	330 U		330
		4-Nitrophenol	330 U		330
		Dibenzofuran	33 U		33

A method blank can validate more than one analyte on more than one work order. The method blanks in this report may validate analytes not determined on this work order, but nonetheless determined in the associated blank.

Because they validate more than one work order, method blank results are not always reported in the same concentration units or to the same detection limits that are used for sample results.

* = blank exceeds control limit

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Quality Control Report
Method Blanks for Work Order 9501827

Blank Name	Samples Verified	Test Description	Result	Units	Control Limit
		2,4-Dinitrotoluene	67 U		67
		Diethyl phthalate	33 U		170
		4-Chlorophenyl phenylether	33 U		[illegible]
		Fluorene	33 U		[illegible]
		4-Nitroaniline	67 U		67
		4,6-Dinitro-2-methylphenol	330 U		[illegible]
		N-Nitrosodiphenylamine	33 U		[illegible]
		1,2-Diphenylhydrazine	67 U		67
		4-Bromophenyl phenyl ether	67 U		[illegible]
		Hexachlorobenzene	67 U		[illegible]
		Pentachlorophenol	330 U		330
		Phenanthrene	33 U		33
		Anthracene	33 U		[illegible]
		Di-n-butyl phthalate	8.3 J		[illegible]
		Fluoranthene	33 U		33
		Pyrene	33 U		[illegible]
		Benzidine	830 U		[illegible]
		Butylbenzylphthalate	33 U		170
		3,3'-Dichlorobenzidine	330 U		[illegible]
		Benzo(a)anthracene	33 U		[illegible]
		Chrysene	33 U		33
		Bis(2-ethylhexyl) phthalate	37		1700
		Di-n-octyl phthalate	33 U		[illegible]
		Benzo(b)fluoranthene	33 U		[illegible]
		Benzo(k)fluoranthene	33 U		33
		Benzo(a)pyrene	33 U		[illegible]
		Indeno(1,2,3-cd)pyrene	33 U		[illegible]
		Dibenzo(a,h)anthracene	33 U		33
		Benzo(g,h,i)perylene	33 U		33
		Carbazole	33 U		[illegible]

A method blank can validate more than one analyte on more than one work order. The method blanks in this report may validate analytes not determined on this work order, but nonetheless determined in the associated blank.

Because they validate more than one work order, method blank results are not always reported in the same concentration units or to the same detection limits that are used for sample results.

* = blank exceeds control limit

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Quality Control Report
Multi-Component Method Blanks
Surrogate Recoveries for Work Order 9501827

Blank Name	Test Description	Surrogate Compound	Recov	LCL	UCL
B013195_MVO_S01	555MS VOA EPA 8240	d4-1,2-Dichloroethane	99	76	121
		d8-Toluene	99	74	128
		p-Bromofluorobenzene	102	72	118
B020795_MSV_S01	Organotins in Soil - GC/MS	Tripropyltin chloride	80	20	160
B020795_MSV_S03	GC/MS ABNs, LTL surrogate limits	2-Fluorophenol	70	33	115
		d5-Phenol	79	45	112
		d4-2-Chlorophenol	75	41	110
		d5-Nitrobenzene	84	38	117
		2-Fluorobiphenyl	74	47	124
		d4-1,2-Dichlorobenzene	77	43	118
		2,4,6-Tribromophenol	75	30	136
		d14-p-Terphenyl	84	51	135

* = Recovery exceeds control limit

Recov = Percent recovery of surrogate compound
LCL = Lower Control Limit
UCL = Upper Control Limit

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Appendix B

MS/MSD, MS/Dup and Duplicate Report

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Chemistry, Microbiology, and Technical Services

Quality Control Report
MS/MSD Report for Work Order 9501827

MS/MSD Name	Sample Fractions Verified	MS/MSD Sample	Analyte	Percent Recovery MS	MSD	RPD	Cont. Limits LCL	UCL	RPD
K013195_MVOS01	1-4	9501825-01	1,1-Dichloroethene	123	125	1	30	160	10
			Trichloroethene	102	102	0	65	146	10
			Benzene	96	98	3	63	141	10
			Toluene	96	97	1	62	148	10
			Chlorobenzene	96	97	0	61	143	10
K020395_CNS01	1-4	9501827-01	Cyanide	84	108	25	50	150	30
K020795_MSVS01	1-4	9501827-02	Monobutyltin trichloride	12*	18 *	42	20	160	50
			Dibutyltin dichloride	84	92	8	20	160	50
			Tributyltin chloride	82	78	5	20	160	50
			Tetrabutyltin	77	78	2	20	160	50
K020795_MSVS02	1-4	9501827-03	Phenol	80	74	7	41	109	28
			2-Chlorophenol	81	72	12	40	106	30
			1,4-Dichlorobenzene	78	67	15	34	107	36
			N-Nitroso-di-n-propylamine	103	92	11	48	118	28
			1,2,4-Trichlorobenzene	86	74	16	40	121	30
			4-Chloro-3-methylphenol	98	88	10	55	120	22
			Acenaphthene	81	76	6	41	122	42
			4-Nitrophenol	73	80	9	23	143	37
			2,4-Dinitrotoluene	82	79	4	32	127	25
			Pentachlorophenol	81	82	1	20	159	43
			Pyrene	99	96	3	25	141	50
K022395_FAAS01	1-4	9501827-01	Tin	15*	14 *	4	50	150	30

* = Value Exceeds Control Limit
RPD = Relative Percent Difference
LCL = Lower Control Limit
UCL = Upper Control Limit
-1 for recovery value indicates that recovery could not be calculated

An MS/MSD pair can validate the results for more than one work order. For this reason, results for analytes not requested on this work order may appear in this MS/MSD report.

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Chemistry, Microbiology, and Technical Services

Quality Control Report

Matrix Spike/Duplicate Report for Work Order 9501827

MS/Dupe Name	Sample Fractions Verified	Sample	Analyte	RPD	MS Recov	Cont. Limits RPD	LCL	UCL
M020795_TOCS02	1-4	9501728-21	Total Organic Carbon	8.8	98	20	50	150

* = Value Exceeds Control Limit
RPD = Relative Percent Difference
LCL = Lower Control Limit
UCL = Upper Control Limit
L = RPD control limit for this analyte is 5x the detection limit. The value appearing in the RPD column is the absolute difference of the duplicates.
-1 for recovery value indicates that recovery could not be calculated

An MS/Duplicate pair can validate the results for more than one work order. For this reason, results for analytes not requested on this work order may appear in this MS/Duplicate report.

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Chemistry, Microbiology, and Technical Services

Quality Control Report
Duplicate Report for Work Order 9501827

Duplicate Name	Sample Fractions Verified	Sample	Analyte	RPD	Limit
D020895_TSM01	1-4	9501827-01	Total Solids	0.25	30
D022395_ICPS01	1-4	9501827-01	Iron	0	30

* = Value Exceeds Control Limit
RPD = Relative Percent Difference
L = RPD control limit for this analyte is 5x the detection limit. The value appearing in the RPD column is the absolute difference of the duplicates.
-1 for recovery value indicates that recovery could not be calculated

A duplicate pair can validate the results for more than one work order. For this reason, results for analytes not requested on this work order may appear in this duplicate report.

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Appendix C

Blank Spike Recovery Report

Laucks Since 1908
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Chemistry, Microbiology, and Technical Services

Quality Control Report
Blank Spike Report for Work Order 9501827

Blank Spike Names Database	Lab Assigned	Fractions Verified	Analyte Name	Recov	LCL	UCL
S020795_MSVS01	S0207ORTSLA	1-4	Dibutyltin dichloride	86	20	160
			Monobutyltin trichloride	46	20	160
			Tetrabutyltin	70	20	160
			Tributyltin chloride	86	20	160
S022395_FAAW01	B0223_AA01	1-4	Tin	90	50	150

* = Value Exceeds Control Limit
LCL = Lower Control Limit
UCL = Upper Control Limit

A blank spike can validate the results for more than one work order. For this reason, results for analytes not requested on this work order may appear in this blank spike report.

Laucks Since 1908
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Appendix D

Standard Reference Material Report

Laucks Since 1908
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Chemistry, Microbiology, and Technical Services

Quality Control Report
Standard Reference Material Report for Work Order 9501827

SRM Name	Fractions Verified	Analyte	Result	Units	TV	LCL	UCL
R020695_CNW02	1-4	Cyanide	0.421	MG/L	0.500	0.323	0.639
R020795_HPNS01	1-4	Naphthalene	96.2	UG/KG	80.0	6.11	154
		Acenaphthylene	16.3		62.0	0	136
		Fluorene	140		106	37.2	175
		Acenaphthene	134		101	28.3	174
		Phenanthrene	226		168	0	441
		Anthracene	113		124	0	247
		Fluoranthene	176		149	0	429
		Pyrene	181		136	0	391
		Chrysene	169		137	0	322
		Benzo(a)anthracene	165		120	0	255
		Benzo(b)fluoranthene	132		153	0	637
		Benzo(a)pyrene	150		126	0	291
		Dibenzo(ah)anthracene	170		104	0	223
		Benzo(ghi)perylene	159		86.0	0	238
R020795_TOCS02	1-4	Total Carbon	3.15	%	3.35	2.68	4.02

* = Value Exceeds Control Limit
TV = True Value
LCL = Lower Control Limit
UCL = Upper Control Limit

A Standard Reference Material can validate the results for more than one work order. For this reason, results for analytes not requested on this work order may appear in this SRM report.

ENDORSEMENT LETTER FROM ENVIRONMENTAL PROTECTION DEPARTMENT

本署檔號
OUR REF: EP 2/N9/46
來函檔號
YOUR REF: NRT/PS/0791/0/201
電話
TEL. NO: 2835 1105
圖文傳真
FAX NO.: 2591 0558

Hong Kong Government
Environmental Protection Department
Headquarters
28th Floor, Southern Centre,
130 Hennessy Road,
Wan Chai, Hong Kong.

環境保護署總部
香港灣仔
軒尼詩道
一百三十號
修頓中心廿八樓

094532

Fax: 2601 3988

23 Oct 1995

ACTION REQUIRED BY	C PS
FILE	
REPLY	
TO SEE	

Binnie Consultants Limited
11th Floor, New Town Tower,
Pak Hok Ting Street, Shatin,
New Territories, Hong Kong

Attention: Mr. N.R. Townsend

Dear Mr. Townsend,

Agreement No. CE 45/93
Reclamation for Shipyard at To Kau Wan, North Lantau
EIA for Operation Phase

I refer to your letter dated 31 August 1995 and the 'Second Response to Comments' related to the captioned development. I would like to confirm that the EIA report is considered endorsed by the SMG subject to the following:

i. Amendments as proposed in the 'Second Response to Comments'

ii. Incorporation of further amendments to para. B2.55 and EM&A manual for both shipyard construction and operation phases, as given in CED's letter dated 11.9.95 (re:(55) in PD CV/94/07).

iii. Revise or incorporation of amendments to Chapter 4 of the final report to take into consideration of suitable mitigation measures on landscape treatment to enable the external appearance of the area look more harmonious with the natural environment.

Thanks for your effort in finalising the report.

(Alan Au)
Ag. Senior Environmental Protection Officer
for Director of Environmental Protection

cc.	CEO, CED	(Attn: Mr C.H. Lam)
	AFD	(Attn: Mr Y.K. Chan)
	PD/LFC, HyD	(Attn: Mr D.S. Paterson)
	PGGE, GEO, CED	(Attn: Mr J.B. Massey)
	DO/TW	(Attn: Ms E. Leung)
	DLO/TW	(Attn: Ms D. Bleach)
	PlanD	(Attn: Mr Fonnie Hung)
	S(AA)3, S(WP)4, S(AP)2, S(NP)1, E(AA)9	

RESPONSES TO COMMENTS

Contents

A. Director of Environmental Protection, Environmental Protection Department

Comment	Response
Letter dated 27th June 1995 (ref: f(32) in EP 2/N9/46 dated 27th)	
<u>Executive Summary</u>	
i. A typing error of ".... is likely to <u>effect</u> ..." should be "affect" in paragraph 6 of page S2.	The text has been corrected.
<u>Responses to Comments</u>	
i. <u>Table 6.9 & 6.10</u>	
The dust emitted from the construction activity will consist of particulate sizes ranging from down to 1 μm to up to 100 μm. For each class of particulate size, there should be value for the mass fraction. In determining the dust impact due to the construction activity, the predicted TSP and RSP dust concentration should be determined from the same set of source data (emission strength and size distribution). The methodology used by the consultants is not correct as it is inappropriate to assume all the dust particles to have 30 μm for TSP and all the dust particles to have 100 μm for TSP and all the dust particles to have 10 μm for RSP.	As stated previously we do not believe the second method to be the correct way of assessing dust. Our assessment did not depend on Tables 6.9 and 6.10. The tables were included so that a report existed comparing the two methods. As mention of Option 2 has caused confusion all references to it have been removed from the text.
ii. <u>Section 7.67</u>	
It is often difficult to completely avoid generate any acidic waste produced by sample preparation (i.e. acid digestion) for AAS analyses. In case acidic waste is indeed arisen from the operation of the laboratory and fall into the classification of chemical waste, dilution and mixing of the waste with other effluent generated at the site is clearly not an acceptable disposal option.	By comparing the laboratory with other larger laboratories undertaking similar work we estimate it would take one to two years to fill a 30 litre Environpace container with acidic wastes. On average the generation of waste is less than 2 l/mth of diluted acidic solutions. It has no effect on the acidity of the waste water. The text has been changed. The acidic waste will be treated as Chemical Waste.
iii. <u>Section 8.40 - Waste Oil</u>	
It seems that the CLS has been practising some extent of "on-site" recycling of waste oil. Nonetheless, it is not clear whether or not such recycling activities can absorb all the waste oil generated at the site. In case there is a surplus of waste oil, the shipyard's operator should ensure that it is either sent to external waste oil collectors for subsequent recycling or is disposal through appropriate facilities (e.g. CWTC).	The text has been changed to make the meaning clearer.

Comment	Response
iv. Section 10.47	
Please incorporate a Complaint Handling Flow Chart as previously suggested.	A flow chart has been incorporated within the manuals.
v. Section 10.91 and para. A7.29	
The text should read as "Reports on Public Health and Medical Subjects No. 71".	This change in the text has been made and appears in the manuals.
EM&A Manual - Shipyard Construction	
i. General & Point 7 of Section A4.5	
The Manual covers the mandatory requirements of EM&A during the construction works. Therefore, any proposed amendment on it should be subject to the agreement of DEP. This point should be highlighted in the manual. Point 7 of section A4.5 should be revised accordingly.	The text has been amended.
ii. Section A4.7	
The Environmental Management Team (EMT) should be able to audit the monitoring data immediately after it becomes available such that the EMT can take necessary actions to mitigate any water quality impacts arising during the construction. If the monitoring data was only passed to the EMT on a monthly basis, it would not facilitate the EMT to act in accordance with the Event Action Plan in case of exceedance of TAT levels.	The text of A4.7 has been amended to ensure that the urgency of making data available to the EMT is made clear.
This section should be revised to clarify clearly how the monitoring data being handled. A time limit for such data handling is necessary. It is highly preferred that the in-situ measured data should reach EMT within 24 hours after the measurement and SS results should be passed to EMT once they are available.	Agreed.
iii. Figure 4.1 and 4.2 of construction phase	
Both figures should be further improved to include the contact person with telephone number and the post, which are highly useful to facilitate the communication. As we understand that some of the related parties are unknown, notes can be added to indicate to fill in the information in future. Moreover we would prefer the Figures being rearranged in a way of "top down" approach.	The figures 4.1 and 4.2 have been amended.

Comment	Response
iv. Section A4.8	
The format of the regular monthly report should be agreed with DEP prior to the issue of the report. Monthly reports should be prepared each month during the construction and submitted to DEP for comments. The reports should contain but not limit an executive summary of the activities, exceedance of TAT levels, causes of exceedance and mitigation measures being taken; all monitoring data with the information indicating the sampling/measurement location, time and weather conditions; detailed description of the findings from auditing of monitoring data, exceedances and actions taken; any complaints with details of investigation results, actions taken and replies to complainant(s).	Section A4.10 has been added.
Following exceedance of the Target level by any parameter for more than two consecutive days, a report should be made to EPD giving details of raw monitoring data, mitigation measures implemented so far and the proposed actions to ensure that reoccurrence will be prevented.	Table 4.1 has been amended to ensure this action will be undertaken.
v. Section A4.9	
It should ensure that one copy of the monthly report should be submitted to Water Service Group of EPD for comments and retention.	More than one copy will be sent to EPD.
vi. Table 4.1 of construction phase	
For the exceedances of Action Level, the Monitoring Team (MT) have to repeat measures to confirm finding on the next day of the exceedance. If two consecutive exceedances of Action Level are observed, the MT should prepare to increase the monitoring frequency.	Agreed. Table 4.1 has been amended.
Please revise point 6 for the event of two consecutive exceedances of Target level in accordance with the comments on section A4.8.	Point 7 has been added.
Please replace all "Identify source" by "Identify source(s) of impacts".	The text has been corrected.

Comment		Response
vii.	<u>Section A5.3, A5.12 & A5.14</u>	
	Dissolve oxygen saturation (%) of marine water should also be measured and reported. The measurement of pH is not a good indicator for the likely impacts that the project may have effect on the water quality such that it should not be applied to marine water. Please revise these sections accordingly.	The text of A5.3, A5.13 and A5.15 has been checked or revised.
viii.	<u>Section A5.19</u>	
	The baseline monitoring shall be 4 days per week for 3 consecutive weeks. Moreover, the proposed monitoring frequency is too low to pick up the likely water quality impacts. Three days per week is the normal requirement of water quality monitoring. As the EIA prediction of less impact on water quality, the consultant may propose, subject to agreement with DEP, to reduce the monitoring frequency after a period of monitoring which demonstrates an acceptable level of water quality, e.g. no exceedance of Action and Target levels.	The text of A5.20 has been amended.
ix.	<u>Section A5.20</u>	
	For a project with long duration, it should include at least two control station (one upstream and one downstream) to take account the natural fluctuation of the water quality. For this case, additional two control stations are required. The control stations should be located in the same water body of the monitoring stations but outside the affected region of the site and other marine activities. The consultant can make proposal for our approval. TAT levels in section A5.21 should be amended accordingly. Appendix A of this memo illustrates typical TAT levels normally be followed.	Table 5.1 (now 5.2) has been amended and two tables have been added. Two control stations are shown in Figure 5.2 and the new Table 5.1.
x.	<u>Section A7.23</u>	
	WPCO discharge licence is required for the effluent discharged from the sewage treatment plant. The monitoring should be started contemporaneously with the commencement of the discharge.	This section is not applicable to the Construction stage and has been removed.

Comment		Response
xi.	Section A7.24	
	Discharge from the laboratory, electroplating and ship manufacturing should only be allowed after the WPCO discharge licences are granted. At that stage, the shipyard shall be considered under operation. The consultant should review whether it is necessary to require water quality monitoring for such effluent discharged during the construction phase.	This section is not applicable and has been removed and all those following it.
EM&A Manual - Shipyard Operation		
i.	Please clarify whether the Engineer/ Architect are still available after the construction of the shipyard. Normally, the shipyard owner, presumably Cheoy Lee Shipyard Limited (Cheoy Lee), shall operate the shipyard and shall be responsible for the related environmental issues. Cheoy Lee shall be in the position to establish an "Environmental Control Team" being responsible for the duties stated in section B4.1 to B4.18. The consultant should have a review on the arrangement of the monitoring and make suitable revision to take account it.	It is not known whether the Engineer/Architect will definitely be available. Section B4 and Figures 4.1 and 4.2 have been amended.
ii.	Concerning the monitoring approach, it is considered as inappropriate to adopt the likely same approach designed for the construction phase monitoring. The monitoring should focus at the compliance of WPCO and TM especially for the effluent discharged.	This section is unnecessary and confusing. It has been removed.
iii.	It is missing those important sections of the sampling methods (e.g. fixed interval sampling, volume proportion sampling, grabbed sampling and etc.), monitoring frequency and report format.	Sampling is now discussed in B5.7.
iv.	Section B2.2	
	Possible impacts arising from shipyard operation and the corresponding mitigation measures should also be included in this section. It should not limit the content to Chapter 1 of the EIA.	The text has been amended.

Comment		Response
v.	<u>Section B3.2</u>	
	Please clarify for what baseline monitoring is proposed, marine water or effluent discharged. As specified in para. 19, the monitoring at operational phase should focus at the compliance of WPCO and TM. Moreover, no baseline monitoring is required for monitoring of effluent discharged.	As no baseline or control monitoring is necessary B3.2 has been removed.
vi.	<u>Figure 4.1 and 4.2 of shipyard operation</u>	
	Figures should be revised to be in line with the general comments above.	These Figures have been amended.
vii.	<u>Section B4.19 and Section B5.21</u>	
	The TAT levels are considered not appropriate with the following reasons: the values are created not based on actual characteristics of the effluent discharged; the ranges between each level are too narrow to facilitate an alarm function and activate proactive actions; the TAT levels of pH is incorrect that lower and upper limits are required (the discharges standard for pH is 6 to 9). I suggest not to use the TAT levels approach for operational monitoring. Discharge limit should be set up according to TM. The consultant may consider to observe the characteristic of the effluent discharged and set up alarm limits for proactive actions, e.g. based on statistic data. Please review these sections, the TAT levels and the Action/Event Plan to incorporate the above comments.	Only action and target levels will be used. B4.19 has been amended.
viii.	<u>Section B5.8, 5.13 to B5.17</u>	
	Testing methods for monitoring parameters of the effluent discharged should be in line with TM in which APHA 17ed is normally referred.	The text has been changed. All references to APHA 18ed have changed to APHA 17ed.

Trigger, Action and Target Levels

Parameters	Trigger	Action	Target
Dissolved Oxygen, DO mg/L (Surface, Middle & Bottom)	Surface & Middle: DO < 5%-ile of baseline data for surface and middle layer Bottom: DO < 5%-ile of baseline data for bottom layer	Surface & Middle: DO < 1%-ile of baseline data for surface and middle layer Bottom: DO < 1%-ile of baseline data for bottom layer	Surface & Middle: < 4 mg/L Bottom: < 2 mg/L
Suspended Solid, SS mg/L (depth-averaged)	SS > 90%-ile of baseline data and SS > 110% upstream control station's SS a the same tide of the same day	SS > 90%-ile of baseline data and SS > 120% upstream control station's SS at the same tide of the same day	SS > 99%-ile of baseline data and SS > 130% upstream control station's SS at the same tide of the same day
Turbidity, Tby, NTU (depth-averaged)	Tby > 90%-ile of baseline data and Tby > 110% upstream control station's Tby at the same tide of the same day	Tby > 95%-ile of baseline data and Tby > 120% upstream control station's Tby at the same tide of the same day	Tby > 99%-ile of baseline data and Tby > 130% upstream control station's Tby at the same tide of the same day

B. Chief Engineer/Port Development, Civil Engineering Office, Civil Engineering Department

Comment	Response
Fax dated 20th June 1995 (ref: ( ) in PD CE 45/93 Pt.5)	
I have the following comments on the 'Draft Executive Summary and Response to Comments' Report attached to your letter of 7.6.95.	
a) Page S-1, 8th Para.	
i) 5th line - Add 'as' between 'considered' and 'an'.	The text has been amended.
ii) Please clarify the area 'where future land use will be industrial'.	The text has been amended.
b) Page 19, Section H	
i) Para 1 a(ii) - 'Figure 6.2' in line 2 should be 'Figure 6.1'.	The text has been amended.
ii) The comments contained in paras 1(d) - 1(h) inclusive of my letter dated 27.3.95 together with your responses to the comments are missing.	Please see below.
Letter dated 27th March 1995 (ref. ( ) in PD CE 45/93 Pt.5)	
d. Section 1.35, 3rd line	
Should this read '1,600,000 m^3 each of soil and rock excavation'?	The text has been amended.
e. Section 1.39	
Replace "barriering" with "barrier".	The text has been amended.
f. Section 7.49	
i) The first sentence should be revised to read as '.... for construction of buildings 380 days after commencement of the works, which started on 23rd December 1994'.	The text has been amended.
ii) Delete the sentence 'Dredging began in January 1994'.	The text has been amended.
g. Section 7.128	
The effect of the expected higher levels of E.Coli, Nitrogen and Phosphate should be addressed.	The effect of higher levels of nutrients is discussed under marine ecology. The text has been amended to emphasize the necessity of meeting the TM.

Comment	Response
h. <u>Section 10.98, 10.100 - 10.106 inclusive</u> As stated in Section 1, the To Kau Wan site is for the possible re-provisioning of Cheoy Lee Shipyard. It should be more appropriate to replace 'Cheoy Lee Shipyard Limited' by 'The shipyard operator'.	 The text has been amended.

C. **Project Director/Lantau Fixed Crossing**

Comment	Response
Memo dated 29th June 1995 (ref: ( ) in HyFX 5/8/1) I refer to your above quoted memo dated 12 June 1995 seeking endorsement of the EIA draft final report.	
2. I do not feel that this office is in a position to endorse the report as its involvement and comments have generally only concerned the interaction/interface of this proposed shipyard with the Lantau Toll Plaza.	Noted.
3. I can say however that the report adequately deals with the interface between the toll plaza and future port development and that I have no further comments to make on the Draft Final Report or Executive Summary and Responses to Comments.	Thank you.

D. District Officer (Tsuen Wan)

Comment	Response
Letter dated 12th June 1995 (ref: (18) in TW D/3/40 Pt. 36) We have no comment on the Executive Summary and Responses to Comments.	 Thank you.

E. District Lands Officer, Tsuen Wan

Comment	Response
Letter dated 13th June 1995 (ref: (36) in DLO/TW L/M 3 in 4/155/92 III)	
I have no comment on the "Executive Summary and Responses to Comments" and "Draft Environmental Impact Assessment" forwarded with your letter of 7 June.	Thank you.

F. Project Director/Lantau Fixed Crossing

Comment	Response
Letter dated 12th June 1995 (ref: HyFX 5/8/1) I refer to your above quoted letter and Draft Executive Summary and Responses to Comments dated 7 June 1995. I have no further comments to make.	Thank you.

G. Principal Government Geotechnical Engineer, Geotechnical Engineering Office, Civil Engineering Department

Comment	Response
Memo dated 12th June 1995 (ref: ( ) in CED TG 2/3/35) This Office has no comments on the captioned report.	Thank you.

H. District Officer (Tsuen Wan)

Comment	Response
Memo dated 12th June 1995 (ref: (22) in TW D/3/40 Pt. 36) We have no further comments and agree to endorse the report.	 Thank you.

I. **Director of Agriculture & Fisheries**

Comment	Response
Memo dated 12th June 1995 (ref: (74) in AF DVL 13/41/3) Thank you for your memo under reference. I have no objection to endorsing the captioned report.	 Thank you.

J. Chief Engineer/Port Development, Civil Engineering Department

Comment	Response
Fax dated 11th September 1995 (ref: PD CV/94/07)	
<u>EM&A Manuals for Shipyard Construction Phase</u>	
Figures 4.1 and 4.2 are applicable to the shipyard operation phase and should be transferred to the EM & A manual for the same phase. Similarly, Figures 4.1 and 4.2 under EM & A manual for operation phase should be transferred to that for the construction phase.	Noted. This has been corrected in the final report.
<u>Para B2.55, Page B-18</u>	
I understand from Highways Department that the sewage from the Lantau Fixed Crossing Toll Plaza is now being planned to be discharged directly to the sea via drains located to the south of Yiu Lian Dockyard (YLD) instead of between YLD and the To Kau Wan site. This paragraph should be amended to take account of the above comments.	Noted. Text has been changed in the final report.

K. District Planning Officer/Lantau & Islands, Planning Department

Comment	Response
Memo dated 14th September 1995 (ref: (23) in LI/L/GEN/62 III)	
(a) Chapter 4 - Visual Impact	
I would recommend that as mitigation measures or design guidelines, landscape treatment should be provided in designing the facilities to enable the external appearance of the area look more harmonious with the natural environment.	Noted. The text has been amended.
(b) Chapter 10 - EM&A	
In connection with (a) above, it is suggested that the requirement of submission of landscape treatment proposal should be included in the EM&A. Further detail comments on landscape mitigation measures will be provided when a landscape proposal is submitted.	The EM&A Manual has been divided into two separate documents. A landscape proposal does not need to be submitted.