Territory Development Department
Urban Area Development Office

West Kowloon Reclamation

Construction Environmental Impact Assessment Report

January 1991

Mott MacDonald Hong Kong Ltd.
in association with
L.G. Mouchel & Partners (Asia)
Urbis Travers Morgan Ltd.
ERL (Asia) Ltd.
MVA Asia
Dredging Research Ltd.
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1. Introduction

WEST KOWLOON RECLAMATION

CONSTRUCTION ENVIRONMENTAL IMPACT ASSESSMENT REPORT

1. INTRODUCTION

Background and Structure of the EIA

1.01 The Government of Hong Kong intends to reclaim 330 ha of land from the sea between Stonecutters Island and the western coastline of the Kowloon Peninsula. The proposed reclamation, as illustrated in Fig 1, will extend westwards beyond the existing waterfront by between 500 and 1,200 metres.

1.02 As part of the Design Study for the West Kowloon Reclamation (WKR) the consultants are required to carry out an Environmental Impact Assessment (EIA) study. In order to be compatible with the tight project timescale the first phase of the EIA is confined to considering the environmental impacts associated with the construction phase of the project only. Impacts arising from the operation of the WKR will be considered and incorporated into an Environment and Planning topic report, to be produced later in the Study.

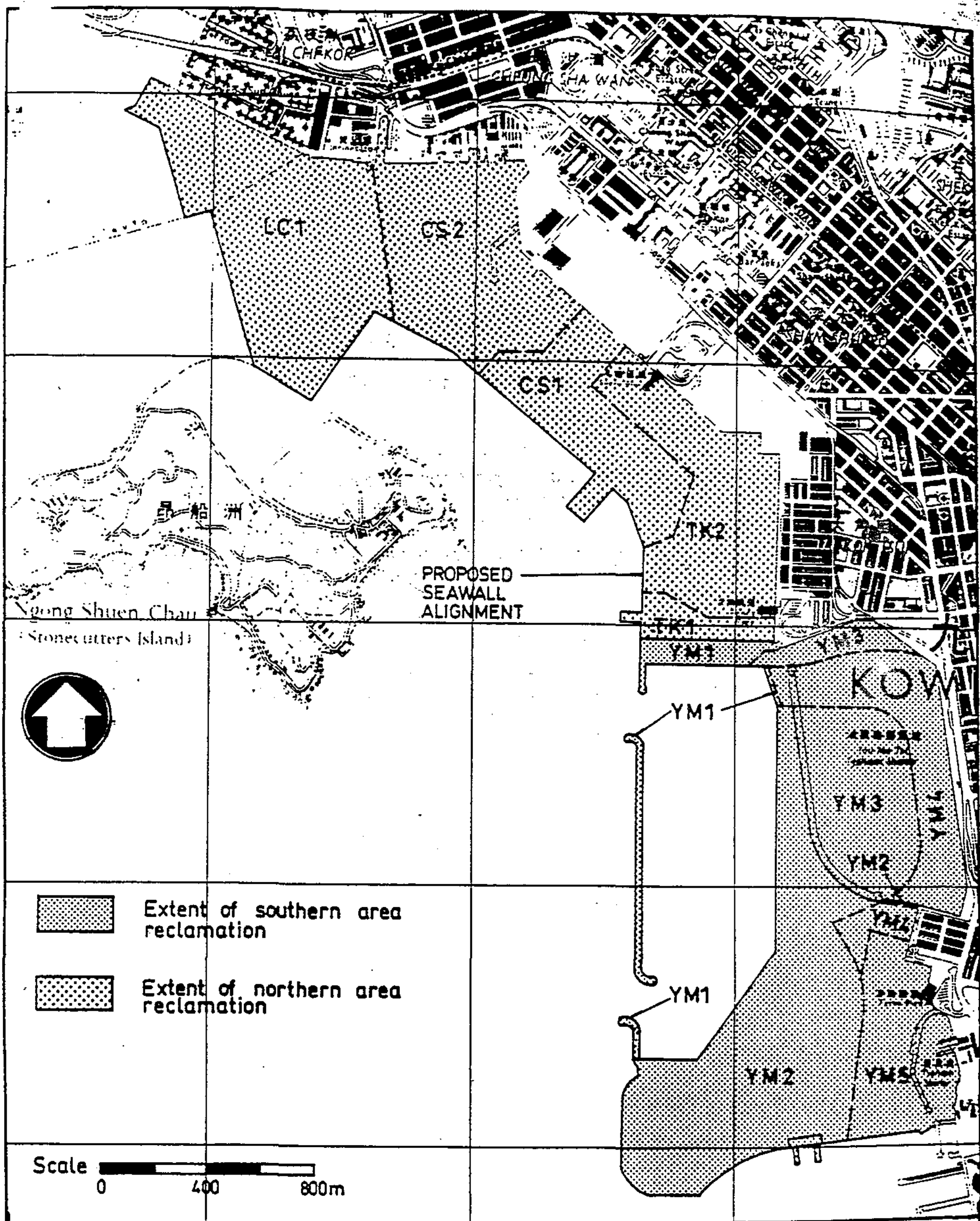
1.03 The management of the West Kowloon Reclamation is undertaken by the Urban Area Development Office (UADO) and an Environmental Working Group has been established, under the chairmanship of the Environmental Protection Department (EPD), to consider the findings of the EIA study.

Purpose of the Report

1.04 The purpose of this Report is to present the findings of the construction EIA Study with regard to the nature and extent of impacts arising as a result of activities associated with the construction phase of the WKR. This includes activities associated with the following :

- o The removal of marine sediments and their subsequent disposal.
- o Seawall construction.
- o The removal of fill from marine and land borrow areas.
- o The placement of fill and formation of the reclamation.
- o The reprovisioning of activities on the new waterfront.
- o The refurbishment of the sewerage system in the West Kowloon hinterland.

1.05 The EIA is intended to establish the extent of potential impacts within the scope of the Brief in order to achieve the following aims :



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WEST KOWLOON RECLAMATION

FIG. 1 -

KEY PLAN

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Scale 1 : 20 000

Sketch No. 285/E/SK/042

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- The recommendation, where necessary, of appropriate and cost effective mitigation measures, to ensure that impacts are reduced to acceptable levels.

- Recommendations for the inclusion of clauses in tender and contract documents to ensure the implementation of such measures.

- The specification of environmental monitoring and audit programmes that will enable the effectiveness of mitigation measures to be determined.

Scope and General Approach

1.06 The construction EIA considers the following key areas of potential impact:

- Noise emitted from plant used for dredging, reclamation and other construction works together with associated road traffic noise.

- The effect on air quality resulting from dust and black smoke generated by construction activities.

- The effect on water quality resulting from construction activities, the phasing of the reclamation and other works in the vicinity, including the West Kowloon Sewerage scheme.

- The effect on water quality of dredging and subsequent disposal of marine sediments.

1.07 The impacts associated with noise and dust emissions are assessed in terms of their predicted effect on sensitive receptors identified in the West Kowloon hinterland. In addition, the effect on activities that are reprovisioned to the WKR early, from other continuing parts of the reclamation, are also considered. Reference is made to Acceptable Noise Levels (ANL) identified in the Noise Control Ordinance, and to Air Quality Objectives (AQO) as contained in the Air Pollution Control Ordinance.

1.08 Water Quality impacts are assessed for the body of water lying between Stonecutters Island and the West Kowloon peninsula, in relation to the requirements for the Victoria Harbour Water Quality Control Zone and associated beneficial uses. Impacts associated with the disposal of marine sediments are assessed (in the absence of any other guidelines) in relation to the Guideline Limits developed for Deep Bay although it is understood that these strictly apply solely to Deep Bay[1] and an integrated approach is adopted which considers the affect of sediment movement and disposal on water quality.

(1) ERL (1989) Deep Bay Guidelines for Dredging, Reclamation and Drainage Works for the Environmental Protection Department, Government of Hong Kong 1989.

Report Structure

1.09 The report is organised as follows :-

- **Section 2** contains a description of the proposed development, including the way in which the WKR is planned to integrate within PADS. This Section details the anticipated project programme, with emphasis on the way in which the phasing of the development affects the extent of various environmental impacts. The finished form of the development is also outlined. Finally, the construction activities associated with the formation of the WKR and any associated reprovisioning works are described and the way in which this information forms an input into the prediction of impacts is indicated.

- **Section 3** describes the existing environment of West Kowloon indicating broad divisions between predominantly residential and predominantly industrial land-use. Land uses likely to constitute sensitive receptors of quality, water quality or noise impacts (such as apartment buildings, recreational areas, schools and colleges) are indicated.

- **Section 4** presents the results of work carried out to establish the current baseline environmental conditions, against which the significance of the impacts resulting from construction will be judged. The results of sampling programmes undertaken to provide data on ambient noise levels, water quality and sediment contamination, are discussed whilst ambient air quality is determined by reference to routine air quality data provided by the EPD. Routine sediment and water quality data is also considered in establishing existing conditions in those media. The results of these sampling activities are presented in Annexes B, C and D.

- **Sections 5, 6, 7 and 8** respectively present assessments of the likely extent and significance of noise, air, water and marine sediment related impacts associated with construction at West Kowloon. For each category of impact specific potential sources and receptors, including those newly reprovisioned, are identified, impacts are predicted and available mitigation measures are described. Likely residual impacts taking possible mitigation into account are also stated.

- **Section 9** considers the likely impacts associated with the winning of land sourced fill from the proposed borrow area at Chok Ko Wan Tsui.

- **Section 10** presents the overall conclusions and recommendations of the construction EIA, including the likelihood and significance of impacts, and the need for and likely effectiveness of various mitigation measures.

- **Annex A** contains details of areas of West Kowloon potentially sensitive to construction related impacts.

- **Annex B** contains supporting information relevant to the assessment of noise impacts.

- **Annex C** contains supporting information relevant to the assessment of water quality impacts.
- **Annex D** contains the results of the marine sediment sampling programme.
- **Annex E** contains monitoring and audit requirements for the WKR.
- **Annex F** contains suggestions for contract clauses to ensure that mitigation measures are implemented.

2. The Proposed Development

2. THE PROPOSED DEVELOPMENT

Introduction

2.01 This section of the Report outlines the reasoning behind the development of the WKR, the expected time scale and the final appearance of its finished form. The activities associated with the construction of the reclamation and reprovisioning of various waterfront activities are then presented. These activities form the major input into subsequent Sections of the Report which consider the prediction of impacts.

The West Kowloon Reclamation (WKR) within PADS

2.02 The WKR falls within the framework of the Port and Airport Development Strategy (PADS). The purpose of PADS is to secure for Hong Kong, an adequate infrastructure system for 1997 and beyond. With the choice of the site for a new airport at Chek Lap Kok, the need arose to provide adequate transport links to the metropolitan area. The WKR will create the necessary land area to support an expressway link from the airport, and a rail link.

2.03 A number of other developments associated with PADS are the subject of ongoing studies, as follows:

- o North Lantau Transport Study.
- o Lantau Fixed Crossing.
- o West Kowloon Expressway.
- o Airport Railway.
- o Western Harbour Crossing.
- o Route 3.

2.04 The findings of this Report should be considered in parallel with the conclusions from the above mentioned studies, as together they will form a band of development that will stretch from north Lantau to Hong Kong Island via the West Kowloon Reclamation.

2.05 The need for the WKR, therefore, is in part to provide sufficient land area to support the West Kowloon Expressway (WKE) and the Airport Rail Link. In addition, it is intended under Metroplan that the reclamation will provide space for relieving some of the existing environmental problems associated with overcrowding and industrial/residential land use conflict in areas of West Kowloon. In particular to improve areas where industrial/residential use conflict exists.

Project Programme

2.06 The timing of the construction programme is constrained by the need to complete the reclamation in time to allow other PADS-related developments to proceed. In particular, the WKR needs to be available for the construction of the WKE and airport railway by mid-1993. This is in order that these transport links can be completed by the time that the new airport is due to open in 1997.

2.07 The phases of the reclamation have been programmed to enable the reprovisioning of certain existing waterfront facilities onto the new waterfront whilst incurring as little interference with these activities as possible. Among such activities are the Hong Kong Ferry piers at Tai Kok Tsui and Sham Shui Po, the CRC pier and go-down, a number of wholesale markets, the shipyards at Cheung Sha Wan, the public cargo working area at Yau Ma Tei and the Government Dockyard, currently located at the Camber Typhoon Shelter. Full details of the activities to be reprovisioned and their present and future locations, can be found in the WKR study Civil Engineering Report.

2.08 The phasing by which the reclamation will occur is indicated in Figure 2.1. From this it can be seen that the first contract to be let in the north of the reclamation will be for the completion of stages TK1, CS1 and LC1(1). This formation will permit the reprovisioning of activities to the new waterfront whilst maintaining access to the old waterfront sites.

2.09 Once the first phases of the reclamation and associated reprovisioning are complete, the later stages can proceed. In the north of the reclamation this will consist of stages TK2, CS2 and the remainder of LC1, the LCII portion. In the south, the first contract, for the construction of the replacement typhoon shelter breakwater and wall has already been let. The next contract to proceed will be for the area S2 as shown in Figure 2.1.

2.10 The timing and the shape of the reclamation phases will have a marked effect on the extent of some impacts, in particular those associated with water quality. In addition, the reprovisioning of certain activities to the reclamation before reclamation work is completed, raises the possibility of construction impacts affecting these activities.

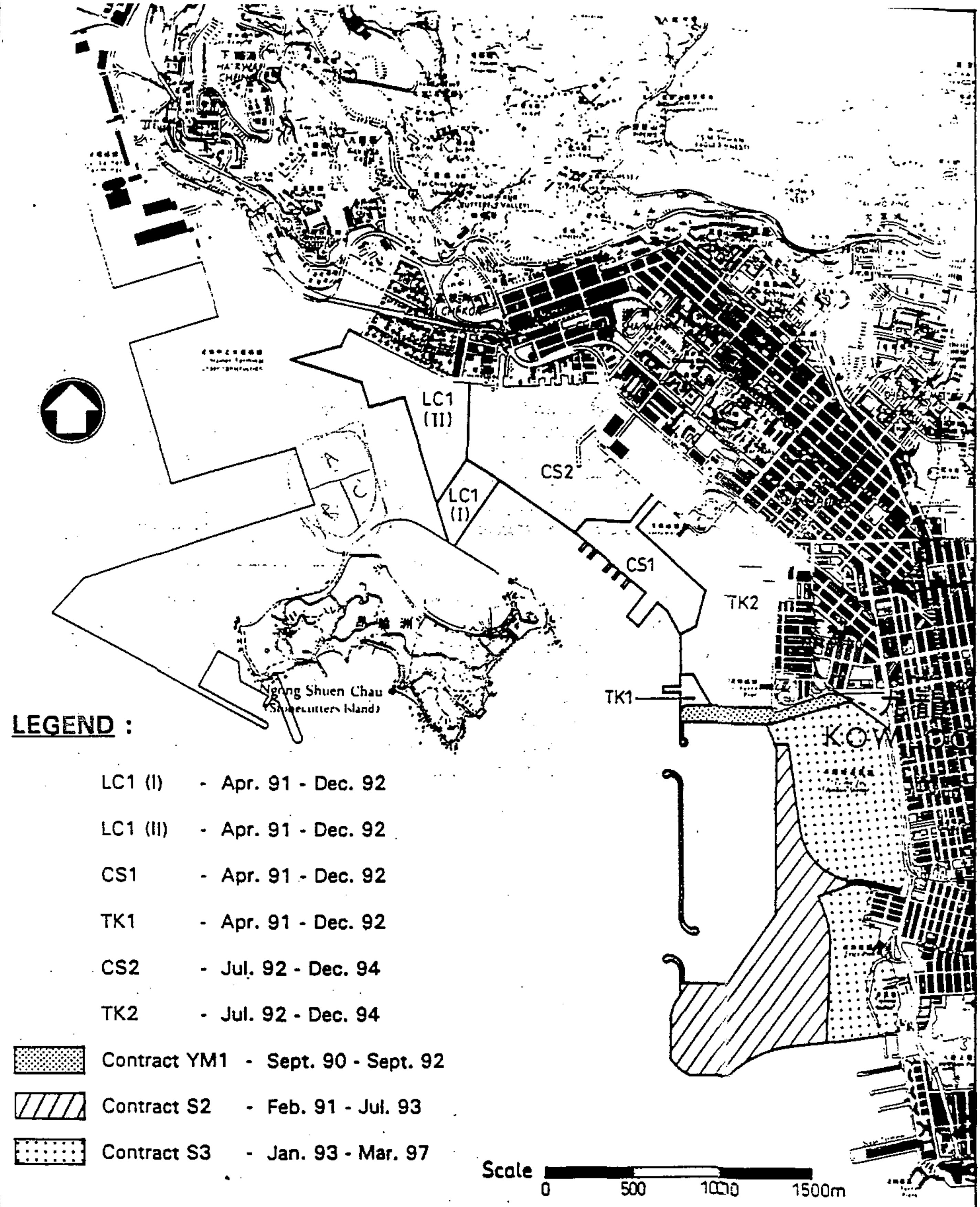
2.11 It should be noted that design of the northern section of the WKR has been undertaken by Mott McDonald (HK) Ltd, whilst the southern section is under the control of CESD. The boundary between the two sections lies at Tai Kok Tsui, just south of the existing ferry pier.

Form of the Development

2.12 The final shape of the WKR has implications with respect to the long term water quality of the area. These are discussed in detail in Section 7.

2.13 The environmental consequences of the alignment of the WKE and the airport railway, and their effect upon adjacent land uses are not the subject of this Report. These issues will be considered, at a later date, and will be a major input to the Topic Report on Environment and Planning (TR14), due to be produced in April 1991.

2.14 Whilst the boundary of the WKR is well established, the proposed land use plans are in the process of development. The working assumption, drawn from Metroplan, is that the northern part of the reclamation will be devoted to industrial use and the southern to commercial. It is intended that the central portion should provide space for residential development, in order to relieve some of the existing land use conflicts in West Kowloon. The availability of land for residential use will be largely constrained by the vertical and horizontal alignments of the WKE and the airport railway.. For this reason, the likely impacts from these transport links will be



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WEST KOWLOON RECLAMATION

FIG. 2.1

THE PHASING OF THE WEST KOWLOON RECLAMATION

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predicted and form a major input into the outline development plan.

Construction and Reprovisioning

2.15 A wide range of activities are associated with construction of the reclamation and reprovisioning of waterfront uses. A number of these activities constitute potentially significant sources of noise impact and effects on air and water quality. In the paragraphs that follow, these activities are profiled and their potential to cause a given impact is indicated.

Dredging of Marine Sediments

2.16 In order for the reclamation to proceed according to programme and to minimize the amount of post-completion settlement, it is intended that large volumes of the marine sediments underlying critical areas will be removed. Alternative methods exist, which improve the structural integrity of the marine deposits but associated time penalties are unacceptable in areas required for early development. Although a number of dredging methods are potentially available, it is anticipated that the nature of the site will determine that grab dredgers are used in the northern portion of the reclamation. It is currently intended that trailer suction hopper dredgers will be used in the southern area.

2.17 The process of reclamation requires that a trench be dredged to allow seawall construction to begin. Thereafter, mud removal behind the line of the seawall can commence. It is expected that the bulk of the mud will be sufficiently uncontaminated to obviate the need for special disposal requirements. Certain areas, however, may be contaminated such that the EPD will require special dredging, transport and disposal methods to be implemented. Recommended contract conditions have been developed and are presented in Annex F which, if used, should ensure that these special arrangements are implemented where necessary.

2.18 The potential impacts associated with this activity are indicated below.

Noise : Grab dredgers have a sound power level[1] of 112 dB(A). The anticipated dredging schedule for the north of the reclamation is that up to 3 grab dredgers will be in use at any one time. In such cases the dredgers are likely to be working at some distance from each other and to be affecting different parts of the waterfront. A proposed dredging and filling schedule for the northern section was produced early in the WKR study. Recent modifications to the construction programme, in particular the liklihood that dredging inshore will not occur in many areas, mean that the schedule has been modified. These changes have been incorporated into the prediction of noise impacts. This information, together with data regarding the distance to the nearest noise sensitive receivers, known attenuation rates due to distance and likely hours of working, will enable the noise impact to be predicted.

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(1) All sound power levels referred to are derived from the Noise Control Ordinance.

Air Quality : No significant impacts are anticipated from this activity.

Water Quality : The creation of elevated levels of suspended solids in the vicinity of dredging activities is inevitable. This will contribute to water quality deterioration, particularly during the later stages of the reclamation when semi-enclosed bodies of water will have been created by the earlier phases of the reclamation. These water bodies will also be subject to continuing discharges from sewers and storm water drains. In more open-water areas, dredging alone is unlikely to result in significant water quality deterioration except immediately adjacent to the dredging activities.

Disposal of Marine Sediments

2.19 It is currently intended that dredged sediments will be transported to the gazetted dumping grounds to the east of Ninepins and at Cheung Chau. The potential for impacts on water quality exists with the transport of the material but this can be minimised by adherence to specified contract conditions. The behaviour of sediments when dumped is understood to some extent. The maximum acceptable rate of dumping is determined by consideration of the solids content of the material to be dumped, the size of the load, the depth of the water into which it is dumped and the topography of the sea bed.

2.20 For relatively uncontaminated sediments the water quality impacts are associated with increased turbidity at, and downstream of, the dump site and the effects on the sea bed from sediment settlement. For contaminated sediments however, the rate at which heavy metals and other contaminants are transferred from the sediment and into solution in the water column may be of concern under certain conditions.

Placement of Rock-fill for Seawall Construction

2.21 Seawall construction will begin with the placement of a sand core in a dredged trench. This will be followed by the placement of a rubble fill. Material for this will be transported by barge from the land borrow area at Chok Ko Wan Tsui on northeast Lantau. The likely impacts associated with this activity are indicated below.

Noise : Transfer of rock material from dumb-steel lighter to the trench is a potentially significant source of noise. Initially, while water depth permits, bottom dumping will occur. Thereafter, placement by grab will be necessary. Data regarding construction schedules, precise distances to the nearest noise sensitive receivers (NSR) and attenuation rates with distance are used to predict likely impacts.

Air Quality : No significant impact is expected.

Water Quality : An increase in turbidity will occur during dumping operations.

Block Placement for Seawall Construction

2.22 It is anticipated that a seawall of precast concrete blocks will be placed on the rubble core. This activity is likely to involve up to 3 teams working a 12 hour day from 6 am to 6 pm for a period of nearly three years in order to achieve the placing of 300 blocks per month, necessary to meet project requirements. In the south, up to 3 teams may also be used. There will be a requirement for a casting area occupying approximately 1 ha on site for both the southern and northern parts of the reclamation. The possible impacts associated with this activity are considered below.

Noise : The placement of blocks is a potential noise source, but wall construction will be remote from noise sensitive receivers (NSRs), generally more than 500 metres distant. It is anticipated that ready-mix concrete will be imported to the site, thus avoiding noise and dusts impacts associated with concrete mixing.

Air Quality : No significant impact is anticipated.

Water Quality : The potential exists for water quality impacts arising from any material that is lost to the water body that has the potential to increase turbidity.

Piling Associated with Pier Construction

2.23 The need to reprovision a number of activities with piers on the new waterfront will mean that extensive piling activity will occur beyond the line of the seawall during the period April to July 1991.

Noise : Piling is a significant source of noise and the potential impact resulting requires detailed consideration.

Air Quality and Water Quality : Piling is unlikely to constitutes a significant source of pollution in this respect.

Demolition of Existing Piers

2.24 Prior to the final phases of the reclamation proceedings, existing piers would need to be removed. For each pier this is likely to take a period of about 3 to 6 months : for the removal of pier fittings; for demolition; and for debris removal In the course of this activity concrete breakers would be used, and potential impacts may include :

Noise : Concrete breakers are likely to constitute a significant noise source. In addition, the activity will be located at the existing seawall, in relatively close proximity to NSRs giving little distance attenuation.

Air Quality : Concrete breaking activities may constitute as a source of dust. As above, the proximity of this activity to sensitive receivers is likely to add to the significance of this activity.

Water Quality : Although quantities of material will inevitably be lost from the pier to the seabed, its inert nature means that it is unlikely to have a significant effect on water quality. A large proportion of this debris would be removed in the course of dredging activity.

Dredging of Marine Fill

2.25 It is anticipated that marine fill will be taken from the gazetted marine borrow area in the South Tat Hong channel, about 1 km offshore from Chai Wan and from the Tung Lung Chau borrow area. Dredging operations are likely to take place 24 hours a day. The following potential for impacts exists :

Noise : Although the dredging operation is likely to be at least 1 km offshore, the potential exists for noise disturbance at south Tathong, particularly at night, due to the operation of trailer suction dredgers. 24 hour ambient noise level measurements have been made at Chai Wan, against which the likely noise level from dredging activities will be assessed.

Air Quality : No impacts are expected.

Water Quality : As a result of the need for overflowing from the barges, in order to ensure a high proportion of solids in the barge load, turbidity will be increased both at and downstream of the borrow area. The extent of impacts will depend on tidal and marine current conditions in the area. It is unlikely that the marine sand will be contaminated, in which case water quality effects should be confined to those associated with an increase in turbidity.

Placement of Marine Fill

2.26 The placement of marine fill is relatively complex in that it has the potential to involve a wide range of different plant types at various stages of the operation. For the purpose of assessing construction impacts it has been assumed that a scenario similar to the following will occur :

- o trailer hopper dredgers will bottom dump fill upto a depth of -8.0m P.D.
- o bottom dumping barges will place fill upto a depth of -3.0m P.D.
- o hydraulic filling will then occur upto a height of +5m P.D.

2.27 At various stages of the filling process the potential for impacts to occur will differ.

Noise : Impacts will be associated with the different types of plant in operation. Generators for powering the hydraulic filling operation are likely to be the most significant source of noise. Impacts are most likely to be significant during night and weekend filling operations.

Air Quality : Impacts are unlikely to be significant as the fill material will be wet, so even if spray filling occurs, dust impacts are very unlikely.

Water Quality : Clearly the potential exists for local increases in suspended solids in areas where filling operations occur.

Placement of Land Sourced-fill

2.28 It is possible that the final metre or so of the reclamation will be completed using completely decomposed granite (CDG) instead of marine sand. This has implications in terms of the method of transport of material to the site, its method of placement and its behaviour once on site.

Noise : Noise impacts at the site will be greater if a large amount of vehicle traffic is required to place the material.

Air Quality : CDG as a fill material is likely to be more susceptible to wind blow so that the potential for dust impacts is increased if this material is used. As reclamation progresses and the landform emerges from its water cover, dust impacts will increase, unless adequately controlled, until such time as the material is fully consolidated or covered.

Water Quality : The impacts associated with the use of CDG are likely to be less than for earlier marine fill activities. CDG will only be placed once the reclamation has emerged above sea-level.

Compaction

2.29 Once material placement is approaching the final desired level, mechanical compactors will be used to aid consolidation of the reclamation and to reduce the amount of subsequent settlement.

Noise : Upto three compactors may be in use on any one area of the reclamation. In the later phases of reclamation, in particular when the activity is occurring near the existing waterfront, this will constitute a significant noise source.

Air Quality : It is possible that the action of compactors will contribute to the immediate generation of dust even if in the long term they act to suppress it by increasing consolidation.

Water Quality : It is unlikely that this activity will have a direct effect on water quality.

Reprovisioning of Piers and Wholesale Market

2.30 The construction and in particular the reprovisioning of the Wholesale Market may require a large amount of piling. As discussed previously, piling is a significant noise source. In addition, Market construction could be a major building site for many years. Consequently the potential for significant impacts exists.

Noise : A significant impact from piling is likely, particularly given the proximity of NSRs at Fat Cheong Street THA and the Nam Cheong Estate.

Air Quality : Dust impacts from the construction site are likely.

Water Quality : Significant impacts are not envisaged.

Work Areas

2.31 A number of works areas have been identified as follows:

- o Southern Area ; adjacent Man Cheong Street
- o Northern Area ; Sham Shui Po, adjacent to Fat Tseung St. THA.
  ; Tai Kok Tsui: HKF boatyard.

At these sites a number of activities are likely, including concrete batching, storage of materials, numerous vehicle movements, and works supervision. The potential for impacts to arise is as follows.

Noise : from vehicle movements and site activity in general. The identified sites are all close to accommodation and efforts should be made to ensure that noisy activities are minimised. Between 1900 and 0700 hours work will only be permitted if it complies with the provisions of the NCO and a Construction Noise Permit is obtained.

Air : Vehicle movements and concrete batching in particular have the potential to create dust.

Water Quality : Fuel oils will require secure, bunded storage to safeguard against spillage.

2.32 **Sewerage Refurbishment**

Drainage improvement works, intended to ensure that the problems of flooding are not exacerbated by development of the reclamation, will affect certain areas of the West Kowloon hinterland. Whilst street workings are common in the area, the addition of WKR - related works will add to the potential for noise and dust impacts. Works progress will be such that individual receivers may be affected for a period of months, and on such a scale that appropriate traffic management schemes will be required.

Air : Particularly in dry weather, major roadworks in residential areas will have the potential to cause impacts on air quality, both from dust and from black smoke.

Noise : Significant noise impacts are likely.

Sensitive receivers likely to b- ıffected at some stage by re-sewerage works are indicated in Annex A, Table 2

2.33 **Transport-Related Impacts**

As a result of construction and operation, the load on the West Kowloon road network will be increased. As a result, air and noise impacts can be expected to increase. It will also be necessary to formulate traffic management plans in response to disruption caused by re-sewerage works in particular. The significance of these impacts is difficult to quantify but will be much reduced if barges are used for transport of bulk materials by sea.

2.34 The effect of the activities outlined above on noise levels and air and water quality is considered in detail in Sections 5 to 8. Sections 3 and 4 that follow outline the nature of the area and the existing environmental conditions.

3. The Surrounding Environment

3. THE SURROUNDING ENVIRONMENT

Introduction

3.01 For the purposes of this EA the study area under consideration consists of the reclamation site and its hinterland as outlined in the Study Brief and presented in Figure 3.1. Environmental impacts at areas outside the immediate study area, however, such as in the vicinity of the borrow areas, are assessed where appropriate.

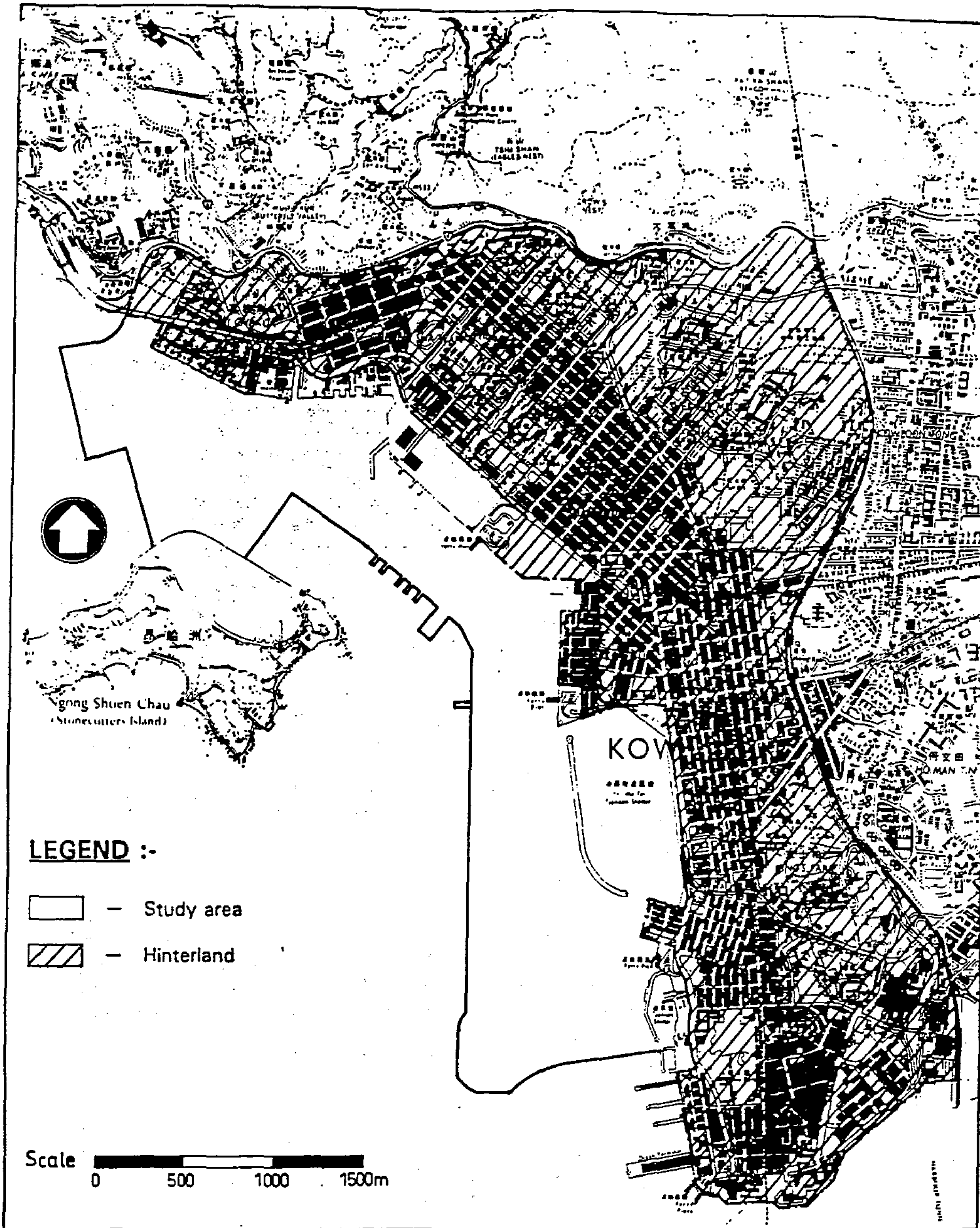
3.02 The existing and planned landuses and developments within the study area were investigated in sufficient detail in order to identify all sensitive uses likely to be affected by the construction activities. The basic study area is comprised of seven districts which from north to south are Lai Chi Kok, Cheung Sha Wan, Sham Shui Po, Mongkok, Yau Ma Tei and Tsim Sha Tsui. In broad terms, the inland area are mainly residential whereas the waterfront areas have more varied landuses. Except at Mei Foo Sun Chuen and Nam Cheong, the waterfront areas in the north are occupied by industries. From Jordan to Tsim Sha Tsui, the landuse gradually changes to mainly commercial. The study area is briefly described in a north-south sequence in the following subsections.

Lai Chi Kok

3.03 The Lai Chi Kok district is dominated by a large private residential estate, Mei Foo Sun Chuen, with a population of 45,000. Adjacent to the estate is a bus depot and then a municipal solid waste incinerator. The incinerator is scheduled to close down in 1990/1991. The Kwai Chung Road is a trunk road running in an east-west direction and bisecting the estate. The trunk road has heavy traffic of 152,000 Annual Average Daily Traffic movements (AADT), which constitutes a significant source of noise and air pollution in the area. To the north of the Kwai Chung Road are the Lai Chi Kok Hospital and Reception Centre.

Cheung Sha Wan

3.04 Cheung Sha Wan is one of the most industrialised districts within the main urban area and was first developed in the 1960s. Old flatted factory buildings dominate the area between King Lam Street and Lai Chi Kok Road. On the waterfront, the Cheung Sha Wan Shipyards occupy an area of 6 ha and are currently intended for reprovisioning on the new waterfront of the WKR just east of Stonecutters Island. Eastwards is the Lai Chi Kok Road THA with a population of 5,000. Further south of Cheung Sha Wan, inland areas are mainly residential including large developments such as So Uk Estate, Lai Kok Estate, Un Chau Street Estate and Cheung Sha Wan Estate. Closer to the waterfront lies Fat Tseung Street THA. The total population of the area is about 70,000. On the waterfront are Wang Cheong Factory Estate, wholesale fish and vegetable markets and an abattoir.



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WEST KOWLOON RECLAMATION

FIG. 3.1 _
WEST KOWLOON RECLAMATION
STUDY AREA AND HINTERLAND

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Sham Shui Po

3.05 Sham Shui Po is one of the oldest residential districts in Hong Kong. The inland area is congested with old buildings of six-to-eight storeys built in the seventies. Community facilities in the area are generally under provided. On the water front are the Hong Kong Ferry Terminal and pier due for reprovisioning on area TK1 of the reclamation. Adjacent is the recently occupied Nam Cheong Estate with a population of about 7,200. Next to the Nam Cheong Estate are an area of open space and a local sport centre, serving the Estate and the inland old district.

Tai Kok Tsui

3.06 Tai Kok Tsui is predominantly residential but industrial blocks also exist. East of Tai Kok Tsui Road and north of Cherry Street the area is dominated by flatted factories with scattered small sitting-out areas, playgrounds and schools. The residential blocks at the waterfront are densely populated and the residents rely heavily on the nearby public cargo working area (PCWA) for employment. The area also falls under a government study scheme to identify any opportunities for comprehensive redevelopment. Further inland is the Mongkok area which is a busy shopping area but which also has a large resident population.

Yau Ma Tei

3.07 The dominant feature of Yau Ma Tei is the typhoon shelter at the waterfront where the existing coastline to the west of Ferry Street supports the public cargo working area. The typhoon shelter supports a population living on dumb lighters and other marine craft. Ferry Street is a primary distribution road connecting Tai Kok Tsui and Jordan districts with an AADT of 84190. The rest of Yau Ma Tei is mainly residential with scattered in-situ redevelopment. The residential blocks are of the R1 type, i.e. with the lower floors used for commercial and workshop purposes. A number of inland areas in Yau Ma Tei are identified for various comprehensive redevelopment and environmental improvement schemes in a government commissioned study.

Tsim Sha Tsui

3.08 At the southernmost part of the Kowloon peninsula lies Tsim Sha Tsui which is a large business and tourist shopping centre. Nearly all the buildings at Tsim Sha Tsui are of the office type with air conditioning, which are unlikely to be affected by the general construction works. However on the waterfront lies the dormitory of the Fire Services Station which is considered to be a potential sensitive receptor to the air and noise pollution associated with the construction works.

General Environment of West Kowloon

3.09 The West Kowloon district is one of the oldest urban areas in the territory and has been through many stages of development. Like most of the older districts of the territory, gradual degradation of the living environment is a major problem. Dilapidated buildings, congested roads, underprovision of open space and residential/ industrial interface problems are common.

3.10 In addition Sham Shui Po, Cheung Sha Wan and Lai Chi Kok fall within the 30 NEF (Noise Exposure Forecast) of Kai Tak Airport. Together with the local influence of the heavy traffic noise the whole area experiences relatively high noise levels. The Lai Chi Kok incinerator and a high level of vehicle emissions also contribute to air pollution problems. A number of severely polluted watercourses draining the area discharge at the waterfront. This results in the bad water quality conditions in the Yau Ma Tei typhoon shelter and at other points adjacent to the sewer and storm water drain outfalls.

3.11 Currently the whole metropolitan area including the West Kowloon districts are the subject of the Metroplan Study. This planning study aims at forming an urban growth pattern and identifying any opportunity for comprehensive redevelopment. A number of areas in the West Kowloon districts are now being considered for comprehensive redevelopment by some private developers and quasi-government bodies (Land Development Corporation, HK Housing Authority and HK Housing Association). This implies that the West Kowloon districts are subject to very dynamic changes as a result of the high level of construction activity. Thus sensitive receivers initially identified in this study may experience higher ambient noise levels during the time period of the WKR due to nearby construction works. In addition, the sensitive receivers themselves will in some cases be redeveloped and disappear. It is against this background of on-going redevelopment that the impacts associated with the WKR Works are assessed.

Location of Sensitive Receivers

3.12 Whilst it is necessary to ensure that potential impacts on the whole of the West Kowloon area are taken into account, the nature of the on-site construction activities is such that the noise and air impacts are likely to affect only the first few blocks inland from the waterfront. Further inland, developments are more likely to be affected by activities taking place in their immediate surroundings than at the reclamation site itself.

3.13 With reference to the revised Chapter 9 of Hong Kong Planning Standards and Guidelines and various Ordinances, the sensitive receivers to the air and noise pollution can be broadly stated as follows :

- o Residential areas
- o Institutions (schools, hospitals, nurseries etc.)
- o Recreational areas (country parks or district open space)

Annex A Table 1 contains a list description of recognized sensitive developments in the West Kowloon district.

4. Existing Environmental Conditions

4. EXISTING ENVIRONMENTAL CONDITIONS

Introduction

4.01 In order to enable the significance of various environmental impacts to be determined it is necessary to establish the existing baseline conditions for a particular environmental parameter. Once these are known, they can be used as a yardstick against which to judge predicted changes. They also serve to show the state of the environment in relation to established limits, guidelines or objectives that relate to a particular parameter. This serves in particular to indicate situations where existing environmental conditions mean that even small increases in environmental pollution could be significant.

4.02 Two main methods are available for establishing existing baseline conditions. If the parameter has been monitored in the area of interest and the information is available, it may be sufficient to define existing conditions. Often, however, sufficiently site specific data are unavailable and it is necessary to instigate a sampling procedure to provide more. The manner in which the background conditions existing in West Kowloon were established, and the results of this work are presented in the sections that follow.

Noise

4.03 Background noise levels for the areas of the West Kowloon waterfront potentially exposed to noise impact as a result of construction activity were not available. It was necessary, therefore, to carry out a programme of 24-hour noise monitoring in order to determine existing noise levels.

Site Selection

4.04 Sites for noise monitoring were selected after reference to the Noise Control Ordinance (NCO) and in consultation with the EPD. As a result of this process, 14 sites on or near the West Kowloon waterfront were identified. At each site one period of continuous 24-hour noise monitoring was undertaken, in the period July to September 1990. The 1 hour L_{10}, L_{90} and $L_{(eq)}$ values were recorded as facade measurements. The location of the noise monitoring sites at the West Kowloon Waterfront is indicated in Annex B, Figure 1 and Table 1.

Recorded Noise Levels

4.05 Annex B Table 2 presents details of the locations and dates at which noise monitoring took place, together with a description of the measuring site and of the main noise sources. 24-hour noise profiles of hourly L_{10}, L_{90} and $L_{(eq)}$ are also presented for each site (Figures 2a-j, Annex B). In the following section, comments regarding the ambient noise levels at each site are confined to a statement regarding existing noise levels and an indication of the periods during which the acceptable noise level for residential accommodation is exceeded. A discussion of the data in relation to the predominant sources of background noise at each site follows;

- Mei Foo Sun Chuen

The noise environment at the sea-front is mainly determined by marine activities as well as by the construction of the new container terminal. Other noise sources include the aircraft overflying this area. Typical noise background for day time and night time were 60 and 52 dB(A) respectively. Within the estate, however, the noise levels measured were very stable throughout the day at about 58-60 dB(A).

- Fat Tseung Street THA

This area is affected by similar noise sources but it is also exposed to noise from container handling and the fish market at the sea front. This is a major noise source especially during the day time. Noise levels could reach 73 B(A) for the $L_{(eq)}$ (1-hour) measurement. In general, the $L_{(eq)}$ level was about 68 dB(A) during the working hours.

- Nam Cheong Estate

Two monitoring locations were chosen for this area and both sites were affected by noisy activities with levels measured at Cheong Yat House facing the sea which was affected by cargo handling activities as well as noises from ferries and buses. Cheong Chung House, however, was also affected by ship-repairing activities and the traffic noise from West Kowloon Corridor.

- Wong Tai Street

This area was mainly affected by shipping activities and the ship-repair works at the dockyard nearby. The background noise reached 64 Db(A) during the day and was also affected by occasional traffic using Wong Tai Street.

- Hoi King Street

This measurement location was close to the Tai Kok Tsui Ferry Pier and the bus terminus and was affected by these activities. Other noise sources came from road traffic as well as the marine activities within the typhoon shelter. Typical day-time background noise levels were around 70 dB(A).

- Cherry Street

Heavy traffic contributed significantly to the noise background and the $L_{(eq)}$ levels remained at 75 Db(A) during the day. Other noise sources came from marine traffic and activities within the typhoon shelter.

- Ferry Street

The sensitive receivers lie along the busy road where more than 30% of traffic comprises heavy vehicles. This produces a noisy environment with background noise levels above 65 dB(A) during the day time. This is the major noise source and the hourly $L_{(eq)}$ is in the region of 75 dB(A). Apart from traffic noise, there was some contribution from the nearby public cargo working area.

- **Man Cheong Street**

  Two monitoring locations were chosen within this area and both sites were affected by marine traffic as well as cargo handling activities within the typhoon shelter. The background noise levels were in the region of 65 dB(A) during the day time period.

- **King George V Memorial Park**

  This area was again affected by heavy traffic passing close to the monitoring location. Other noise sources were park visitors. The background noise levels measured were about 65 dB(A).

- **Canton Road**

  Due to the proximity of the measurement location to Canton Road, the noise levels recorded were mainly due to traffic. The measured results were higher than the ones obtained at King George V Memorial Park because of the shorter distance to the road. Moreover, it is also possible that road repair works made some contribution to the day time noise levels. The measured background noise levels were between 68-71 dB(A).

Air Quality

4.06 The existing air quality in the West Kowloon area has been determined on the basis of routine air quality monitoring data obtained from EPD. The advantage of using this data is that it is based on year-round monitoring and will, therefore, enable realistic average values for each of the parameters to be determined. If on-site sampling had been carried out, the data would have been collected over a period of one month in the summer. It is likely that this would have imparted bias to the background levels, making them less representative of year round ambient conditions.

4.07 The WKR area stretches from Mei Foo Sun Chuen to Tsim Sha Tsui. Within this area there are two EPD routine air quality monitoring stations located quite close to the proposed reclamation. One of the monitoring sites is located at Yen Chow Street Police Station, Sham Shui Po and the other at Empire Centre, Tsim Sha Tsui. Although the latter is quite far away from the reclamation site, the air quality results should still reflect the general air quality in the southern section of the reclaimed land. The results of the monitoring were supplied by EPD and are presented in Tables 4.1 and 4.2.

4.08 The reclamation area is located within the urban environment and is close to industrial as well as traffic sources. As a result, the particulate levels are quite high in the Sham Shui Po area. The monthly averages of Total Suspended Particulates (TSP) for August 1989 reached 148 ug/m^3 and the annual average is 109 ug/m^3. This high level of dust is likely to be the result of vehicular emissions since the site is surrounded by heavy traffic. However, further to the south, the TSP levels recorded in the Tsim Sha Tsui area are lower, with an annual average of 77 ug/m^3. This may be the result of lower traffic volumes in this area. However the SO_2 levels are generally higher than the Sham Shui Po area due to local emissions from restaurants and hotel boilers. It is also possible that there is some contribution from industrial sources further to the north-east. The levels of SO_2 at both sites are low when compared with the Air Quality Objectives.

4.09 From the annual averages, the TSP and Respirable Suspended Particulates (RSP) levels exceed the Air Quality Objectives, from 1986-1988 for both sites with some improvement for Tsim Sha Tsui in 1989 which falls within the Air Quality Objectives. In general, the air quality of these areas is affected by particulates from local sources. Consequently there is a need to address this issue in the air quality assessment since the major pollutant from construction activities is dust.

4.10 Besides the pollutant sources, the potential for the dispersion of air pollutants is also important and this depends very much on the prevailing wind conditions. The Royal Observatory has an automatic weather station at Cheung Sha Wan which is in the vicinity of the proposed reclamation area. The winds are generally very calm, more than 70% of the winds are lower than 3 m/s and mainly blow from the east. However, more southerly winds will be experienced during the summer time. A wind rose for Cheung Sha Wan station (Figure 4.1) summarises the prevailing wind conditions of the study area.

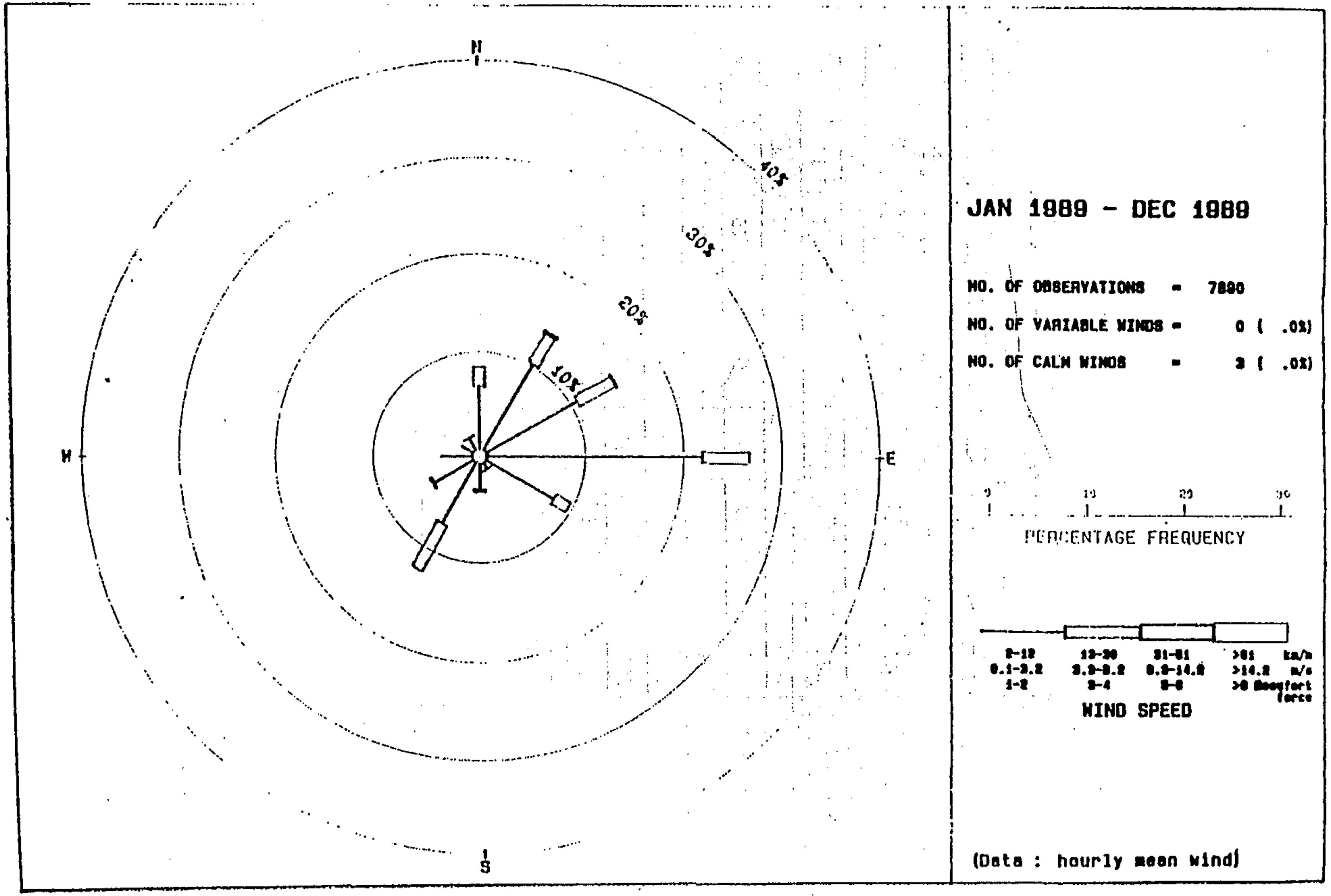
Table 4.1 : Annual Averages recorded for air pollutants at routine monitoring stations in or near the study area 1985-1989.

Year	Annual Averages (ug/m^3)						
	Sham Shui Po				Tsim Sha Tsui		
	SO2	NOX	TSP	RSP	SO2	TSP	RSP
1985	21	---	82	50	50	65	42
1986	17	---	95	61	49	89	60
1987	15	---	99	61	35	90	63
1988	21	---	119	65	53	95	59
1989	12	109	109	61	42	77	52
NOTE : The NO_2 level of Sham Shui Po for 1989 was 47 ug/m^3							

Table 4.2 : Monthly averages recorded for air pollutants at routine monitoring stations in or near the study area 1989.

Monthly Averages (ug/m³) Year : 1989							
Station	Sham Shui Po				Tsim Sha Tsui		
Pollutant	SO2	NOX	TSP	RSP	SO2	TSP	RSP
JAN	9	115	125	81	62	122	75
FEB	23	127	113	70	39	87	59
MAR	20	119	121	67	35	100	58
APR	19	149	96	58	25	58	33
MAY	9	106	66	38	29	52	36
JUN	5	88	111	53	24	51	34
JUL	6	87	109	44	46	59	45
AUG	14	107	148	68	59	65	55
SEP	6	67	88	51	48	67	46
OCT	7	83	103	56	38	74	53
NOV	13	92	88	64	44	79	59
DEC	13	158	136	90	46	99	85

Figure 4.1 : Wind Rose for Cheung Sha Wan



4.11 The impact of construction activities on air quality is likely to be confined to an influence on the levels of suspended particulates as a result of dust generation. There may also be generation of black smoke by some plant in use on site. The results of air quality impact prediction are presented in Section 6.

Water Quality

Introduction

4.12 Existing water quality in the area between the West Kowloon Waterfront and Stonecutters Island has been determined using a combination of :

- o Routine monitoring data provided by EPD derived largely from the fixed monitoring stations VM9, VM10 and VM11 illustrated in figure 1 of Annex C.
- o Site specific sampling stations used by the consultants for the purpose of the present study illustrated in figure 2 of Annex C.
- o Information on flows and pollution loads from three key references :
  - . The Sewage Strategy Study[1]
  - . The North West Kowloon Sewage Master Plan[2]
  - . The EPD Technical Paper on effluent producing industries[3].

Existing Water Quality

4.13 The primary influences on water quality in the WKR project area are :

- o The deposition of fine particulates originating from the Pearl River.
- o Low tidal currents of less than 0.4m/sec that limit the flushing capacity of the area.
- o Daily flows from the storm and foul sewer system of an estimated 278,000 m^3/day[1], and associated with this, a daily pollutant load of 55 to 75 tonnes of BOD[2][3].

(1) Watson Hawksley et al (1989) : Sewage Strategy Study Appendices Part 1

(2) Acer/J. Taylor (1990) : North West Kowloon Sewage Master Plan

(3) EDP Technical Paper EDP/TP (1989) : Survey of effluent producing industries in Cheung Sha Wan

4.14 The effects of the latter point dominate water quality although this is compounded by the limited capacity for dispersion of the total pollution load entering the area. Pollution of the West Kowloon coast is manifest in the following :

- o High eutrophic potential due to nutrient enrichment.
- o High suspended solids values associated with effluent particulates.
- o Dissolved oxygen levels typically less than 50% saturation, but with a significant deterioration toward inshore areas.
- o Coliform bacteria concentrations greater than 10^5/100 ml.
- o Nutrient, chlorophyll(a), and BOD levels all indicative of eutrophication.

Contributing Factors

4.15 Imbalances in the distribution of pollutant inputs, and variations in the flushing capacity due to landform configurations in the nearshore area, contribute to marked localised effects. This is best illustrated by the case of Yau Ma Tei typhoon shelter where high pollutant loading and minimal water exchange contribute to the maintenance of anoxic conditions throughout the year. At immediately adjacent open water monitoring stations, EPD data shows marked differences in a number of key parameters and generally improved water quality.

4.16 Recent studies[(1)(2)] have shown that of the total daily BOD loading an estimated 31% discharges from the storm drain system via expedient connections from residential, commercial and industrial sources and 69% from the foul sewer outfalls.

4.17 Of the storm drain loading, three outfalls, one at Sham Shui Po and two discharging to Yau Ma Tei typhoon shelter, account for more than 50% of the total. The principal source of industrial contaminants is the Cheung Sha Wan industrial area, from which an estimated 46 factories discharge illegally to the storm water system entering the sea at Waterboat Dock and Hing Wah Street outfall[(3)] (stations 7 and 15 respectively of the water sampling programme, Figure 2 Annex C). Estimates by EPD and other studies of contaminated effluent from this source are in close agreement, and suggest daily discharges of :

- o 277 - 290 Kgs/day of toxic metals
- o 5100 Kgs/day BOD
- o 11400 Kgs/day COD
- o 7600 Kgs/day suspended solids.

4.18 Data from the EPD routine monitoring programme has suggested a general decline in water quality in recent years, with North West Kowloon suffering some of the worst eutrophication problems arising in Hong Kong.

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(1) Watson Hawksley et al (1989) : Sewage Strategy Study Appendices Part 1
(2) Acer/J. Taylor (1990) : North West Kowloon Sewage Master Plan
(3) EDP Technical Paper EDP/TP (1989) : Survey of effluent producing industries in Cheung Sha Wan

Components of the Assessment

4.19 In order to clarify information on the distribution of the pollutant loads, to gauge any adverse effects on water quality arising from sediment resuspension during dredging, and to formulate projections on adverse impacts arising from the construction programme, the approach to the assessment has incorporated three components :

- o. A site specific water sampling survey to determine spatial variation in key water quality parameters between nearshore and offshore areas.
- o A simulation exercise utilising the Government's WHAMO depth averaged water quality model and baseline data on flows and loads from the Sewage Strategy Study[1], in order to formulate projected water quality changes arising from modification of the landform configuration and water movement regime.
- o Elutriate testing carried out in conjunction with the sediment sampling programme in order to assess the potential uptake of metal to the water column and marine food chain during dredging operations.

4.20 The water sampling survey is described later in this section, and results discussed in relation to previous work in the study area and the proposed Water Quality Objectives for Victoria Harbour Water Quality Control Zone. Both the modelling and elutriate testing are discussed in Section 7. The following section examines the criteria and standards against which water quality is assessed.

Water Quality Objectives

4.21 In the course of this study findings have been considered in relation to the current or proposed Water Quality Objectives for designated areas under the Water Pollution Control Ordinance (1982). In the context of West Kowloon this is of some importance as it is proposed to implement controls through the establishment of the Victoria Harbour Water Quality Control Zone (VHWQCZ) under the above Ordinance. As these controls will come into effect prior to the completion of the WKR, it is useful to consider the standards or Water Quality Objectives (WQO) likely to be applied, and the implications of meeting those objectives.

4.22 In principle, WQOs are quantitative or qualitative standards required to maintain specified beneficial uses (BUs) allocated to the designated water control zones, and may be applied either as :

- o maximum permissable concentrations, or
- o limit values which should not be exceeded for more than a specified number of sampling occasions or time periods.

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(1) Watson Hawksley et al (1989) : Sewage Strategy Study Appendices Part 1

4.23 Provisional BUs proposed for VHWQCZ identified during the Sewage Strategy Study[1] and the relevant WQOs associated with these BUs are presented in Table 1 Annex C. It is considered appropriate in the light of the present study and based on an assessment of sensitive receptors within the project area (see Section 7) to take note of the requirements of two additional BU's.

BUs specified within the Sewage Strategy Study include :

- **BU3 - As a habitat for marine life**

  WQOs aim to maintain marine resources regardless of their value as an exploitable resource.

- **BU7 - Navigation and Shipping**

  WQOs to ensure the free movement of all vessels.

- **BU8 - Aesthetic Features**

  General WQOs aimed at preventing visually intrusive and odour problems.

4.24 Additional BUs considered appropriate in the context of the present study include :

- **BU6 - For Domestic and Industrial Purposes**

  WQOs aimed at protecting domestic and industrial users of water abstracted for flushing, cooling and desalination purposes.

- **BU5 - Secondary Contact**

  Standards designed to protect those who might reasonably expect to become immersed in water.

4.25 For the purpose of establishing quantitative values for dangerous substances as a measure of water quality contamination ERL proposed the following standards as provisional Dangerous Substances values for Deep Bay[2]. These concentrations are in general agreement with EEC discharge values for Grey List Substances, and as such may be seen as an appropriate measure of contamination in the context of West Kowloon.

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(1) Watson Hawksley et al (1989) : Sewage Strategy Study Appendices Part 1

(2) ERL (1989) : Deep Bay Guidelines for the Dredging Reclamation and Drainage Works

Table 4.3 Water Quality Objectives for Dangerous Substances

Determinand	Water Quality Objective			
Cadmium	< 1 mg/l -	annual	average	dissolved
Copper	< 5 mg/l -	"	"	"
Lead	< 10 mg/l -	"	"	"
Zinc	< 40 mg/l -	"	"	"
Nickel	< 30 mg/l -	"	"	"
Chromium	< 15 mg/l -	"	"	"
Arsenic	< 25 mg/l -	"	"	"
Mercury	300 ug/l -	"	"	"

Water Sampling

4.26 Previous water quality studies in West Kowloon have either involved long term monitoring from fixed stations, as in the case of the EPD routine monitoring programme, or have involved site specific monitoring in inshore areas as in the case of the North West Kowloon Sewage Master Plan monitoring. The objective of the sampling conducted during the present study was to gain some insight into distributional variation of a number of key parameters, rather than absolute numbers, with emphasis on the relationship between inshore and open water stations. A single sampling occasion as carried out during this study precludes the latter as seasonal, tidal and discharge effects may induce significant short-term variation.

Site Selection and Methodology

4.27 The criteria adopted in site selection were :

- o to select sampling points in the vicinity of all major marine outfalls and seawater intakes on the Kowloon shore, rather than to work to a fixed grid pattern.
- o to supplement this with sampling stations representative of open water conditions and to include among them these of the EPD routine monitoring stations for comparative purposes.

The station co-ordinates and locations are illustrated in Table 2 and Figure 2 of Annex C.

4.28 Samples at 28 stations were taken at the locations listed. For each station 2 x 1 litre samples were taken from both 1 metre beneath the surface and within 2 metres of the sea bed. All samples were chilled in ice prior to their return to the laboratory for analysis. Surface and bottom measurements of temperature, dissolved oxygen and pH were recorded in situ. Analysis of a further five parameters was carried out to APHA standards. Analytical difficulties meant that suspended solids values and inorganic nitrogen concentrations were recorded from 20 stations only. Both field data and analytical results are presented in Table 3 of Annex C.

Results

4.29 Table 4.4 summarises the results of the sampling event.

Table 4.4 Summary of Results by District

Catchment/ Area	DO (mg/l)	Inorganic Nitrogen (mg/l)	Chl(a) (ug/l)	BOD (mg/l)	FC (per 100 ml)	SS (mg/l)
Lai Chi Kok	6.45	0.18	51.75	4.75	76,000	41.0
Cheung Sha Wan	3.69	0.44	73.75	20.42	58,850	66.0
Sham Shui Po	3.16	0.347	100.0	28.5	119,225	103.0
Tai Kok Tsui	3.95	0.115	110.0	29.5	3,300	34.5
Yau Ma Tei	0.857	0.362	98.0	36.3	68,471	44.5
Offshore Stations	6.87	0.161	58.81	3.182	4,751	34.7
Nearshore and Outfalls	3.62	0.288	86.7	23.9	65,169	57.8

Note :
- All values are arithmetic mean values of Key Parameters for Inshore/Offshore Areas
- Chl = Chlorophyll
- FC = Faecal Coliforms
- DO = Dissolved Oxygen
- SS = Suspended Solids

4.30 In interpreting the results presented it is emphasised that a spot survey as carried out provides relative values for comparative purposes. Many of the individual values recorded for general parameters, most noticeably BOD, chlorophyll, and suspended solids, are extremely high, and such results returned from a longer sampling period would give very serious cause for concern regarding current water quality conditions in West Kowloon. It is considered that there are indeed very severe pollution problems in the West Kowloon project area, and that this data serves to reinforce evidence of a general deterioration in water quality from previous and on-going studies. It is not suggested, however, that this data should be viewed in isolation.

Observations on Key Parameters

4.31 - Dissolved Oxygen

Mean dissolved oxygen data in Table 4.4 shows a major differentiation between open water stations and those in the vicinity of discharge points on the Kowloon shore.

As anticipated, dissolved oxygen levels of 0.85 mg/l in Yau Ma Tei typhoon shelter typify anoxic conditions, this being attributable to the very high effluent loading in association with very limited water exchange capacity. Mean levels of 6.37 mg/l in off-shore positions are high in relation to the long term average, although EPD data for station VM9 shows a mean dissolved oxygen level of 5.9 mg/l for July over a number of years. We believe these elevated dissolved oxygen levels are associated with very high recorded chlorophyll levels, indicative of an intense algal bloom. Dissolved oxygen levels fail to comply in general with the requirements of BU3 and BU6.

4.32 - Chlorophyll (a)

Recorded Chlorophyll levels indicate extremely high levels of algal production even by Hong Kong standards and highly eutrophic conditions. They suggest an intense algal bloom was underway at the time of sampling. Maximum values of 100 ug/l are similar to levels recorded previously only in Tolo harbour and Tuen Mun typhoon shelter. Although EPD have recorded levels in excess of 70 ug/l in N.W. Kowloon there are clearly concerns that if these recorded concentrations are dependable, and the condition is sustained, waters in the project area are experiencing a significant decline in water quality that may parallel the deterioration of Tolo Harbour, which has similarly been the recipient of very high discharges of human effluent and associated nutrient enrichment.

4.33 - Suspended Solids

High recorded suspended solids values in the vicinity of marine outfalls are associated with high concentrations of effluent particulates, and are in general agreement with values from outfall locations recorded during the N.W. Kowloon Sewage Master Plan Study[1] which showed values in the range 8.0 - 1100 mg/l. During the latter study mean suspended solids levels of 75.0 mg/l were recorded from stations replicated during the present study and showing a recorded mean concentration of 57 mg/l. Although values from open water stations were elevated, they were significantly lower than the inshore stations. EPD routine monitoring of offshore stations shows rather lower suspended solids levels (means 12.3 mg/l) although the range for N.W. Kowloon during the period July 1988 - July 1989 was within 3.5 - 35.0 (mg/l). The implication of the reduced levels at sampling stations immediately adjacent to the Kowloon shore, but in more open conditions, is that the deposition of material discharged from the marine outfalls occurs quite quickly and is probably confined to a limited area. This is partly corroborated by the reported annual dredging requirements in the vicinity of some outfalls (Port Works personal communication) Values recorded fail to comply with the WQOs of BU3 (marine life) and BU6 (Domestic and Industrial abstraction).

(1) Acer/J. Taylor (1990) : North West Kowloon Sewage Master Plan

4.34 - BOD

Of parameters recorded during the present study, BOD loading shows the most marked differentiation between nearshore and offshore stations, with mean levels of 28.9 and 3.2 respectively. The latter falls within the range of 0.3 - 5.1 mg/l recorded by EPD during 1988[1]. High inshore values are again associated with the very substantial effluent discharges from the storm and foul sewer system on the Kowloon shore, but conform closely with the results of monitoring in the vicinity of outfalls during the N.W. Kowloon Sewage Master Plan study[1]. These results tend to conform to the general trend observed in dissolved oxygen and suspended solids values, with depletion of the former and elevation of the latter in nearshore sites. This reinforces the general impression that different water quality regimes operate in the nearshore area from the more exposed offshore positions, with effluent discharges and organic pollution as the primary determinant.

4.35 - Faecal Coliforms

Faecal coliform numbers conform to general expectations of high concentrations in the vicinity of sewage discharge points with a significant reduction in open water sampling positions. Mean concentrations for open water and nearshore stations were 4750 and 65170/100 ml. respectively. Given the large temporal variations in coliform numbers (EPD data shows counts of 0 - 70,000 for stn. VM9 in the period 1986-89) data from offshore positions conforms closely to comparative monitoring. Inshore counts were slightly lower than long term EPD data but still fall within the anticipated range. Levels of this magnitude clearly fail to conform to the general compliance standards of BUs 5 (secondary contact) and 6 (Domestic and Industrial abstraction).

4.36 - Inorganic Nitrogen

Inorganic nitrogen concentrations were rather lower than expected for the area although mean values for Cheung Sha Wan, Sham Shui Po, and Yau Ma Tei were all in excess of 0.3 mg/l, the level that is generally indicative of eutrophication. Offshore values were correspondingly lower at 0.16 mg/l. These latter values do not comply with the long term mean derived from EPD data of >0.4 mg/l, and it is possible that the results of analysis during the present study underestimate the actual values. They none the less indicate the presence of nutrient inputs to the area that exceed that required for maintenance of acceptable water quality.

Summary of Ambient Water Quality Conditions

4.37 Values of a number of key parameters recorded during the present study show levels that are indicative of a highly eutrophic water body. The principal constraint to improved water quality rests with the very considerable volumes of untreated domestic and industrial effluent that are discharged, frequently through illegal connections, via the storm water and/or foul sewer system. There is a direct link between deteriorating conditions and the continued discharge of effluents characterised by high BOD, nutrients, Coliform, and suspended solids values, and reduced dissolved oxygen levels. Similarly, on a localised scale there is a direct

(1) EPD (1989) : Marine Water Quality in Hong Kong 1989. Water Policy Group, HK Government

relationship between pollutant loading/general water quality conditions, and proximity to marine outfalls.

4.38 At the present time water quality does not comply with the provisional requirements of ~~the~~ Victoria Harbour Water Quality Control Zone. Failure to comply is in a number of instances associated with the percentage increase over background values attributable to marine outfall discharges. At the present time, BU3 (Marine Life) has limited application to the nearshore area of N.W. Kowloon. Oxygen depletion in bottom waters in association with unconsolidated sediments, high deposition rates and the discharge of significant volumes of toxic materials, inhibit colonisation by benthic and demersal biota. The Consultants conclude that regardless of constraints on water quality induced by the proposed WKR works (Section 7.0), ambient water quality conditions are such that only the imposition of stringent controls on effluent discharges and the full implementation of planned government re-sewerage and drainage works will bring about significant improvements in water quality, and permit general compliance with the proposed WQOs for the area.

Marine Sediments

4.39 One of the first construction activities for the reclamation involves the removal of large quantities of marine sediments. An estimated 20 Mm^3. of sediments will be removed from the northern section of the reclamation area alone. In order to determine the most suitable disposal method for this material, it was necessary to obtain sediment samples and determine the degree of contamination in relation to available sediment contamination criteria (see section 4.48)

4.40 The characteristics of marine sediments in the West Kowloon area are strongly influenced by three processes :

- o weak bottom currents;
- o extremely high levels of domestic and industrial effluent discharged from the West Kowloon hinterland;
- o the deposition of fine particulates from the Pearl River.

This combination of factors is the primary influence on both the physical and chemical processes within the bottom sediments and the water column.

Sediment Characteristics and Principal Influences

4.41 In terms of physical properties, sediments are generally fine with a high silt/clay fraction (<63 microns) representing more than 80% by dry weight. The organic matter content is high, comprising in excess of 3.0% by dry weight, this being attributable to the domestic effluent discharges from the foul sewer and storm drain system. Organic pollution in association with oxygen depletion result in a largely anaerobic environment and a very poor benthic fauna.

4.42 Other features, associated with the daily discharge of an estimated 278,000 m^3 of effluent from the storm and foul sewer systems[1] include high levels of organic micro-pollutants, toxic metals, and coliform bacteria.

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(1) Acer/J. Taylor (1990) : North West Kowloon Sewage Master Plan

4.43 As a result of the relatively weak currents (0.2 - 0.4 m/sec)[1], there is only limited dispersion of any contaminated materials entering the area either from the Rambler Channel, or from marine outfalls. This results in pronounced localised effects on sediments, primarily regarding contaminant composition. This is reflected in a marked deterioration in both sediment and water quality immediately adjacent to the Kowloon shore, and in particular, in the vicinity of :

o Yau Ma Tei Typhoon Shelter
o Cheung Sha Wan Industrial area
o Sham Shui Po

4.44 The major contribution of these three locations to the total pollutant load entering the waters of West Kowloon has already been discussed. In the context of bottom sediment quality, the pollutant load derived from these areas is of major concern due to the routine discharge, via expedient connections, of a diverse range of toxic metals and micro pollutants, including Poly-chlorinated Bi-phenyls (PCBs) and Poly-cyclic Aromatic Hydrocarbons (PAHs). On the basis of findings from other major studies in the area, including the Sewage Strategy study 1989[2], the North West Kowloon Sewage Master Plan (1990)[3], and routine monitoring and spot surveys by EPD, there is substantial evidence that many of these substances, on a localised scale, exceed the guideline concentrations for Deep Bay[4], currently utilised as a general measure of sediment contamination in HK waters.

Sediment Sampling Requirement

4.45 Due to the potential for bio-accumulation of contaminants and the limited understanding of both the pathways and speciation changes that may influence their transference through the marine food chain, it was considered necessary to identify in more detail the concentration and distribution of sediment contaminants. The aim was to identify those areas where the degree of contamination was such that alternative disposal routes for dredge spoil might need to be considered.

4.46 In addition to the consultants sampling programme, CESD simultaneously conducted a sediment survey in the southern sector of the WKR project area. The results of this and other studies carried out in West Kowloon are considered in this section in relation to results from our own sampling programme.

4.47 The guidelines against which sampling results were assessed are presented in the following paragraphs.

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(1) Maunsell Scott Wilson (1990) : CT8 study. Site investigation and engineering study for development of CT8

(2) Watson Hawksley et al (1989) : Sewage Strategy Study Appendices Part 1

(3) Acer/J. Taylor (1990) : North West Kowloon Sewage Master Plan

(4) ERL/EPD (1989) Deep Bay Guidelines/or Dredging Reclamation and Drainage Works

Sediment Contamination - Standards and Quality Objectives

4.48 Although a study to examine the standards and quality objectives for contaminants in marine sediments has recently been commissioned by the DEP, there are at present no limit values for dangerous substances that apply to Hong Kong sediments in general. As a result, the most commonly used criteria to determine sediment contamination are the interim guideline concentrations for contaminants developed for Deep Bay[1]. In the absence of alternative limit values/quality objectives, these values have been adopted as criteria for the present study, and are detailed in Table 4.5 below.

Table 4.5 Interim Guideline Concentrations for Sediment Contamination

Parameter	Limit Value (mg/Kg or ppm)
Cadmium (Cd)	15.0
Chromium (Cr)	500.0
Copper (Cu)	500.0
Lead (Pb)	200.0
Mercury (Hg)	5.0
Nickel (Ni)	500.0
Zinc (Zn)	2000.0

Source[1]

Sediment Sampling

Site Selection and Methodology

4.49 The principal criteria adopted in site selection for the sediment survey were :

- o proximity to marine outfalls
- o proximity to areas previously identified as receiving significant industrial discharges e.g. Yau Ma Tei.

4.50 Sampling was carried out in three stages as follows:

- o Series A samples - Initially, 40 sampling stations were selected to provide broad coverage of the reclamation project area. Where possible they were located at 20 metre and 100 metre distances offshore from significant marine outfalls in order to gain some indication of dispersion from these point sources. The locations of all sampling stations from Series A, B and C are illustrated in Figure 1 Annex D. Precise locations are presented in Table 1a Annex D.

(1) ERL/EPD (1989) : Deep Bay Guidelines for Dredging, Reclamation and Drainage Works

- o Series B samples - An additional group of 37 stations were subsequently sampled in order to provide information on the seaward distribution of contaminants. The sample locations of this second stage are presented in Table 1b Annex D.

- o Series C samples - In order to both corroborate data retrieved from the Series A sampling programme, and to clarify available information on the variation in concentration of trace metals with depth, a further series of depth profiled samples were taken from five positions in Yau Ma Tei Typhoon shelter. The locations of these stations are also illustrated in Figure 1 Appendix D. Analytical results for the three series are presented in tables 3, 4, 5 and 6 of Annex D.

4.51 Sampling was carried out between August and November 1990. Sample series A and B were retrieved using a 2.0 metre Gravity corer that produced a mean core length of 82.6 cm. The exceptions to this were stations 16 and 18 where the nature of the substrate required grab samples to be taken. Sample series C was retrieved using a piston core to retrieve 1.0 metre samples from three depth ranges, 0-1 metre, 1-2 metres, and 2-3 metres.

4.52 Position fixing by the sampling vessel was achieved through the use of shore based trisponder beacons, set up specifically for this purpose. On recovery all samples were iced, and on return to the laboratory were frozen prior to analysis. The sediment analysis, carried out on bulk sub-samples, involved the testing of twelve parameters. These and the methodology adopted are outlined in Table 2, Annex D.

Series A and B Results

4.53 Full results of the sample analysis are presented in Tables 3 and 4 of Annex D. The following section details the concentrations and distribution of the principal parameters examined, and the implications of these in the formulation of ambient environmental conditions are also discussed. Data are considered both in the context of individual sampling stations, and also, in the case of inshore areas, in terms of catchment areas, as the evidence suggests a strong correlation between the distribution of industrial/residential/commercial areas and degrees of sediment contamination. For the purpose of defining catchments, sampling stations are allocated as follows :

- o Lai Chi Kok - stations 1 - 6
- o Cheung Sha Wan - stations 7 - 17
- o Sham Shui Po - stations 18 - 24
- o Tai Kok Tsui - stations 25 - 29
- o Yau Ma Tei - stations 30 - 37
- o Tsim Sha Tsui - stations 37 - 40

o **Copper**

4.54 The three highest recorded values of copper all exceed the guideline threshold value of 500 mg/Kg by between 60 and 300 mg/Kg. The highest recorded value was 800 mg from sampling station 8 (Waterboat Dock at Cheung Sha Wan). The second highest value of 600 mg from station 10 was also located in the Cheung Sha Wan catchment in the vicinity of Hing Wah Street marine outfall. The only remaining value that failed to comply with the guideline figure was 560 mg/Kg recorded from station 28 in Tai Kok Tsui.

4.55 In terms of catchment, Cheung Sha Wan also recorded the highest mean concentration of 327 mg/Kg. The high values recorded here are attributable to the proliferation of electroplating, and printed circuit board manufacturing in the Cheung Sha Wan industrial area.

4.56 When compared with other data recorded in the vicinity these results show a strong similarity. Copper values recorded during the North West Kowloon Sewage Master Plan study showed a maximum value in Cheung Sha Wan of 799 mg/Kg and a mean value for the catchment of 367 mg/Kg. Similarly they confirm the results of effluent analysis recorded by both the latter study and EPD[1]. EPD estimated the daily discharge from 47 factories to the Waterboat Dock to be 213 kgs of Total Toxic Metal (TTM) per day, of which more than 97% was derived from electroplating and electronic component manufacturers.

4.57 Other than in the immediate nearshore area there was a marked reduction in copper concentrations with distance offshore. This is reflected in differences between Series A (stations 1-40) and Series B (stations 41-77) which showed mean values of 222.08 mg/Kg and 108.67 mg/Kg respectively.

o **Zinc**

4.58 The highest zinc values recorded from inshore stations 15 and 12, again in Cheung Sha Wan, showed concentrations of 470 and 400 mg/Kg respectively. Although well below the interim guideline concentration, these figures still indicate a significant level of industrial contamination. The highest overall values however were recorded from offshore positions 76, 45,and 59 at concentrations of 1300, 990 and 880 mg/Kg. There is no clear distributional relationship between the stations showing high values, although it should still be noted that they remain significantly lower than the interim guideline figure of 2000 mg/Kg.

4.59 In terms of mean concentration by catchment, the average for Cheung Sha Wan was 222 mg/Kg, with the next highest being Sham Shui Po and Yau Ma Tei with a mean value in both cases of 138 mg/Kg. EPD data recorded as part of the routine sampling programme between 1987 and 1989, showed a slightly higher mean value of 225 mg/Kg. Of interest are the very much higher values recorded by EPD from Station VS16 in Yau Ma Tei where values of up to 1400 mg/Kg were found.

4.60 The peak concentrations recorded in Cheung Sha Wan during the present study, do in general conform to values presented in the recent North West Kowloon Sewage Master Plan Study[2]. For stations in the same location they recorded a mean concentration of 270 mg as against 220 mg obtained during the present survey.

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(1) EPD Technical Paper EPD/TP (1989) : Survey of effluent producing industries in Cheung Sha Wan

(2) Acer/J. Taylor (1990) : North West Kowloon Sewage Master Plan

o Nickel

4.61 In general, recorded concentrations of nickel were low, both in absolute terms, and in relation to the interim guideline concentration. The highest values recorded were from stations 21, 10 and 28, at concentrations in the range 66-70 mg/Kg. The highest mean values by catchment were recorded from Tai Kok Tsui and Cheung Sha Wan with values of 40 and 32 mg/Kg respectively. These values fall within the same order of magnitude as the levels recorded at the EPD monitoring stations, where a mean value of 25.2 mg/Kg was recorded over the 1987-1989 period. A significant difference between Series A and Series B stations was again observed with mean concentrations of 53.2 and 24.1 mg/Kg respectively.

o **Lead**

4.62 As with copper, lead also failed to comply with the interim guidelines at a number of stations. This applied in four cases, at stations 30 and 31 in Yau Ma Tei, where values of 220 and 230 mg/Kg were recorded, as (against the guideline concentration of 200 mg/Kg), and at stations 50 and 76 which both showed concentrations of 210 mg/Kg. The distribution of lead is discussed further in the context of Series C samples in Section 4.77.

4.63 In all catchments, however, there were areas where lead concentrations were close to the limit value as follows :

Location	Sampling Stations	Concn. Range (mg/Kg)
Cheung Sha Wan	12 - 14	140-160
Sham Shui Po	19 - 21	130-180
Tai Kok Tsui	28 - 29	120-150
Yau Ma Tei	30 - 32	140-230

Although substantially higher values have been recorded intermittently in different studies, the above ranges conform closely to those recorded from outfall sediments during the North West Kowloon Sewage Master Plan Study[1].

o Cadmium

4.64 Cadmium values recorded throughout much of the survey area were not significant in relation to the guideline value, with 1.0 or < 1.0 mg/Kg being recorded at more than 40% of all stations sampled. The highest values which were considered significant were recorded from station 10 in Cheung Sha Wan (8.0 mg/Kg), station 6 in Lai Chi Kok (7.0 mg/Kg) and station 37 in Yau Ma Tei (6.0 mg/Kg).

4.65 It appears likely that the principle sources of cadmium in West Kowloon will be, as with copper, the electroplating and electronics industries, as substantial amounts may be used in solder, and electroplating rinse water may typically contain 100 - 500 ppm (mg/l). As with other metals, the recorded values are not significantly different from other data recorded in the WKR area. The North West Sewage Master Plan Study also showed approximately 40% of stations with values of 1.0 mg/Kg or less. Series B stations showed values of less than 1.0 mg/Kg in all cases.

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(1) Acer/J. Taylor (1990) : North West Kowloon Sewage Master Plan

o Chromium

4.66 Chromium values in West Kowloon fall within the range 5.0-130.0 mg/Kg, with the highest recorded sample concentrations of 130 mg/Kg and 90 mg/Kg occurring at stations 12 and 21 in Cheung Sha Wan and Sham Shui Po respectively. The former catchment had the highest mean concentration of 71.0 mg/Kg, clearly well below the current interim guideline value of 500 mg/Kg.

o Mercury

4.67 Mercury concentrations recorded during the Series A and B surveys were similar to levels recorded elsewhere in Hong Kong waters (see table 4.6), all complying with the interim guideline concentration of 5.0 mg/Kg, and are not at this stage considered to represent a significant pollution problem. This was not the case with Series C samples and these are discussed separately. The highest recorded levels in series A and B were from Stations 8 (Cheung Sha Wan), and 1 (Lai Chi Kok) with concentrations of 0.78 mg/Kg and 0.74 mg/Kg respectively. The catchment with the highest mean sediment loading was Lai Chi Kok with 0.52 mg/Kg. The mean concentration of mercury in West Kowloon sediments compared favourably with those from Victoria Harbour, Tin Shui Wai, and the EPD routine monitoring results. They were, however, in conflict with early results from the CESD sampling programme in the WKR southern sector where mean surface concentrations in excess of 10.0 mg/Kg were reported. Although subsequent testing of replicate samples failed to corroborate these results, the consultants considered it prudent, in the light of the extreme toxicity of mercury, and the constraints this might impose on dredge spoil disposal options, to conduct additional tests in the course of this survey. To this end, elutriate tests, based on methods adopted under US EPA/federal Standards, were carried out on a small number of samples but the results appeared inconclusive. In addition, a third series of samples were taken and Mercury levels of the same order of magnitude to those found in the CESD survey were observed at one station.

<u>Table 4.6 Mercury Concentrations in Hong Kong Sediments</u> (Surface Concns)

Study	West Kowloon Reclamation Ref. i	West Kowloon Reclamation Ref. ii	Tin Shui Wai Developments Ref. iii	NW Kowloon S. Study Ref. iv	Victoria Harbour Monitoring Ref. v	Victoria Harbour WHC Study Ref. vi	West Kowloon Reclamation - Yau Ma Tei Series C (Ref. i)
$\bar{X}$ Concn. Hg(mg/kg)	0.367	9.316	0.23	1.099	0.876	0.416	5.020
S.D.	0.185	2.265	0.053	0.871	0.551	0.216	6.702
Max.	0.780	14.0	0.420	2.290	1.900	0.970	17.000
Min.	0.110	5.7	0.130	0.030	0.300	0.050	1.700

Ref. i - Mott MacDonald 1990 (present study)
Ref. ii - CESD WKR monitoring 1990 (pers. comm.)
Ref. iii - Binnie & Partners Tin Shui Wai Development WP4 1984
Ref. iv - Acer/John Lang N.W. Kowloon Sewage Master Plan Study 1990
Ref. v - EPD Routine Monitoring programme Vic. Harbour 1987-89 (pers. comm.)
Ref. vi - EPD Western Harbour Crossing Study 1990 (pers. comm.).

o Other Parameters

4.68 Sediment nutrient loadings to the inner areas of West Kowloon are as expected very high due to substantial discharges from the foul sewer system. EPD data from the routine monitoring stations VS6-VS9 in offshore positions show a mean Total Nitrogen value of 906 mg/Kg. The results of this study from areas closer to the points of discharge show a slightly higher level of 1354 mg/Kg. This is to be expected due to the limited dispersion of solids from the marine outfalls, which is reflected in levels of up to 2800 mg/Kg recorded at stations 22 and 23. Both of these sampling stations are in the immediate vicinity of the largest foul sewer outfall in the WKR project area.

4.69 As with nutrient loadings, organic matter content of sediments in the nearshore area is somewhat higher than the average of around 3.0% for this area of Victoria Harbour, with a general mean of 3.9% rising in Yau Ma Tei to in excess of 5.0%. This is also a consequence of the very high levels of effluent discharge.

4.70 Chemical Oxygen Demand also shows a substantial increase in nearshore areas when compared with background values for sediments of approximately 3100 mg/Kg recorded at the EPD monitoring stations VE6-VS9. Present results give a mean figure for the WKR project area of 50,000 mg/Kg, indicative, in conjunction with other data retrieved, of a grossly polluted environment.

Sediment Deposition

4.71 Evaluation of the distribution and degree of sediment contamination requires determination of both the vertical distribution of contaminants and the sediment deposition rate. In the absence of direct measurements of sediment deposition in the project area, the estimates of Chalmers[1] have been adopted. They propose an annual mean siltation rate for Victoria Harbour from all sources of 40 mm; of this rate, 15-30% is represented by the natural influx of suspended sediment, but it also includes estimates for sewage solids in addition to losses arising from dredging and reclamation activities. Chalmers' estimate conforms well with direct measurements recorded during the course of the Victoria Harbour Hydraulic and Water Quality Studies.

4.72 A feature of siltation is the increase in the deposition rate with the square of the suspended solids concentration, indicating that much higher deposition rates may occur in the nearshore area of West Kowloon due to the significantly higher suspended solids levels than those in more offshore positions. Data from this water quality study and from the North West Kowloon Sewage Plan[2] show mean suspended solids concentrations in the vicinity of marine outfalls of 70-100 mg/l. Corresponding data recorded at EPD monitoring stations VM9-VM11 between January 1990 and July 1990 show mean suspended solids concentrations of 5.3 mg/l. Hydraulics Research have pointed out that in embayments or typhoon shelters, siltation rates of up to 100 mm/year might be expected.

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(1) Chalmers, M.L. (1984) Preliminary Assessment of Sedimentation in Victoria Harbour, Hong Kong. Geological Society of Hong Kong, Bull. No.1 pp 117-129 1984

(2) Acer/J. Taylor (1990) : Northwest Kowloon Sewage Master Plan

4.73 Although this would imply that sediments in the 0-1.0 metre range may have been deposited over a period of 10-25 years, it seems likely that there is considerable variation, with the higher deposition rates occurring only in localised areas - this is partly corroborated by the localised annual maintenance dredging requirements in areas such as the Cheung Sha Wan boatyards, and Yau Ma Tei typhoon shelter. In the latter, the annual maintenance dredging volume is 100,000 cubic metres of spoil. This figure represents an annual deposition rate of slightly less than 20.0 cms/annum, or five times the annual average deposition rate quoted by Chalmers.

4.74 The distribution of metals with depth that was recorded during the CESD West Kowloon survey demonstrated that the highest concentrations of some metals, most notably copper and lead occur in the 0-1 metre depth range. Although providing no conclusive evidence of deposition rates, it should be noted that both these metals are associated with effluent discharges from electroplating and electronic component manufacturing businesses, and that both of these sectors have only proliferated during the past two decades. During the course of site investigation activities the issue of sediment deposition and contaminant profiles has been addressed, however there are clear disparities in recorded trace metal contamination values from the same sites, and inconsistencies in their vertical distribution.

4.75 We attribute this feature to two processes:

- The highest concentrations of trace metals occur generally in confined nearshore areas, and the principal point sources of this material are the storm and foul sewers that simultaneously discharge high volumes of suspended organic material. Industrial effluent discharges are generally discontinuous, occurring on completion of a process run, and as a consequence trace metal concentrations within discharges vary considerably with time. The opposite applies to the bulk of the solids within the sewer outfalls which are discharged on a continuous basis.

- Because of high sediment deposition rates in these areas, maintenance dredging on a regular basis removes a significant proportion of contaminated sediment but leaves pockets of material or hot spots. Maintenance dredging in combination with high deposition rates produces a non-homogeneous distribution of contaminants extending to a significant depth within the deposits at confined locations such as Typhoon shelters. This is illustrated in the results obtained from analysis of sediment profiles retrieved during the Series C sampling during the present study, and discussed in the following section.

Sediment Contamination Profile (Series C samples)

4.76 Sediment profiles from series C samples retrieved from five stations and three depths in Yau Ma Tei typhoon shelter showed elevated levels of a number of metals at all depths.

4.77 Of particular concern were high lead and Mercury values. As a measure of the extent of these elevated concentrations it may be noted that in the series A and b surveys of West Kowloon, only five values in excess of the interim guideline values were recorded, whereas in Yau Ma Tei (Series C) eleven values in excess of the guideline figures were recorded from five stations.

o Mercury

Mercury values from Station S5 at depths between 0 and 2.0 metres are the highest concentrations of Mercury in marine sediment recorded in Hong Kong. In three of the five stations sampled the recorded values exceeded the guideline values of 5.0 mg/kg, and the concentrations of 13.5-17.0 mg/kg from station 5 give cause for serious concern. It is important to emphasize that concentrations of up to 7.6 mg/kg were recorded in the depth range 2.0-3.0 metres, and that all of the depth ranges analyzed showed values in excess of the Deep Bay guideline values.

o Lead

In the case of lead values, four stations out of the five stations sampled showed concentrations in excess of the guideline value of 200 mg/kg. The worst locations were stations 2 and 5 where levels of 359.0 and 300.9 were recorded against a guideline value of 200 mg/kg. The frequency of these high concentrations, their broad distribution with depth, and the consistency of concentrations in excess of the interim limit values are reason for serious concern in view of the anticipated dredging and spoil disposal requirements for this area.

Summary of Ambient Conditions in WKR Sediments

4.78 The following points summarise the ambient conditions in WKR area sediments :

- Sedimentation processes in West Kowloon are assisted by weak currents in combination with substantial inputs of suspended solids from the Pearl River and marine outfalls discharging from the West Kowloon hinterland.

- Sediments contain a high silt/clay fraction (>80% d.w.), with 3-5% organic matter, and high nutrient and COD levels. They are anaerobic, and indicative of a highly polluted environment.

- Of 539 observations of contaminant concentrations, during the series A and B sampling programmes only 7 exceeded the interim guideline concentrations for Deep Bay. Three of these values were for copper, and four for lead. In the series C sampling survey, 11 values of lead and mercury exceeded the guideline concentrations in Yau Ma Tei typhoon shelter.

- The catchment with the highest concentrations of toxic metals was Cheung Sha Wan. This area recorded the highest values of copper, zinc, and chromium, and some of the highest levels of lead and nickel. It also had the highest concentration of total toxic metals in West Kowloon with 741.0 mg/Kg.

- The highest frequency of elevated metal concentrations at all depths and the highest values of mercury were retrieved from Yau Ma Tei typhoon shelter.

- The primary contributors to toxic metal contamination of sediments are the electroplating and electronics industry sectors - most notably in the Cheung Sha Wan industrial area.

- o Sediment profiles suggest that the greatest concentrations of metals occur in the range 0-1.0 metres, but very high concentrations may occur at depths < 2.0 metres in confined areas

- o Evidence suggests that the sediment deposition rate is 40.0 mm/annum with the highest rates in the nearshore area of West Kowloon. On a localised basis rates may be substantially greater, especially in the vicinity of outfalls and in typhoon shelters. We suggest in Yau Ma Tei typhoon shelter this may be as high as 20 cm/annum.

- o Evidence from EPD monitoring suggests significant PCB contamination.

- o From the perspective of spoil disposal requirements, we suggest that at two locations in particular marine sediment is unsuitable for disposal to gazetted marine dumping sites. These areas are:

  - the nearshore zone adjacent to cheung Sha Wan; and
  - Yau Ma Tei typhoon shelter

- o Sediment from these locations should remain in site or be allocated to contained-disposal sites.

5. Noise Impacts

5. NOISE IMPACTS

Introduction

5.01 The scale of the construction activities necessary to the establishment of the West Kowloon Reclamation suggests a potential for significant noise impact to occur at noise sensitive receivers (NSR) in the existing West Kowloon hinterland. Against this, however, it should be considered that many of these activities will be occurring at distances in excess of 500 metres from the current seawall, and thus may be sufficiently mitigated by distance attenuation.

5.02 The approach adopted to predict likely noise impacts involved obtaining three sets of information, as follows :-

- baseline noise levels at the West Kowloon waterfront;
- the noise levels generated by types of construction plant or construction activity;
- the distance from the noise source to the receiver.

5.03 Once this information was known it was then possible to relate individual or groups of noise sources, to discrete neighbourhoods on the West Kowloon Waterfront. The likely distance from source to receiver was determined in consultation with the engineering design team, and allowed the extent of noise attenuation with distance to be predicted. It was then possible to determine the likely cumulative noise impact resulting from the different sources.

5.04 The predicted impact was then compared with two sets of criteria :

- the acceptable noise level (ANL) for sensitive receivers as specified in the Noise Control Ordinance (NCO);
- the existing background noise levels.

On this basis it was possible to determine the significance of the noise impact at each neighbourhood.

Potential Sources

5.05 As indicated in Section 2, a wide range of noise sources will be located on the reclamation works. For most of the types of plant involved in these construction activities the sound power level can be obtained by reference to the Technical Memorandum on Noise from Construction work other than Percussive Piling. For activities where levels have not been determined, an estimate was made.

5.06 The principal activities associated with construction of the West Kowloon Reclamation are profiled below :-

o **Dredging of Marine Sediments**

In the northern part of the reclamation up to 3 grab dredgers, with a sound power level (SWL) of 112 dB(A) will be used, in addition to which a tugboat (SWL 110 dB(A)) is likely to be present for transporting barges. In the southern part it is intended that a trailer suction hopper dredger, with an assumed SWL of 111 dB(A) will be used.

- **Placement of Rockfill for Seawall Construction**

  Placement of the rubble fill for the seawall will involve using grabs to remove material from barges and place it on the line of the wall. The estimated SWL from this activity is 112 dB(A).

- **Block placement for Seawall Construction**

  As with the above activity, a crane and grab arrangement will be necessary, with a likely SWL of 112 dB(A). It is anticipated that in the north of the reclamation two teams will work simultaneously, whilst in the southern area upto 3 teams may be working.

- **Piling for Pier Construction**

  As with seawall construction, noise from this activity can be predicted with reasonable accuracy as it occurs at a relatively fixed distance from the noise receiver. The plant used will be diesel hammers to drive steel piles, with an SWL of 132 dB(A). It is likely that a maximum of 3 piling rigs will be in operation at any one time, for a total of 10 hours over a 12 hour working day.

- **Demolition of Existing Piers**

  This activity will involve the use of an estimated 2 concrete breakers per pier over a 12 hour working day. The SWL from a mounted pneumatic breaker is 122 dB(A). Pier demolition is likely to take between 3 and 6 months.

- **Placement of Marine Fill**

  Fill will be placed by a combination of bottom dumping and "rainbowing" upto sea level. Further fill placement, to a height of +2.5m PD will be done hydraulically for which the generators powering the pumps are likely to be the most significant noise source.

- **Placement of Land Sourced-fill**

  The final few metres of the reclamation in the north may be completed using completely decomposed granite (CDG). It is assumed that the material will be transported, from the quarry at North Lantau by barge. It is considered by the engineering design team that the material supply will be the limiting factor so that only 2 bulldozers per site will be required. The SWL from this plant is 115 dB(A).

- **Compaction**

  Mechanical compactors will be used to aid consolidation of the reclamation. It is likely that a maximum of two per work site will be used. The plant has an SWL of 105 dB(A).

- o **Reprovisioning of Piers and Wholesale Market**

  In the north of the reclamation a number of ferry piers and a wholesale market require reprovisioning. In the south, a public cargo working area must be reprovisioned. The piling associated with the piers has been considered already. In addition, a large number of piles may be required for construction of the market depending on the choice of market option. Once the foundation for the market has been completed, noise should not be a problem.

- o **Works Areas at Sham Shui Po and Man Cheong St.**

  Two works areas have been identified for the initial phases of the reclamation, as captioned above. A third, at the site of the HK ferry shipyard, is likely to be needed for the later phases. As a result of the concentration of activity at these sites it is possible that they may constitute significant noise sources.

It is assumed that the above constitute the primary noise sources during construction.

Sensitive Receivers

5.07 The sites were chosen for baseline noise monitoring in order to represent the situation at existing NSRs on the West Kowloon waterfront. Subsequently, ten "noise neighbourhoods" were identified. It is considered that because of their location and orientation with respect to the construction activities, NSRs within these areas can be regarded as likely to receive a similar impact. The ten noise neighbourhoods and the background monitoring points which relate to them are indicated in Table 5.1. The location of the neighbourhoods and the background noise monitoring sites is also depicted in Figure 1, Annex B.

5.08 The criteria for determining the extent of noise impacts were determined and agreed in consultation with the noise policy group of EPD. It was determined that noise levels produced by construction activities should not exceed the acceptable noise level (ANL) as contained in the Noise Control Ordinance (NCO) Technical Memoranda. Other noise criteria such as noise levels at the nearest NSR facade, from the construction activities alone, should not exceed 75 dB(A) L eq (30 min) when ambient L eq is not greater than 70 dB(A) or should not exceed 5 dB(A) above the ambient L eq when ambient L eq is greater than 70 dB(A). The background noise levels obtained during 24 hour monitoring were discussed in section 4 and are presented in figures 2a-j, Annex B.

Predicted Impacts

5.09 Using data regarding background noise levels and the type and phasing of construction activities, the likely noise impact at the various neighbourhoods during the period from 1991 to 1997 has been determined.

5.10 The manner in which the reclamation is anticipated to proceed is critical to the extent and timing of the impacts at any given site. In general the noise neighbourhoods at either end of the reclamation will be affected by construction activities for a shorter period of time than those waterfront areas towards the middle of West Kowloon.

Table 5.1 Noise neighbourhoods and associated noise sensitive receivers

Noise Neighbourhoods	Sensitive Uses
Mei Foo Sun Chuen, Lai Chi Kok	- Residential blocks - Waterfront walkway - Community Centre - Delia Memorial School
Fat Tseung Street THA, Sham Shui Po	- Temporary housing area
Nam Cheong Estate, Sham Shui Po	- Residential buildings - Public open space
Wong Tai Street, Tai Kok Tsui	- Residential buildings
Hoi King Street, Tai Kok Tsui	- Residential buildings
Cherry Street, Tai Kok Tsui	- Residential blocks - Sharon Luthern School - Ming Kei College
Ferry Street, Yau Ma Tei	- Residential blocks - Yau Ma Tei Catholic Primary School
Man Cheong Street, Yau Ma Tei	- Residential blocks
King George V Memoria Park, Jordan	- The Park
Canton Road, Tsim Sha Tsui	- Government medical and dental clinics - Kowloon Park - Schools

Approach

5.11 For each noise neighbourhood a construction activity programme was determined. This outlined the planned phasing of different activities over the main construction period (1991 - 1994), as they related to different phases of the reclamation. These activity programmes are presented in Annex B, Tables 3(a-j). Reference to these programmes enabled determination of time periods when construction activity would be at a peak.

5.12 It was assumed that activities of distances in excess of 1.5km from the receiver would be indistinguishable from background.

5.13 For each neighbourhood, the time at which many construction activities coincided, or when particularly noisy activities such as piling were planned, were taken to be times of peak noise impact and the noise impact for these times was determined. In addition, activities known to be occurring adjacent to the seawall were investigated. If it was found that the ANL were not exceeded and the background levels were not increased significantly then it was assumed that impact would be insignificant and the assessment proceeded no further. If the noise impact was found to be significant, the next noisiest stage in the programme was predicted for that neighbourhood. The process was repeated until phases in the programme were found where the noise impact became insignificant. In this way critical phases in the programme were defined for each neighbourhood, indicating when noise impacts would become unacceptable.

5.14 Reference was then made to the likely number of people to be affected in each neighbourhood. In some cases this information was provided direct by the Housing Department or by estates management offices. In other cases, the likely number of inhabitants was estimated by reference to a photographic record obtained during field surveys.

5.15 The noise impacts resulting from multiple sources were modelled using a computer programme to determine the degree of attenuation due to distance, and for the cumulative effect of the total numbers of plant from several noise sources. The notional distance referred to in Figure 3 of Annex B is the distance from a point, that lies midway between the site boundary and the location of the noise producing activity, to the NSR. The minimum distance is from a point in the site, closest to the NSR, to the NSR itself.

Neighbourhood Impacts

5.16 Predicted noise levels for each of the neighbourhoods are outlined in the section that follows. Key noise sources, i.e. those responsible for a substantial component of the noise impact are identified. This is in order to better identify targets for mitigation measures. Periods during which noise levels, in the absence of mitigation measures, will be unacceptable are outlined for each neighbourhood.

Predicted Noise Impacts

5.17 The following paragraphs outline the predicted noise impacts for the ten noise neighbourhoods outlined on the West Kowloon waterfront. The data to support these findings are presented in Table 4 (General Construction Noise) and Table 5 (Piling Noise) of Annex B. The criteria used to define an unacceptable impact is a 5 dB(A) increase above background levels during the day time and the use of the acceptable noise level (ANL) for these areas, as specified in the NCO.

Mei Foo Sun Chuen

5.18 Approximately 4,200 people will be affected by noise from dredging and fill placement activities between May '91 and January '94 taking place on reclamation area LC1. Piling noise is not predicted to affect this area. However, it is not anticipated that dredging and fill placement activities will take place close to the existing seawall, as a result of the likelihood that marine sediments will be left in-situ and reclamation will proceed by foundation improvement and surcharging. The noise levels may reach 82 dB(A) when bulldozers and compactors are working right in front of the receivers. This activity will be very disturbing but for a short period of time (4 weeks) only. More generally, noise levels will be increased by reclamation activities. A maximum of 8 dB(A) above current background levels may result.

Fat Tseung Street THA

5.19 A population of 500 will be affected by mud dredging at CS1, during June 91 and by fill-placement during February and March '92 from the same area. Pier demolition at CS2 will affect the area from January to June '93 and fill placement will be critical during January '94 at CS2 and TK2. The noisiest activities will come from demolition of the present piers on CS2 with noise levels up to 80 dB(A) for 13 weeks. Throughout the initial phase of construction the adjacent proposed works area may constitute a significant noise source; from general construction activities and vehicle movements.

5.20 Piling for piers on CS1 from April to August '91 and for piers and the wholesale market between August '91 and March '92 will produce noise levels between 17 and 29 dB(A) above current background levels, but this is still within the ANL for piling activities. Piling for the market will depend on the market development option selected but is unlikely to be extensive.

5.21 Fat Tseung Street THA is unique among sensitive receivers at West Kowloon in that noise impacts can be efficiently mitigated by provision of noise barriers which would provide a 10 dB(A) reduction in predicted noise levels.

Nam Cheong Estate

5.22 Up to 2,500 people may be affected by mud dredging on area TK2 between August '92 and April '93 but noise levels are unlikely to be much greater than current background. Fill placement on the same area between May '93 and June '94 will also be of concern. The placement of marine fill and land-sourced fill will become the most significant noise sources. There will be between 11 and 18 dB(A) exceedance above the existing background levels, for a period of four weeks.

5.23 Piling noise from pier construction on CS1 and TK1 will affect the area between April '91 and April '92, producing noise levels between 3 and 15 dB(A) above background levels.

Wong Tai Street

5.24 Mud dredging and fill placement on CS1 and TK2 will affect approximately 1,700 people for certain periods between August '92 and July '94 with noise levels upto 17 dB(A) above background. These will become the predominent noise sources for a long period but high noise levels upto 82 dB(A) will only last for short periods of time while operating close to the sensitive receivers.

5.25 Piling for piers on CS1 and TK1 will produce noise levels between 8 and 16 dB(A) above background during the period April '91 to December '92. There may be some impact to the kindergarten on the 2nd floor in Tai Yik House.

Hoi King Street

5.26 Dredging and filling activities in the southern section of the WKR will affect approximately 200 people with noise levels upto 20 dB(A) above background levels during July, October and November '91, February - March and October-November '92, and from July '93 to February '94. These activities will become the major noise sources when they are operating chose to the shoreline.

5.27 Piling activities on CS1, TK1 and the southern part of the reclamation will produce noise levels upto 17 dB(A) above background levels during the period April '91 to December '92 but this lies within the ANL from piling.

Cherry Street

5.28 From July to September '91 approximately 500 people will be affected by dredging and seawall construction on the southern part of the reclamation. In particular the Ming Kei College and Sharon Luthern School may be affected with noise level predicted at 8-14 dB(A) above background. No other significant noise impacts are predicted for this neighbourhood, due mainly to the relatively high background noise levels. Piling noise is predicted upto 75 dB(A) and should not affected the schools in view of the high noise background.

Ferry Street

5.29 Dredging and filling of the existing Yau Ma Tei Typhoon Shelter will affect approximately 3,000 people and the Yau Ma Tei Catholic Primary School with noise levels upto 11 dB(A) above background levels during the period June '93 to February '94. The distance between the waterfront and the receivers together with the high background noise levels would reduce the noise impact from construction activities. However, the predicted noise level would still exceed the criteria level for a short period of time.

5.30 Piling activities associated with the marine dolphins in contract 1 of the southern section, together with piling on TK1 will produce noise levels upto 9 dB(A) above background during the periods December '91 to February '92 and September '92 to July '93. This will not have a significant impact to the surroundings.

Man Cheong Street

5.31 Dredging and filling activities on the south of the reclamation will produce noise levels upto 17 dB(A) above background levels during the periods August '91 to April '92 and from July '93 to February '94 upto 2,500 people may be affected. Sheet piling for construction of the bridge to carry the access road to the PCWA will result in noise levels of 88 dB(A) which exceed the ANL. This will require restricted operation of 5 hours on any day not being a general holiday. The proposed works area adjacent to Man Cheong St has the potential to cause further long term noise impact. It will be necessary to ensure that construction work is limited to between 0700 and 1900 hours.

King George V Park

5.32 This area is not expected to experience noise impacts from general construction activities but piling activities may produce noise levels upto 8 dB(A) above background levels, during the period October '91 to September '93.

Canton Road

5.33 General construction activities from dredging and sea wall construction on S2 will produce noise levels upto 57 dB(A) which is lower than the daytime background. On the other hand, piling activities may produce noise levels in this area upto 9 dB(A) above background during the period October '91 to April '92. With the predicted noise levels of 73 dB(A), this should not be a problem as it falls well below the ANL for piling activities. Besides, the high traffic noise background which reaches 72 dB(A) during the day time would also lessen the impact.

Daytime and Nighttime Activities

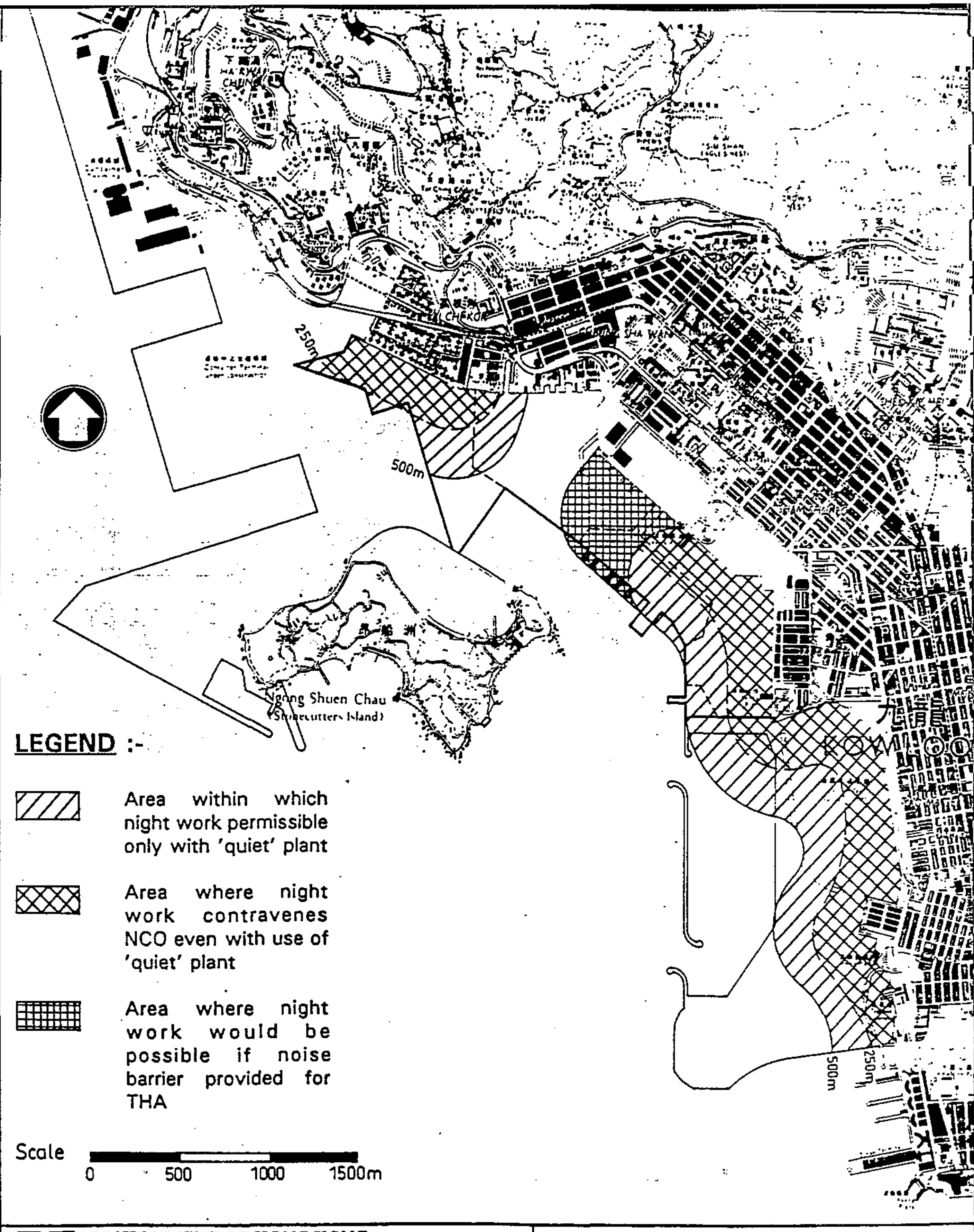
5.34 A distinction has been drawn between noise impacts occurring during the daytime and those at nighttime. ANL differ for residential accommodation between day and night and the background noise levels are also different. In addition, the construction activities occurring are different. The main noise source, piling, is expected to occur for 10 hours, over a 12 hour day. Other activities such as seawall construction may occur over an 18 hour period whilst it is anticipated that dredging and filling operations may be 24 hour where permissable.

5.35 Of particular concern in this respect is the possibility of 24 hour dredging and filling operations. In this event it would be necessary to comply with the Noise Control Ordinance and adhere to a 55 dB(A) and in some cases 50 dB(A) nighttime (between 2300 and 0700 hours) and weekend noise limit. Predictions of expected noise levels suggest that dredging and filling within 500 m of noise sensitive receivers will not achieve compliance with the ordinance (Fig 5.1). In view of this it is suggested that quiet equipment be specified in contract documents as a requirement for night-time working. This should decrease the critical distance to approximately 250 metres within which nighttime working will contravene the ordinance. Between 1900 and 2300 hours, noise restrictions are not as tight and working closer to the seawall may be permissable. Further possible measures include the creation of a noise barrier on the seaward side of Fat Tseung Street THA (after obtaining the agreement of residents) which would enable working close into the seawall. The likelihood that dredging will not occur in a number of areas adjacent to the seawall (as indicated on Fig 5.2) will reduce the potential for noise impacts. It should also lessen demands on dredging plant such that programming will be able to minimise the amount of 24 hour operations.

5.36 If 24 hour working does occur, the contractor will need to apply for a construction noise permit to work between the hours of 1900 and 0700. The application must state the type of plant to be used, the distances to the noise sensitive receivers, and the times when working is intended. The application must demonstrate that appropriate basic noise level (BNLs) will not be exceeded. The relevant BNLs can be obtained by reference to Table 2 of the Technical Memorandum on Noise from Construction Work other than from Percussion Piling, available from the EPD.

Sewerage Refurbishment

5.37 In addition to impacts experienced at the waterfront, parts of the West Kowloon hinterland will be affected by noise impacts resulting from an extensive sewerage refurbishment scheme associated with the reclamation. As a consequence of the



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TERRITORY DEVELOPMENT DEPARTMENT
URBAN AREA DEVELOPMENT OFFICE

WEST KOWLOON RECLAMATION

FIG 5.1
AREAS WHERE 24 HOUR DREDGING AND FILLING MAY CONTRAVENE NCO

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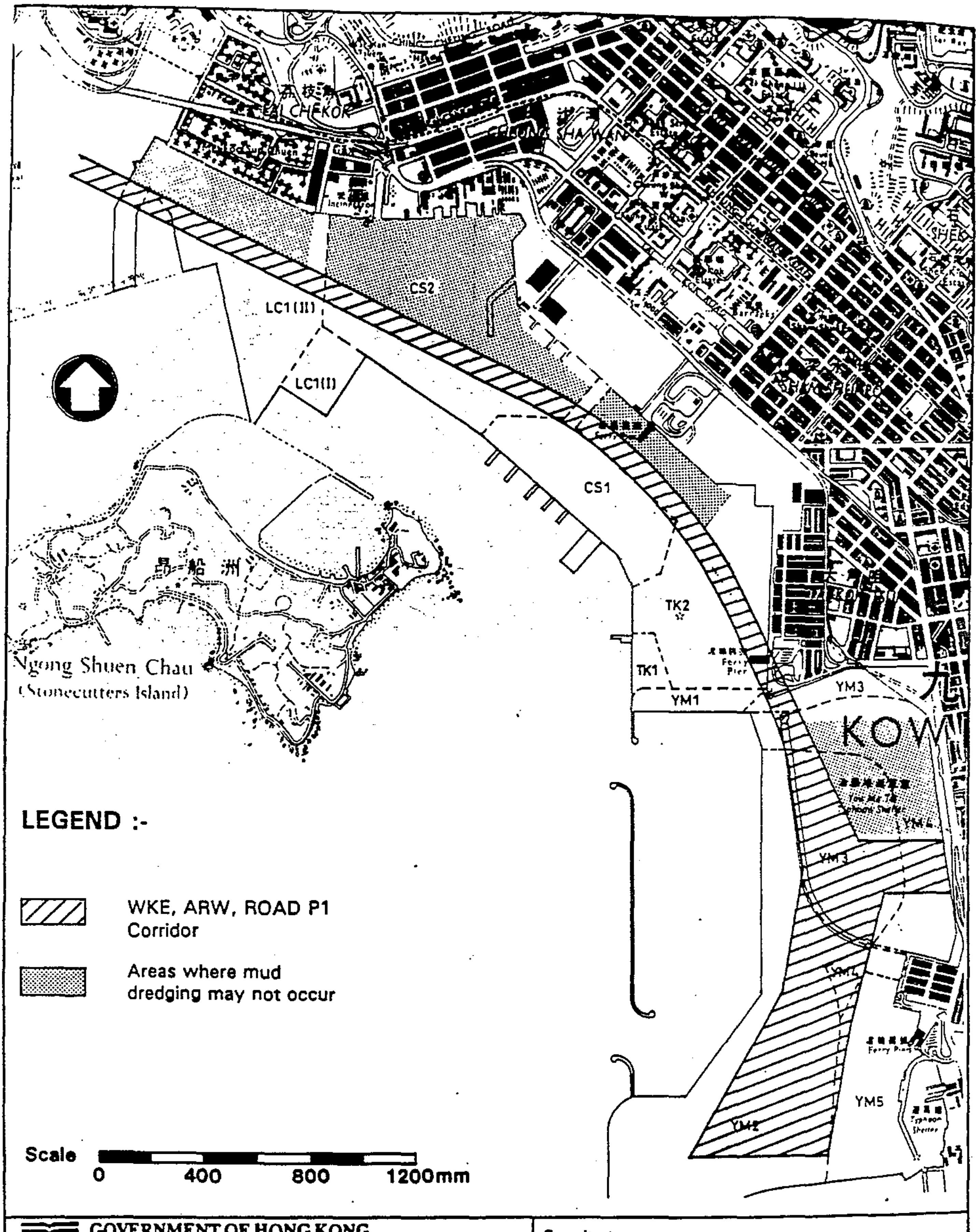

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WEST KOWLOON RECLAMATION

FIG. 5.2

AREAS WHERE MUD DREDGING MAY NOT OCCUR

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relatively slow likely rate of progress (an average of perhaps 10 m/week) it is anticipated that sensitive receivers will be affected for up to 2 or 3 months in some cases. The plant involved will include concrete breakers, excavators, compressors and compactors and is likely to produce a significant noise impact. Details of the areas to be affected are presented in Table 2 Annex A.

Mitigation

5.38 Quiet plant should be specified for all works associated with sewerage relaying. In addition working should not exceed a 12-hour day, from 0700 to 1900. Impacts on residential buildings are still likely to be significant but in view of the nature of the environment, adequate mitigation is unlikely to be possible.

5.39 From the results indicated in the previous section, some activity associated with dredging and fill placement will also exceed the daytime recommended guideline of a 5 dB(A) increase above existing noise background levels at certain waterfront sites. Unmitigated activity will exceed this recommended level and mitigation measures should be incorporated into the contracts to reduce the impacts. During the holidays and between 1900-0700, construction work will require a construction noise permit. The acceptable noise levels during these periods are 55 and 50 dB(A) (70 and 65 dB(A) between the hours of 1900 and 2300) depending on the locality of the sensitive receivers. Any noise produced from the construction activities will be controlled under the NCO within these specific hours.

5.40 It is important to clarify the status of acceptable noise levels (ANL) as defined under the Technical Memorandum of the NCO. These levels apply to noise generated by construction activities other than piling. More latitude is permitted with noise generated by piling activities because of its intermittent nature. The nature of the noise produced by these two categories of activity is sufficiently different that separate levels of control are required. Similarly, the difference in the quality of the noise impact precludes the addition of noise from these two sources into one common score. The following outlines the controls presented under the Technical Memorandum:

- **Technical Memorandum on noise from construction work other than Percussive Piling;**

For general construction work, no noise restrictions are imposed during daytime hours of normal days (0700-1900 Monday-Saturday inclusive) but, during evenings (1900-2300) and night-time (2300-0700) and Sundays and Public Holidays, a construction noise permit (CNP) is required from EPD who will assess the application in accordance with the Technical Memorandum on "Noise from Construction Work other than Percussive Piling". Acceptable Noise Levels (ANL) have been stipulated, assuming no correction for the duration of the CNP or multiple site situation, which must not be exceeded and these are given in Table 5.2.

Table 5.2 Acceptable Noise Levels (ANL) for General Construction Work			
	Area Sensitivity Rating (ASR)		
Time Period	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

From the study of the surrounding noise environment it is considered that ASR for the designated NSRs should be "B" and "C", and the corresponding ANLs for general construction work are 65 dB(A) during evenings and daytimes of public holidays, and 50 dB(A) and 55 db(A) for the night-time.

o **Technical Memorandum on noise from percussive piling**

Another set of noise criteria is applied to control the noise from piling activities. The ANL for piling noise is generally 85 dB(A) for receivers with windows or other openings but without a central air conditioning system. However, 10 dB(A) is subtracted from the ANL for NSR's which are hospitals, medical clinics and educational institutions. The CNL is designed as 85 dB(A) in the study.

A permit will be required from EPD for the carrying out of percussive piling. In determining the issue of permit, EPD will compare the corrected Noise Level (CNL) with the ANL and in the event that the CNL exceeds the ANL, EPD will impose restrictions on the permitted hours of piling operation in accordance with Table 5.3.

Table 5.3 Permitted Hours of Operation	
Amount by which CNL exceeds ANL	Permitted hours of operation on any day not being a general holiday
more than 10 dB(A)	0800 to 0900 AND 1230 to 1330 AND 1700 to 1800
between 1 dB(A) and 10 dB(A)	0800 to 0930 AND 1200 to 1400 AND 1630 to 1800
no exceedance	0700 to 1900

Further clarification may be obtained by reference to the Technical Memorandum of the Noise Control Ordinance.

Key Activities to be Mitigated

5.41 The options available for mitigation range from the type of plant to the timing and location of activities. Certain activities by their nature, can only be controlled by specification of quiet or silenced equipment, the provision of noise screening or the timing of the activity during the day. One example of this is piling, as it must occur at a specific location. Other activities, such as dredging or filling, can often be organised so that they do not occur at night in areas close to sensitive receivers.

5.42 To reduce the noise levels from dredging operation to 55 dB(A) at sensitive receivers will require such equipment to be located 500 m or more away from the NSRs. This will be one of the ways to achieve the criteria level. For sensitive receivers located in a quiet environment, the dredging operation should not be permitted within 900 m from NSRs so as to achieve the 50 dB(A) standard. If the contractor wishes to carry out works closer to the shoreline at night, either silenced equipment or quiet working methods must be employed. Moreover, it is recommended that the frequency and duration of noisy activities should be minimised and should be timed for the middle of the day, late morning or early evening as far as practicable. Engine covers should be kept closed when powered mechanical equipment is in operation. The use of quiet plant has the potential to reduce noise levels by about 5 dB(A).

5.43 Besides source control, the overall noise levels can also be reduced by re-scheduling of the construction activities. This can be done by shifting noisy operations to reduce the cumulative effect on certain noise sensitive receivers.

5.44 From the results of the prediction, piling does not cause a significant problem except for residents at Man Cheong Street which is predicted to have a noise levels of 88 dB(A) for a duration of 2 weeks. Under the NCO, it is recommended to reduce the piling hours to 5 hours each day between 0800-0930, 1200-1400 and 1630-1800. In addition, the contractor should use drop hammer and/or other quieter construction methods as far as practicable. This should be applied to all piling sites in order to reduce the overall impact to the surrounding environment.

5.45 Disturbance to residential streets and disruption to traffic flow caused by resewerage works in the West Kowloon hinterland will result in noise impacts in some areas. An adequate traffic management scheme should be arranged, in consultation with the Highways Department and the Royal Hong Kong Police Force.

Monitoring and Audit

5.46 Monitoring and Audit requirements for noise associated with the WKR to ensure compliance with the NCO and the effectiveness of mitigation measures are presented in Annex E.

5.47 Requirements for mitigation of noise impacts should be included in tender and contract documents. Suggested contract clauses to ensure mitigation of noise impacts are contained in Annex F.

6. Air Quality Impacts

6. AIR QUALITY IMPACTS

Introduction

6.01 Impacts on air quality may arise from earth moving activities during reclamation and other construction activities within the working area such as concrete batching, material handling and vehicle movement on unpaved roads. These activities will generate a significant amount of dust to the surrounding environment if uncontrolled. Other pollutants may arise from exhaust emissions from trucks and other powered mechanical equipment within the construction site, but the impacts should be limited due to the relatively small numbers of plant involved and the generally large distance to sensitive receptors. This section presents an assessment of the potential air quality impacts to sensitive receptors based on the existing available information.

Potential Sources

6.02 During the WKR Works, a vast quantity of fill material will be imported from borrow areas. Dust emissions will arise from various operations such as fill material handling during the later stages of reclamation, stockpiling, concrete batching, and truck movements on unpaved haul roads. These operations may cause adverse air quality impacts in the vicinity if uncontrolled. The dust emission rates for these sources have been estimated using "Compilation of Air Pollutant Emission Factors", AP-42, USEPA, 4th edition 1986. Details of each emission source are discussed below. Other general construction and demolition activities (for example demolition of existing ferry piers) will also produce dust but are not expected to be significant when compared to the activities considered below.

Handling of the Fill Material

6.03 The total quantity of marine fill required for the reclamation is 29 Mm^3. This would require approximately 185,000 m^3 of sand to be transported by hopper/barge to site every week. Several methods of placing the fill material are available. It is probable that the contractor would use a combination of methods which would depend on the method of fill transport from borrow area and the location and accessibility of the area being filled at the time. The sand will most probably be transported to the site by bottom dumping barge/hopper and "rainbowing" or jetting into the fill area.

6.04 Due to the wet nature of the marine fill, dust emissions will be minimised. Emissions may still occur, however, when the fill material is being spread by bulldozers. Moreover, it is likely that the top layer of the reclamation will comprise completely decomposed granite (CDG). This operation is likely to be the major source of dust. The emission rate from unloading operations will be 0.028 Kg/ton. Assuming a rate of transport to the reclamation of 500 ton per day, the dust emission rate will be 1.17 Kg/hour. Once the reclaimed area has been built up to the design level, the area will be compacted which should act to reduce dust emissions from the site.

Stockpiling

6.05 Stockpiling of material inevitably incurs an element of double-handling and as such it is likely that the contractor will make every effort to ensure that the amount of stockpiling is minimised. Although there are no definite plans for stockpiling the fill material, it is still possible that the contractor will have stockpiles of building material within the working area. These will be of small quantity and the emission rates are, respectively, 15 and 4 Kg/hectare/day approximately for active and inactive stockpiles. Assuming the size of the stockpiles is 50x50 metres, the emission rates become 154 g/hr and 41 g/hr respectively. This is not considered to have significant air quality impact potential.

Concrete Batching Plant

6.06 It has been proposed that 2 concrete batching plans with a capacity of 60 cubic metres per hour will be installed in the northern area of the site. One of them will be located in the working area next to the bus terminal at Sham Shui Po Ferry Pier. The other one will be located at the existing Hong Kong Ferry shipyard. These plants are intended to produce concrete for the construction of the reprovisioned facilities. The operation of these plans will create fugitive dust emissions from cement silos, aggregate stockpiles, cement conveying and the movement of truck mixers on unpaved roads. To predict the likely impact from these activities, an emission factor of 0.12 Kg/m^3 is used as a worst-case scenario (assuming no control measures), and gives an emission rate of 7.2 Kg/hr. The use of normal control measures should ensure, however, that emissions are reduced to a maximum of about 0.7 Kg/hour.

6.07 Such operation is also classified as a Specified Process which is controlled under the Air Pollution Control Ordinance. The contractor is required to apply for the necessary permit from EPD before commencing such operation.

Vehicle Movement Over Unpaved Haul Roads

6.08 When a vehicle travels on an unpaved road, particles are lifted and dropped from the rolling wheels. Dust emission from this source will depend on vehicle speed and weight, surface silt content and moisture content. It has been estimated that the emission factor from vehicles on unpaved roads is 3650 g/vehicle/km for an average vehicle weight of 20 tonnes travelling at 20 km/hr on an unpaved road.

6.09 Most of the vehicles on site are used for transportation of the construction material such as cement and aggregate for concrete batching, piles, steel bars and general building materials for construction. It is expected that only 5 vehicles per hour will be generated from transportation of this material. The bulk of the fill material will be transported to the site by barge which significantly reduces the amount of the material to be transported by road.

Sensitive Receptors

6.10 Most of the sensitive receptors are residential buildings lying along the existing waterfront and are the same as those considered in the noise impact assessment. A detailed description of the area has been provided in sections 3 and 4, and Annex A.

Predicted Impacts

Introduction

6.11 As identified in 6.02, there are four major dust sources which may affect the air quality of the surrounding environment. Since the exact location of each operation has not yet been fixed, the likely impact will depend on their location with respect to the nearest sensitive receptors.. The prediction results are based on worst-case meteorological conditions in which 2 m/s and 5 m/s wind are blowing directly to receptors under atmospheric stability class D.

Prediction Methodology

6.12 Two computer models have been used to predict different dust emission sources; both are Gaussian dispersion models. The short-term version of the Industrial Source Complex Dispersion Model as employed to predict the particulate concentration from stationary sources. In addition, a line source dispersion model, CALINE 3, was used to predict the particulate concentration from unpaved haul roads. Both models require the gravitational settling velocity for the particulates as input parameters.

6.13 Based on the users guide to the ISC model, the gravitational settling velocity was calculated by assuming one category of particle size (0-30 microns) and a particle density of 2500 Kg/m^3. This gives the gravitational settling velocity of 3.0 cm/s and the reflection coefficient of 0.68. The models can only predict the maximum one-hour particulate concentration due to the absence of appropriate wind data over the 24-hour period. Therefore, the predicted concentration can only be compared with the criterion for dust arising from construction activities, which is 0.5 mg/m^3 over one hour.

Dust Emissions from Fill Material Handling

6.14 Table 6.1 gives the dust emissions from a hypothetical scenario of unloading CDG onto the top layer of reclaimed land at 500 ton per day over an area of 900 square metres. The results indicate that the impact will be confined to within a short distance (100 m) from the source and should not become a problem provided proper control measures, such as minimisation of drop heights, are implemented.

Table 6.1

Predicted Ground Level Concentrations of Particulates Resulting from Unloading Activities

	Particulate Concentration (ug/m^3)	
Downwind Distance(m)	Wind Speed (2 m/s)	Wind Speed (5 m/s)
50	865	347
100	570	231
200	263	109
300	144	60
400	92	39
500	64	27

Dust Emissions from Stockpiles

6.15 Similarly, the likely impacts from active stockpiles and inactive stockpiles were predicted and the results are shown in Table 6.2. The model results indicate that the impact from such activity is low and should not cause any problem even when located close to sensitive receptors.

Table 6.2

Predicted Ground Level Particulate Concentration Resulting from Active or Inactive Stockpiles

Downwind Distance (m)	Particulate Concentration (ug/m^3)			
	Wind Speed 2 (m/s)		Wind Speed (5 m/s)	
	Active Pile	Inactive Pile	Active Pile	Inactive Pile
50	57	15	23	6
100	42	11	15	4
200	27	7	11	3
300	15	4	8	2
400	11	3	4	1
500	8	2	3	1

Dust Emissions from Concrete Batching

6.16 The proposed batching plants are of a small capacity which can run at 60 m^3/hr and the emission rate is 0.12 Kg/m^3 if uncontrolled. When this is emitted over an area of 30 m x 30 m the predicted particulate concentrations are shown in Table 6.3. The results show that the particulate concentration will exceed the one-hour criteria within 400 m from source. However, with proper control measures, the plant can be made acceptable within 100 m, and these measures are likely to be required as a condition of granting a permit for this Specified Process.

Table 6.3

Predicted Ground Level Particulate Concentration Resulting from Concrete Batching

Downwind Distance (m)	Particulate Concentration (ug/m^3)			
	Wind Speed (2 m/s)		Wind Speed (5 m/s)	
	Uncontrolled	Controlled	Uncontrolled	Controlled
50	5320	532	2130	213
100	3500	350	1420	142
200	1620	162	668	67
300	890	89	371	37
400	565	57	238	24
500	392	39	166	17

Dust Emission from Vehicles on Unpaved Road

6.17 Due to the small number of vehicles travelling on site, the amount of dust generated will be limited. Moreover, most of the haul roads will be located away from sensitive receptors. For example, the haul road for the reclaimed area off Sham Shui Po Ferry Pier will cause the ambient dust level to be raised by about 100 ug/m^3. With proper control, the effect from vehicle movements could be further reduced to negligible levels. Table 6.4 gives some predicted particulate concentrations under different scenarios. The proximity of the haul route to the Fat Tseung St. THA makes it essential that good site practice is observed and dust suppression techniques such as frequent watering of site roads are employed.

6.18 The modelling results indicate that all four operations will contribute to increased particulate levels but that the concrete batching is likely to be the most significant source. However, this can be controlled effectively with pollution control measures and significant impacts can be limited to within 100m from source. Particulate emissions from unloading activities may constitute a problem when operations are close to sensitive receptors. Water spraying and compaction reduces such emissions. Similarly, the impact from vehicles travelling on unpaved roads can be reduced by the above measures. Further improvement can be affected by restricting the vehicle speed and paving the haul road.

Table 6.4

Predicted Ground Level Particulate Concentration Resulting from Vehicle Movement on Unpaved Road

Downwind Distance (m)	Particulate Concentration (ug/m^3)			
	Wind Speed (2 m/s)		Wind Speed (5 m/s)	
	Near Parallel Wind	Cross Wind	Near Parallel Wind	Cross Wind
50	177	137	80	63
100	103	86	46	40
200	51	51	23	23
300	29	40	11	17
400	17	34	6	17
500	11	29	6	11

6.19 Most of the sensitive receptors are located well away from the working area except when the operation proceeds to the sea-front. However stationary sources such as the concrete batching plants should be located at more than 200 m away from nearby receptors. Moreover, the prevailing easterly wind will also help to carry away the pollutants seawards from the source towards the harbour and away from sensitive receptors for most of the year. Onshore winds, however, can be expected during the summer period. By taking these factors into account, it is considered that the overall impact can be brought within acceptable limits.

6.20 Recent project development indicate that a number of areas adjacent to the existing sea wall, eg at Mei Foo Sun Chuen, will be reclaimed using foundation improvement and surcharging. In these cases, the reclamation level will be about 5.0m above its final level, for a period of about a year. Large areas of unconsolidated material constitute a potential dust source. It is recommended that such surcharged areas should be treated to reduce the potential for air quality impact. A number of options exist for this such as covering the surcharge with a thin layer of gravel, or spraying the surface with a bitumen binder.

Mitigation

6.21 It should be noted that whilst none of the dust sources profiled above should result in unacceptable impacts in isolation, the possibility exists that a concentration of these activities in any given area of the reclamation may produce a significant impact. It is important, therefore, that recognized dust suppression measures should be employed as a matter of course.

In general, dust should be controlled at source through proper site construction management. The following mitigation measures are considered appropriate and should be implemented during construction as necessary :

Handling of Fill Material

6.22 Every effort and precaution should be taken to minimise dust emissions during the handling of soft fill material. Dust emissions will arise from loading of the fill material and spreading it around. Water spraying can reduce dust emissions significantly. Drop heights should be kept to the minimum practicable. Due to its wet nature, however, it is not expected that marine fill will create much dust, at least until the later stages of filling.

Vehicle Dust Control

6.23 Vehicles with open load carrying sections used for transporting materials on public roads and thereby having the potential to create dust should have properly fitting side and tail boards. The material should be dampened as necessary and covered by a tarpaulin which should be properly secured and extended over the edges of the side and tail boards. Such covering is a legal requirement.

6.24 Regular compaction is recommended for un-paved roadways that are frequently used on site. Water sprays should be used to control dust as necessary on these paved surfaces.

6.25 Vehicles should be restricted to a maximum speed of 8 km per hour and be confined to designated roadways when inside the site.

6.26 A wheel-wash trough should be provided at vehicular traffic exits from the site to minimise the quantity of material deposited on public roads.

Wind Blown Dust from Stockpiling activities

6.27 The most effective way to minimise dust nuisance is to strictly enforce good site management such as minimising drop heights and controlling dust by the use of water sprays. In addition, the stockpile should be located 100 m or more away from any sensitive receptors.

Concrete Batching Plant

6.28 Dust from the concrete batching plant can be controlled by various means. The fugitive emissions from the cement silos should be controlled by bag filters whereas emissions from conveying the product can be reduced by covering the conveyor belt. Spray systems at transfer points for the aggregate can further reduce emissions. Careful siting of the plant within the construction site can also reduce the dust impacts to nearby sensitive receptors. It is also recommended that the plant should be located at least 100 m from residential development.

Pier Demolition

6.29 At one site on the reclamation, at Tai Kok Tsui, demolition of an existing pier will be necessary in the vicinity of sensitive receivers. Thus is a potentially significant source of dust to people using the ferry or the local sitting out area. It will be necesssary to ensure adequate water spraying during the operation to suppress dust.

Monitoring and Audit

6.30 In order to assess the extent of air quality impacts during the construction period, and to determine the effectiveness of routine mitigation measures, routine monitoring of air quality will be required. Details are presented in 2., Annex E. Examples of mitigation measures that should be included in contract documents are presented in Annex F.

7. Water Quality Impacts

7. WATER QUALITY IMPACTS

Background

7.01 Existing water and sediment quality in Victoria Harbour and HK waters in general, reflect a major imbalance within the eco-system caused by the overloading of the coastal waters with domestic and industrial effluents. The resulting nutrient enrichment has promoted the development of eutrophic conditions reflected in an increasing incidence of dinoflagellate blooms or "red tides" with corresponding toxic effects. These in turn lead to further oxygen depletion as the bloom decays. The general trend has thus been a progressive deterioration in water quality. The result of this process has been the elevation or suppression of a number of critical water quality parameter values to a level where they exceed or come very close to the water quality compliance standards established under the Water Pollution Control Ordinance (1982).

7.02 Under these circumstances, and within the context of the environmental assessment two issues arise :-

- o Firstly, short term deterioration in water quality conditions commonly associated with the type of construction programme investigated in this study, may assume more significant dimensions, because of the proximity to threshold values for key parameters, even under ambient conditions.

- o The prediction of water quality changes is constrained by the difficulty of attributing generalised effects to specific construction activities, rather than for example to effluent discharges. In practise many of the potential impacts arise from the combined effects of WKR construction activities and conditions brought about by peripheral or adjacent activities.

Potential Sources of Water Quality Impact

7.03 Principal activities or sources that have the potential to generate adverse impacts throughout the WKR construction phase are as follows :

- o Dredging Activities will generate increased suspended sediment loadings to the water column, with corresponding effects on BOD and dissolved oxygen levels. Further potential effects include the release to the water column of bacteria and soluble forms of pollutants, including metals; the more readily released metals occurring in the WKR sediments would be nickel, chromium, copper and lead. In general, cadium and mercury are not readily released, although in the case of the latter, limited amounts of organo-mercury compounds may be formed in the presence of methylating bacteria.

  Adverse effects associated with the above processes, primarily with the release of suspended sediments, varies with the dredging method adopted, the physical and chemical characteristics of the spoil/fill, contractual controls, and the type of activity including :

  - dredging of contaminated sediments;
  - dredging of uncontaminated sediments;

- sediment transport and disposal activities;
- associated reclamation/fill activities;

These issues are discussed in greater detail in Section 8.0 Sediment Impacts. The distribution and dispersion of suspended material, and hence, concentration, will be influenced by the points considered below.

o Landform Configuration during both the interim and long term period will influence flushing capacity within the project area. Two primary influences will be :

- the proposed closure of the channel between Stonecutters Island and the N.W. Kowloon shore by the requirements of the CT7/CT8 development in conjunction with WKR, and the associated increase in residence time of water in the northern part of the project area. On the basis of available estimates we anticipate a reduction in current speeds of > 80%. Based on results from the WHAMO water quality modelling exercise, we anticipate no significant water movement in the northern part of the project area.

- the operational requirements of the reprovisioning programme which will result in the establishment during the interim period of a number of semi-enclosed water bodies. The extent to which the creation of these water bodies exerts adverse impacts is largely determined by effluent flows. The interim (1992/93) and long term landforms of the reclamation are illustrated in Figure 3 and 4 of Annex C respectively. The semi-enclosed areas (including the reprovisioned Yau Ma Tei typhoon shelter), at December 1992 will comprise an estimated area of approximately 270 ha, and will at this point continue to receive a daily pollutant loading of 55-75 tonnes of BOD.

o Effluent Flows will continue to discharge at current volumes until the proposed implementation of the N.W. Kowloon Sewage treatment and Disposal Programme (Stage 1) in early 1993. Reprovisioning and programming requirements will result in the diversion of stormwater flows to discharge points on the seaward side of the WKR around the same time. In the short term this will result in accumulation of effluent in the embayed areas described above, with the potential for a significant deterioration in water quality in such areas, but in the long term water quality should improve.

Sensitive Receptors

7.04 The consultants have sought to identify sensitive receptors within the context and compliance requirements of the Victoria Harbour Water Quality Control Zone. As has been noted, however, the failure of existing conditions to comply with the criteria adopted under the above, means that in purely practical terms emphasis has been placed on identifying activities where utilisation of seawater may impinge on public health interests.

- Industrial and domestic seawater abstraction

The principal consumers of seawater for flushing and cooling purposes in West Kowloon include :

- The MTR seawater intake at Lai Chi Kok (coordinates 833100E 821600N)

- The WSD seawater intake at Cheung Sha Wan (coordinates 833500E 821200N)

- The CFT seawater intake at Tsim Sha Tsui

Of these, the MTR intake is seen as the most critical due to :

- Its position in one of the most polluted parts of the WKR project area, and more particularly in the proximity of the Waterboat Dock outfall (Station 7 Fig. 2, Annex C).

- Its location in one of the embayed areas noted above and the associated potential for accumulation of effluents and increased suspended solids loadings.

- The very substantial intake flow of 112,000 m^3/day.

Discussion with MTRC has suggested a critical threshold, based on operational requirements, of a suspended solids level of 180 mg/l. Adopting the proposed VHWQCZ limit value for dissolved oxygen levels would require minimum dissolved oxygen concentration of 2.0 mg/l (bottom values on 90% of sampling occasions), and coliform numbers of 20,000/100 ml. (annual geometric mean). The consultants have adopted these criteria for all intakes in the WKR area.

Depth averaged values for these parameters in the vicinity of the above intakes on a single sampling are presented in Table 7.1, and should be seen only as indicative of conditions :

Table 7.1

Water Quality in the Vicinity of Existing Intakes

Location	DO (mg/l)	SS (mg/l)	E. Coli (per 100 ml)
MTRC	4.58	32.0	33000
WSD	4.31	70.0	60725
CFT	5.45	36.0	1615

- Marine Life

  Under current circumstances, given the depletion of marine life under ambient conditions due to the considerable pollutant loading, the consultants do not believe the adoption of this category of BU as a sensitive receptor particularly meaningful. The transfer and bio-accumulation of contaminants through adsorbtion to suspended particulate material might offer one route by which adverse impacts associated with construction activities may be transferred via the food chain, eg. via filter feeders such as bivalve molluscs. While such an eventuality would give cause for concern, in the present context, there is insufficient evidence available to quantify this possibility.

- Public Health Interests

  Concern regarding public health interests is associated with the potential for considerable accumulation of effluents in the embayed areas previously discussed. Ambient values for E. Coli suggest a potentially significant increase may occur. E. Coli are utilised as an indicator species, and it may be anticipated that other pathogenic forms may be present within the sediments. Public health concerns centre on :

  - Reprovisioning of the wholesale markets in the largest of the embayed areas where water quality is expected in the short term to deteriorate significantly.

  - The very limited possibility of compliance with the general provisions of BU5 (secondary contact), especially in the context of bacterial concentrations.

Predicted impacts

7.05 Water Quality Impacts associated with construction activities are examined in the following section from the perspective of :

- simulated projections utilising the WHAMO depth averaged water quality model.

- projections derived from physical sampling carried out during the present study in conjunction with water quality monitoring results from the EPD routine monitoring programme and other studies carried out in the project area.

Water Quality Modelling

7.06 For the purpose of evaluating water quality conditions in the project area under worst case conditions, i.e. prior to implementation of the N.W. Kowloon Sewage Treatment and disposal plan (stage 1) and with the embayed areas in place, the following assumptions were made :

- For the purpose of establishing baseline conditions, data drawn from the Sewage Strategy Study[1] - this study suggested total pollutant loadings rather higher than the more recent N.W. Kowloon Sewage Master Plan Study[2] and as such was seen to represent a conservative approach.

- Projections were made for water quality conditions in late 1992 at which points :

  - Tidal currents and flushing capacity would be reduced due to closure of the Stonecutters/Kowloon Channel.

  - In the nearshore area, some 200 Ha would be partially enclosed by the new reclamation works.

  - Effluent flows would continue at the present rate of discharge.

- Projections were based on the depth averaged water quality model under neap tide conditions. The grid size of the model was reduced to 50 metres from the original 250 metre Harbour model Grid.

- Discharge points and loadings assumed in the model tests are presented in Table 4 Annex C.

- Constraints to the models application in this situation and the assumptions adopted include :

  - At the reduced grid size the number of data points in the nearshore area is confined because of the landform configuration.

  - Based on observation of the area, effluent dispersal and deposition of suspended solids may not conform to the assumptions made on distribution.

  - Data utilised for baseline purposes was not based exclusively on physical monitoring.

  - As a result of these factors, some of the baseline values appear to be rather low in relation to results recorded during water quality monitoring, both during the present study, and others in the study area. Of more importance however is the projected magnitude of change brought about by the input assumptions.

- Modelling Results

  The results from the WHAMO runs with projected values for dissolved oxygen (mg/l), E. Coli (per 100 ml), suspended solids (mg/l) and BOD

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(1) Watson Hawksley et al (1989) : Sewage Strategy Study Appendices Part 1
(2) Acer/J. Taylor (1990) : North West Kowloon Sewage Master Plan

(mg/l) for reference points located in the waterbody off West Kowloon (Figure 5 Annex C), are presented in Figure 6a-l Annex C.

The indication points of interest in this exercise are B, C, D, E, F, M and N, since all points south and west show no major changes in any of the parameters considered that could be attributed to WKR.

In the case of dissolved oxygen values a general decrease in percentage saturation in 1993 can be observed in relation to the baseline case, and as anticipated, inshore positions D and E show the most significant deterioration falling from 50% to 30%. As position D is located in Yau Ma Tei the base percentage saturation may have been overestimated due to the points noted above. Biochemical oxygen demand similarly shows a progressive increase throughout the area in relation to the base case with the most significant changes occuring at D.

Suspended sediment values on the other hand show a decrease at all indication points with the exception of C where no significant change occurs. It is believed that the projected decline in suspended solids values reflects the models dependance on background values and the limited resolution in confined inshore areas.

As previously noted, it is believed that distinct regimes operate in the offshore and nearshore areas, with water quality in the former determined largely by background flows from the Rambler Channel, whereas water quality conditions in the latter case are determined almost exclusively by effluent flows. Under the proposed scenario, with the channel closed between Stonecutters and the mainland, is anticipated a reduction in offshore suspended solids values, although accumulation of effluents as a consequence of substantially reduced flushing and exchange capacity in the embayed nearshore area would produce significantly elevated values of BOD and reduced levels of dissolved oxygen.

Impact assessment

7.07 On the basis of sampling activities and a revue of other relevant studies, the following conclusions have been drawn concerning water quality impacts arising both as a consequence of, and during, the construction phase of WKR. They are considered under the following headings :

- o Dredging related impacts
- o Landform and Effluent Discharge Impacts
- o Cumulative Impacts

Dredging Related Impacts

7.08 As noted in section 8.1, dredging activites will generate significant increases in suspended solids loadings to the water column with corresponding adverse effects on water quality through reduced dissolved oxygen values and elevated BOD values. The significance and magnitude of these effects will differ between nearshore and open water stations, due to differing flow characteristics, proximity to sensitive receptors, and dredge spoil characteristics.

7.09 Anticipated suspended solids concentrations in the vicinity of dredgers to be in the order of 100-300 mg/l. The very weak tidal currents will result in limited dispersion of this material and quite rapid deposition despite the high proportion of fine particulates. In nearshore areas, and in particular within the embayed areas, dispersion of suspended material will be more restricted, but will promote poorer water quality conditions which will be reflected in reduced dissolved oxygen, increased BOD, and higher nutrient levels. For a considerable part of the reclamation programme, the elevated suspended solids levels are not expected to comply with the requirements of 180 mg/l specified for the MTRC seawater intake. Similarly, dissolved oxygen levels are not expected to conform to the requirements of BU6.

7.10 Section 4 of this report discusses the results of investigations into sediment contamination. The results of this component of the study have suggested that in specific areas i.e. Cheung Sha Wan and Yau Ma Tei, heavy metal concentrations (lead and copper) exceed the guideline limit values proposed under the Deep Bay Guidelines(1). Although sediment concentrations of all metals were indicative of widespread pollution in the WKR project area, only 5 out of total of 280 observations failed to comply with the above measures of contamination. Of concern, were reported mercury concentrations from sediment samples in the protect area that exceeded the limit value for this black list metal. These results were recorded from analysis carried out on behalf of CESD. Subsequent results from the consultants sediment sampling programme failed to corroborate these levels of contamination. It was decided to carry out elutriate tests on the sediment samples to gain some indication of the potential uptake of mercury to the water column, as it is by this pathway that toxic forms may enter the food chain. The analysis, however, produced results which were considered erroneous.

7.11 It is recommended that the next series of samples to be taken should undergo supervised elutriate testing to provide more reliable results on mercury concentrations.

7.12 This exercise has a bearing on the selection of disposal methods for contaminated material, since clearly if there was a possibility of transfer of this metal to the food chain through its soluble form it would be necessary to consider alternative methods of disposal. On the basis of the current data collected by the consultants, however, it is not considered that this is necessary.

7.13 Dredging activity will require the disposal of up to 20 million m^3 of dredge spoil from the WKR project. Under current circumstances, it is not envisaged that any opportunities for disposal other than marine dumping in gazetted areas will be available. Despite the degree of contamination in some areas. It is not considered that the available evidence justifies the separate disposal of material from areas such as Cheung Sha Wan and Yau Ma Tei.

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(1) ERL/EPD (1989) : Deep Bay Guidelines for Dredging, Reclamation and Drainage Activities

Landform and Effluent Impacts

7.14 The proposed landform configuration for the interim construction period has been developed to comply with the logistical requirements of reprovisioning; from an environmental perspective it will result in the creation of substantial partially enclosed water bodies with limited flushing capacity.

7.15 Current pollution problems in West Kowloon are attributed predominantly to the very substantial effluent loading to the coastal waters. Under current proposals these flows of 55-75 tonnes of BOD/day will continue to be discharged from the present outfalls until late 1992. At this point the trunk sewer system established under the N.W. Kowloon Sewage Treatment and Disposal plan will divert flows from the foul sewer system to a treatment plant on Stonecutters Island. It is suggested that the successful implementation of this programme and the subsequent implementation of the N.W. Kowloon Sewage Master Plan may effectively reduce the pollutant loading to the WKR project area by between 30 and 70%. During the interim period, however, the continuation of these discharges to confined areas is expected to promote anoxic conditions similar to those experienced at present in Yau Ma Tei typhoon shelter. Dissolved oxygen levels on a localised basis of < 1.0 mg/l and a correspondingly high BOD are anticipated.

7.16 There must also be some concern regarding the proliferation of eutrophic conditions associated with the very high nutrient inputs, reduced flows and, in open water positions, reduced suspended solids values. The latter may permit greater penetration of solar radiation, thus promoting increased primary production, leading potentially to the development of intense algal blooms such as those experienced in Tolo Harbour.

Cumulative Effects

7.17 Between January 1991 and early 1993, there will be a progressive deterioration in water quality in West Kowloon arising from :

- o Reduced tidal currents and increased residence time.
- o Sustained effluent discharges.
- o Increased suspended solid levels in confined areas.

7.18 From 1993 until completion of the dredging and reclamation works in July 1994 we would anticipate a general improvement in water quality conditions, this being attributable to the reduction in total pollutant loading from the foul sewer and storm drain system by an estimated 30 - 60%.

7.19 Throughout the construction phase, but more specifically, prior to 1993 water quality conditions that comply with the provisional requirements of the Victoria Harbour Water Quality Control Zone (VHWQCZ) cannot be envisaged, although further reductions in industrial pollutant loadings due to the proposed implementation of a technical memorandum (under the Water Pollution Control Ordinance 1982) in November 1990 are anticipated.

Impact Mitigation

7.20 The present assessment of water quality impacts arising as a consequence of, or during the construction phase of WKR, has concluded firstly, that present conditions fail to comply with anticipated water quality standards under the VHWQCZ, and secondly, that the primary causes of potentially adverse effects on the marine environment are associated with :

- Effluent Flows - discharging from the storm and foul sewer marine outfalls in West Kowloon, contributing to nutrient enrichment, localised oxygen depletion, bacterial contamination, and in general to the promotion of widespread eutrophic conditions.

- Landform Configuration - including the closure of the channel between Stonecutters Island and the mainland, and the creation of substantial semi-enclosed water bodies, contributing to reduced flushing capacity, and associated with this the further promotion of eutrophic conditions.

- Dredging activities - contributing to elevated suspended solids concentrations in the vicinity of dredging and fill operations, and associated with this, increased oxygen demand arising from the suspension and resuspension of sediments.

Effluent Flows

7.21 The failure of existing water quality in West Kowloon to comply with the most fundamental standards is attributable almost exclusively to the massive pollutant loading stemming from the storm and foul sewer network. It has to be emphasised that this is the single most important underlying cause of a debilitated marine environment and impoverished marine life in the WKR project area. Because of the proximity of the water body to its assimilative capacity, and to the threshold values for the key water quality parameters, the added impacts of activities associated more directly with construction activities may result in adverse water quality conditions out of proportion to the effects attributable to these activities in the absence of such effluent flows. The magnitude of the impacts from this source are such that, although not directly associated with construction activities, it is considered imperative that the Government should proceed with its water pollution control plans in this area. The prospect for improved water quality conditions in West Kowloon is entirely subject to the successful completion and implementation of

- The North West Kowloon Sewage Treatment and Disposal Programme - Stage 1.

- The North West Kowloon Sewage Master Plan.

- A significant decrease in the discharge of untreated industrial effluent and the establishment and enforcement of a system of pre-treatment and/or disposal at source for contaminated effluent.

Failure to achieve this will result in significant increases in long term social and economic costs.

Landform Configuration

7.22 As previously emphasised, the effects of the landform configuration will be to reduce tidal exchange and to permit the accumulation of effluent in confined water bodies, promoting the development of water quality conditions in these areas that may be similar to, or worse, than conditions currently experienced in Yau Ma Tei typhoon shelter. Different opportunities for mitigating these potential impacts have been considered, including the possibility of temporarily diverting flows discharging to confined areas. It has been necessary to conclude that on practical grounds such ideas are not realistic for the following reasons :

- o It is not possible to state conclusively that this course of action would bring about a significant improvement in overall water quality - it is possible that the effect would simply be to extend the distribution of rather worse conditions than currently exist.

- o The temporary diversion of effluent flows would impose severe constraints on the dredging programme, and the general movement of vessels in the project area. It would result in substantial slippage in the reclamation and reprovisioning programme, with corresponding increases in costs.

- o Bringing forward the WKR drainage reprovisioning programme would not be viable as the timetable is determined by the need to complete the inland sections first. This cannot be accommodated under the NWKSTD programme.

7.23 Opportunities for modifying the interim landform to permit increased flushing of the impounded areas are similarly not considered to be realistic, as the primary determinants of the interim phase are the operational requirements of those facilities due to be reprovisioned. It has not been possible to identify any minor modifications that might be expected to significantly strengthen tidal flows. Improvement in water quality will best be achieved by timely completion of the works and the full implementation of the proposed resewerage schemes referred to earlier.

Dredging activities

7.24 The adoption of contractual conditions that specify acceptable operating practices and water quality requirements in the vicinity of dredgers can mitigate against the worst effects of sediment resuspension arising from dredging activity. To ensure maintenance of conditions that comply with the requirements of the industrial abstractors, the only realistic option is a contractual requirement to fit silt curtains around the seawater intakes of MTRC and WSD. It is believed that this will ensure the maintenance of suspended solids levels to levels below 150 mg/l. The alternative, of requiring silt curtains to be fitted around each operating dredger would significantly constrain the production rate of each dredger. The full conditions for water pollution control and water quality monitoring requirements are detailed in Annex F.

7.25 In considering appropriate mitigation measures for impacts arising during the construction phase of the WKR, the overriding feature has been the very poor ambient water quality conditions, and the constraints this imposes on available options through existing proximity to threshold/limit values. It is therefore appropriate to re-iterate, that although mitigation of impacts arising from direct construction related activity i.e. dredging, is feasible, a significant further deterioration in water quality in the short term is anticipated, in the absence of effective action to reduce, divert, and treat existing effluent discharges to the project area.

Monitoring and Audit

7.26 The recommendations for Water Quality monitoring presented in Annex E were finalised after extensive consultation with a number of H.K. Government Departments and are different to those presented in the draft construction EIA report.

8. Marine Sediment Impacts

8. MARINE SEDIMENT IMPACTS

8.01 This section considers the impacts associated with the removal, movement and disposal of large quantities of sediments associated with the WKR. As a result of these activities occurring in a marine environment the impacts resulting from them affect primarily, the waterbody in that area. Consequently, the effects of sediment removal and disposal on the water column have been presented in some detail in Section 7. It is inevitable that some overlap should occur as the sediment and marine enrivonments cannot be effectively separated. Noise and Air Quality impacts associated with these activities are considered in sections 5 and 6.

8.02 Impacts arising from the following activities :

- o Marine sediments
  - dredging
  - transport
  - disposal
- o Marine fill
  - winning
  - transport
  - placement

are considered in turn.

Dredging of Marine Sediments

8.03 The nature and extent of contamination of the marine sediments is outlined in Section 4. It is not considered that contamination is sufficiently advanced as to require separate disposal arrangements for certain areas of mud. The impacts outlined in this section are a more detailed indication of the levels of suspended solids that are likely to result from dredging activities.

8.04 Dredging is likely to occur by grab dredger in the northern section of the reclamation and by trailer suction hopper dredger in the southern section. A brief outline of the method of working for each is given below.

o Grab Dredgers

The grab dredger is one of the most common forms of mechanical dredger. It comprises a slewing crane which lowers and hoists a grab in and out of the water. Grabs may be either pontoon-mounted or fitted to self-propelled hopper vessels. The former are most common and they discharge their spoil into barges moored alongside, thus enabling long periods of continuous operation. Grabs perform best in soft or loose soils and are ideally suited to working in confined areas. Large grabs are well suited to the removal of debris, which often occurs in harbour areas and is present in the WKR area.

- o Trailing Suction Hopper Dredgers

  This dredger is a sea-going, self-propelled vessel which is equipped with a suction pipe designed to trail over the seabed as it advances. The excavated soil-works mixture is discharged into the hopper where it tends to settle in the lower part of the hopper whilst excess water is discharged over the side through an overflow. In fine silt, however, material may settle only slowly and much can be lost through the overflow before a good load is obtained.

  At disposal grounds, trailer dredgers can discharge their load directly through doors or valves in the bottom of the hull. Many dredgers are also capable of discharging directly to reclamation through a bow-mounted pipeline connection or by jetting the soil-water mixture through nozzles.

Criteria

8.05 All methods of dredging result in the release of some material into the water column. The potential magnitude of sediment resuspension and possible mitigating measures need therefore to be examined. Two measures of sediment resuspension are relevant to WKR :-

- o The absolute level of turbidity generated in the vicinity of the dredging operations.
- o The total quantity of solids released during dredging, irrespective of actual turbidity levels.

8.06 Absolute turbidity levels, in mg/l, can have wide ranging effects on the environment. In this particular case, the most important considerations (in view of existing very poor environmental conditions) are likely to be the mobilisation of noxious contaminants, rather than the turbidity levels themselves, and the potential effects of turbidity on any water intakes as discussed in section 7.

8.07 The total quantity of solids released is important with respect to some aspects of environmental preservation and to potential siltation in nearby areas which will not be incorporated into the reclamation and which are required in future for navigation. Solids release may also affect adjacent contracts if the project were to be divided into several dredging contracts.

Predicted Impacts

8.08 A number of investigations have been undertaken, particularly in the USA and the Netherlands, into the degree of sediment resuspension resulting from different dredging methods. It is possible to draw the broad conclusion that the effects of dredging are difficult to predict quantifiably with any high degree of accuracy and that only a qualitative ranking is possible.

8.09 Dredgers produce turbidity at different levels, in different places and at different production rates. If the total amount of material which is put into suspension is the important consideration, it is necessary to 'normalise' turbidity general against a standard quantity of material dredged. Such normalisation can produce a significantly different picture of the 'polluting' effects of dredgers. Table 8.1 summarises the results of recent tests.

8.10 In this table, the parameter 'S' signifies the weight of solids put into suspension per cubic metre of in-situ material dredged. As can be seen, whilst the trailer dredger produces a higher level of absolute turbidity, the net result, in terms of the proportion of material which is placed in suspension, is somewhat better than the other methods.

8.11 The 'S' factors given in Table 8.1 for grab dredgers, the type most likely to be used to dredge the sediments in the northern section of the WKR, are for small grabs. It is anticipated that much larger grabs will be used. The effects of using larger capacity equipment are likely to be an increase in turbidity levels but an overall decrease of the 'S' factor. Actual measurements for large grabs are not available but we would expect the 'S' factor to be reduced by approximately 50% for a $10m^3$ grab and even more for very large grabs of $20m^3$ or more.

8.12 For the purposes of estimating the potential effects of dredging at WKR the figures presented in Table 8.2 should be used.

Table 8.1

Turbidity Levels and Sediment Resuspension for Various Types of Dredger

Dredger Type :	Grab Dredger	Grab Dredger	Trailer Dredger	Trailer Dredger
Circumstances	Watertight grab with silt screen	Watertight grab, no silt screen	no over-flowing	Over-flowing
Size :	$3m^3$	$3m^3$	$6,100m^3$	$6,100m^3$
Production Rate, m^3/hr	102	166	5,400	4,125
Increase of turbidity (mg/l)	20	100	150	400
S (kg/m^3)	5	20	4	13

Table 8.2

Estimated Turbidity Increase and 'S' Factors for Grab Dredging Operations at WKR.

Dredging method	Turbidity increase (mg/l)	'S' (kg/m³)
Open grab, no siltscreen		
3m³	175	25
10m³	390	17
20m³	620	12
Open grab, with siltscreen		
3m³	35	10
10m³	80	7
20m³	125	5
Watertight grab, no siltscreen		
3m³	100	20
10m³	225	14
20m³	350	11
Watertight grab, with siltscreen		
3m³	20	5
10m³	45	3
20m³	71	2

Notes :

Figures for turbidity increase are related to areas very close to the dredger. Actual turbidity will vary considerably, depending upon distance from dredger, currents and duration of operations.

All figures have been intuitively extrapolated from measurements made with small grabs. Different figures may apply in situations which differ from those where the measurements were made.

Mitigation measures

8.13 In order to minimise the degree of sediment resuspension and escape occurring at the site certain precautions should be implemented during dredging operations. Examples are given in table 8.3.

Table 8.3 Mitigation Measures available for grab and trailer dredging

Grab dredging : - Use of closed grabs - Accurate and careful loading of barges to minimise "splashing" - Not overloading barges
Trailer dredging : - No de-gassing installation to be allowed to discharge water overboard. - No overflowing or lean mixture overboard systems to be used. - Trailing speed to be reduced.

8.14 In addition to using the above, silt screens should be used to restrict the level of suspended solids entering the 3 main water intakes in the area. Regular inspection and maintenance of these intakes should ensure that suspended solids levels do not exceed the upper limits stipulated by these sensitive users.

8.15 In order to ensure that sediment levels remain acceptable during working, a monitoring programme is required. Details of this are presented in Annex E.

8.16 Annex F contains examples of measures that should be included in contract documents to ensure the mitigation of the effects of dredging transport and disposal of marine sediments from West Kowloon.

Transport of Marine Sediments

8.17 The potential exists for the loss of dredged sediment during transit to affect water quality. The impact will be in the form of increased turbidity in the wake of transport vessels. Whilst it is not anticipated that this will produce a significant impact, uncontrolled transport over the course of the construction period may possibly result in affects on the seabed along the line of the transport routes.

8.18 Transport of marine sediments to the dumping grounds at Cheung Chau and East of Ninepins is likely to occur both by barge and by hopper dredger. The main cause for concern is the loss of material in transit. Losses from hopper dredgers should not occur, but losses from barges are a possibility due to :

- o leakage through bottom doors and valves;
- o slopping overboard from full barges in poor sea conditions; and
- o material being washed off the deck.

8.19 Quantification of the extent of these losses is not possible but experience suggests that the potential losses are high. In addition the practice of "short dumping", whereby material is not transported all the way to the dump site by the contractor in order to make savings in time and cost has to be considered.

Mitigation

8.20 Slopping overboard and deck wash-off can be overcome easily by 'good housekeeping' during dredging operations and by ensuring that barges and hoppers are not overloaded. Specification clauses should be included in contracts to ensure that contractors make a reasonable effort to minimise such losses.

8.21 Leakage is less easy to control and where there is a requirement to prevent any leakage (during contaminated material transport) it may be necessary to eliminate the use of certain types of barge or to specify the use of purpose built sealed units. Any serious leakage will be visually detectable when barges are under tow.

8.22 "Short dumping" is difficult to prevent. Even if a contractor is apprehended in the course of this practice, the fines imposed are frequently insufficient to act as a deterrent. Increased fines or the revokation of the dumping licence, together with improved detection and enforcement is recommended.

Disposal of Marine Sediments

8.23 It is anticipated that two gazetted dumping grounds will be used for sediment disposal; Cheung Chau (1988 capacity 37.4 Mm^3) and East of Ninepins, with a capacity of 31.3 Mm^3 (1988).

8.24 There are two aspects to be considered when evaluating the aspect of disposal; the method of placing the mud in the desired location on the sea bed, or in the disposal pit, and the effects of the mud in its final position.

8.25 In terms of placing, the method must be such as to ensure that the major part of the volume to be disposed is retained within the disposal site. The effects of the smaller quantity which does not finally come to rest in the disposal site must also be evaluated and be found acceptable.

8.26 When considering the effects of the disposed material in its final resting place, it is necessary to ensure that:

- o it will remain in place or that any future movement is acceptable,
- o its effect on navigation and anchoring is acceptable,
- o its effect on the local marine environment is acceptable in both the short and long terms.

8.27 It is likely that, in view of the transport methods, ie. barges or hoppers, all but the most contaminated dredged mud will simply be bottom dumped at the disposal sites.

Effects of bottom dumping

8.28 Bottom dumping, and the processes which operate to transport the dumped material, have received some attention in Hong Kong during the last two years. The method was used successfully to place dredged muds into worked out borrow pits in Urmston Road during the Tin Shui Wai Land Formation Contract.

8.29 When material is released rapidly from a barge or a hopper it falls as a rather coherent mass at high velocity. This phase of the dumping process is termed 'convective descent'. Expansion and dilution of the spoil cloud results in a progressive reduction of density and, at a certain depth, the density contrast between the spoil and the surrounding water is so slight that 'collapse' occurs, at which point the spoil continues to fall at the terminal velocity of the individual soil particles.

8.30 The descent velocity and rate of dilution during the convective descent phase are directly related to the size of the vessel's discharge openings and the speed of discharge. The velocity is generally greatest and the rate of dilution smallest when discharging rapidly from large vessels. Thus, if dumping is to result in the placement of spoil within a certain area of the sea bed, it is necessary to ensure that the dumping vessel and rate of discharge are suited to the conditions at the dump site. The primary objective is to ensure that the spoil reaches the sea bed before collapse takes place. If this is achieved, the spoil spreads radially from the impact point as a density current which progressively slows and eventually stops.

8.31 If placement is achieved without the spoil reaching the collapse point, then loss of material can occur in one of two ways:

- o material is stripped from the descending spoil cloud,
- o material deposited on the sea bed is eroded and transported by currents.

8.32 In the case of the former mechanism, the quantity lost is generally only a small proportion of the total. Estimates vary but less than 5% appears to be assured and the quantity may actually be of the order of 1%. This type of loss can be minimised by dumping large volumes of spoil from large vessels. Use of small vessels will result in a greater proportion of the spoil being stripped and increases the risk that the descending spoil cloud may collapse prior to impact with the sea bed.

8.33 Loss of material by erosion is not possible to control directly. It is inevitable that some dumped material, which will have a very low initial density, will be in the form of mobile fluid mud and, if there are sea bed currents, will be transported easily from the target area. Indirect control, or prevention, is most simply achieved by dumping into depressions, preferably well defined pits. This will drastically reduce the possibility of escape.

8.34 The dredging method, and thus the nature of the material being dumped, has an important influence on the magnitude of losses. Marine muds dredged by any form of suction dredger will largely be reduced to a slurry as they pass through the dredging system (ie. cutters, dragheads, pumps etc). The slurry undergoes further dilution during dumping with loss of material as described above. If the mud is dredged by grab, bucket or backhoe dredger it is subject to very little dilution and will be discharged from the dumping vessel in the form of large lumps at, or very close to, the in-situ mud density. Such material, even if it reached the collapse point, would still have a high descent velocity because of the effective particle size and very little material would be lost either by stripping or by later erosion on the sea bed.

Measures to minimise loss of dumped material during dumping

8.35 Losses during dumping

Dumping of uncontaminated material at gazetted disposal sites has, in the past, not been subject to any methodological control such as specification of vessel size or discharge speed. Control has been restricted only to the normal requirements of disposal permits with respect to record keeping, reporting procedures and short-dumping. In view of the size of the disposal areas, their distance from environmentally sensitive areas and the nature of the material being dumped, it is suggested that no special controls need be implemented for the WKR project.

8.36 It is considered unlikely that any sediments will be identified with sufficient levels of contamination to require special disposal arrangements. In the event that some contaminated material is identified, it is suggested that disposal in the Urmston Road Pits, followed by capping with uncontaminated layers might be an acceptable solution. If this is undertaken, control may be necessary in order to ensure that:-

- losses due to stripping in the convective descent phase are minimised
- collapse does not occur before the spoil mass impacts the sea bed
- the radially spreading bottom density surge does not escape the pit
- losses due to erosion of the dumped material are prevented or minimised.

8.37 The nature of the controls will vary according to the method of dredging and transport. If, as is envisaged, the mud is dredged by grab and transported by barges, control need only be limited to ensuring that dumping takes place accurately over the centre of the disposal pit.

8.38 If suction methods are employed, more comprehensive control may be required, eg. Use of trailing suction hopper dredgers:

- Accurate positioning at least 120 metres from the foot of the pit slope.
- The pit to be at least three metres deep, relative to the surrounding sea bed.
- Discharge to take place from a stationary vessel.

Other suction methods with barge transport will require :

- As above, but barges must not be less than 750m^3 capacity and must be of the split hull type to ensure rapid discharge.

8.39 After dumping, trailer dredgers have typically 1-2,000m^3 of dirty water remaining in the hopper which is usually pumped overboard before dredging restarts. In the case of very contaminated materials, such discharges would have to be prohibited even though this would result in a marked reduction of productivity. Similarly, barges should be prevented from washing any materials out of the hopper which may remain after dumping.

8.40 For the purposes of estimating loss of contaminated sediment to the wider marine environment arising directly from the dumping operations, a total loss of 1-2% is likely if the above controls were adopted except in the case of dumping suction-dredged material from barges where losses may amount to 2-4%. This loss would be incurred during convective descent and impact on previously dumped material.

8.41 If such losses are unacceptable, a potential solution is to discharge the spoil through a delivery pipe to the bottom of the pit. With trailing suction hopper dredgers, this can be achieved using the suction pipe and a by-pass fitted between the hopper and the suction inlet. A simple system such as this would only work in the case of a true slurry with a very low sand content. If there were a noticeable content of sand, it would be necessary to modify a standard self-discharging system (which is not fitted to all trailer dredgers) by providing a connection between the suction inlet and the pressure side of the dredge pump.

8.42 Fitting a delivery pipe to a barge would require more radical modification and is unlikely to be considered worthwhile if alternative disposal methods are available.

Measures to Minimise Loss of Dumped Material After Dumping

8.43 Loss of material by erosion cannot sensibly be estimated without detailed studies. A limited number of current observations were made during the dumping trials undertaken in Urmston Road in 1988 which are of some assistance in assessing the risk of such loss. Over a flat sea bed in a water depth of 21 metres, current speeds of between 0.25 and 0.76m/sec were recorded about 1.5m above bed level at various states of the tide in June 1988. During trials carried out in December of that year currents of between 0.25 and 0.49m/sec were recorded just above bed level on the slope of a borrow pit, approximately 3 metres below adjacent sea bed level.

8.44 These velocities suggest that there is a considerable potential for movement of recently dumped mud. However, during the same trials, it was observed that even very slowly moving mud density currents induced by dumping appeared to be almost unaffected by the tidal current direction. This suggests that the density contrast between the fluid mud and the surrounding seawater, combined with friction between the mud and the more solid bottom, are sufficient to ensure that most of the dumped material is not moved by tidal currents.

8.45 The dumped material settles quickly to form a reasonably high density mud, particularly if it is dumped in very thin layers. It may be prudent to dump contaminated materials at, or shortly before, slack water in order to permit this initial settlement to take place before tidal currents increase.

8.46 The above data is far from conclusive and, if it is considered important to ensure that little or no material is removed by erosion, it may be necessary to increase the minimum depth of the pits into which contaminated material may be dumped, particularly if it has been dredged by suction methods. Depths of more than 7.5 metres, rather than 3 metres, may be required in the latter case.

Marine Fill Winning and Placement

8.47 Assuming that all of the marine muds are to be dredged from the WKR site, approximately 30 Mm^3 of dredged marine fill material will be required for the northern part of the WKR. At the time of writing the favoured site indicated by the Fill Management Committee (FMC) is for the area to the east of Tung Lung Chau. The fill for the southern part of the WKR is likely to be sourced from the South Tathong Channel.

Borrow Area Environments

Tung Lung Chau

8.48 The borrow area for the northern part of the WKR is located between Tung Lung Chau and the Ninepins Islands and has been estimated by FMC to contain potential granular material deposits amounting to 19 Mm^3. It is possible, however, that total resources considerably in excess of this figure will be proved by further investigations.

8.49 Much of the western part of the area was formerly a gazetted spoil disposal area. The seismic surveys clearly show a considerable amount of dumped material in the disposal area and over much of the rest of the borrow area. This latter material is almost certainly the result of extensive short-dumping associated with the existing disposal area east of Ninepins.

8.50 The nature of the dumped material is not known with certainty but probably comprises mostly CDG and dredged marine mud. In addition, building rubble, cobbles and boulders may be expected, together with metallic debris dredged from the harbour area. Such material could prove a serious hindrance to dredging operations and will be investigated further, possibly by trial dredging, before a final decision is made regarding the suitability of the area.

South Tathong Channel

8.51 This area is presently under consideration as the main source of fill for the southern part of WKR and it is understood that detailed investigations are to be undertaken in the near future.

8.52 The existing limited data suggest that the area is probably covered by 2-4 metres of fine to medium grained, silty clayey sand. This is underlain by a channel which is infilled with fine to medium grained clayey silty alluvial sand which, in parts, is underlain by a basal marine sand. Studies to date suggest that potential resources of granular material in this area to amount approximately 25Mm^3 with an additional 29Mm^3 lying below -40mPD. Although the area lies at the end of the South Tathong shipping channel, it is not particularly busy. There are thought to be no sea bed obstructions which would hinder dredging operations.

Method of Removal

8.53 At this stage of the study the method of removal of material from the borrow areas has not been defined. As a result of potentially adverse sea conditions experienced at Tung Lung Chau, however, it is assumed that Trailing Suction Hopper dredgers will be used as they are the only type for dredger capable of operating effectively under such conditions. Dredgers will be served by a fleet of barges which, when moored alongside, will be filled by spray pipe.

Predicated Impacts

8.54 Two aspects require consideration with regard to the generation of impacts :

- o generation of turbidity during dredging operations
- o disposal of overburden and interburden

Turbidity

8.55 On the assumption that trailing suction hopper dredgers will be used for winning fill material, turbidity will be generated in a number of ways:

- o overflow from the hopper and discharge from lean mixture overboard (LMOB) systems

- o discharge from de-gassing installations
- o disturbance around the draghead

These mechanisms will apply to the dredging of both fill material and any unsuitable materials which have to be removed.

8.56 Overflow from the hopper or from LMOB systems is by far the greatest cause of sediment resuspension during trailer dredger operations. The quantity of material released in this way depends on the overall economics of the dredging and transport operation. When transport distances are great it becomes more efficient to extend the overflow time. The actual period of overflow during fill dredging cannot be established at present because detailed data relating to the particle size of the granular material is not yet available. In addition, economic overflow time is a function of the vessel size and design, both of which are unknown.

8.57 As an approximate indication, however, it can be assumed that about 30% of the fine sand fraction is lost during overflow from a medium size trailer dredger, falling to less than 10% for medium sand. Loss of the silt fraction may be expected to be considerable, especially during the later stages of loading. The limited data which is available from the borrow area indicates that the surficial marine sands have a fines content (<63 microns) of up to 25-30% with an average of approximately 12%. The fine sand fraction amounts to between 10 and 35%. These figures suggest an overall loss of between 10 and 15% of the total quantity dredged. The material which is lost might be expected to comprise, very approximately, 7% clay, 36% silt and 57% predominantly fine sand.

8.58 If 30Mm^3 of fill material is required for the northern part of the reclamation for example, it would be necessary to dredge an additional 3.3-5.3 Mm^3 to offset the overflow losses. The sand fraction, amounting to between 1.9 and 3.0 Mm^3 might reasonably be expected to settle within, or very close to, the borrow area. The silt and clay fractions, which together may amount to between 1.4 and 2.3 Mm^3 may take up a maximum of about 80 hours to settle to the sea bed, but this must be considered an extreme value. Currents are variable in both speed and direction in this area and fine material may be expected to be spread, very thinly, over a considerable area with no tangible adverse effects.

Transport of Marine Fill

8.59 It is anticipated that transport of marine fill to the site from the borrow area will be by barge or hopper dredger. it is considered that this is unlikely to have any adverse effect on the environment along the transport route. The only possible effect might be the loss of material through bottom openings but this is something which contractors themselves are likely to make every effort to prevent. Such loss of material would, in any event, be spread over a very large area and would be most unlikely to have any detrimental effect. No special provisions concerning environmental effects of fill transport are envisaged in the contract documents.

Placement of Marine Fill

8.60 Several methods of placing the fill material are available. It is probable that the contractor would use a combination of methods which would depend partly upon the method of fill transport from the borrow area and partly on the location and accessibility of the area being filled at the time. It is possible that any of the following methods could be used.

- o bottom dumping directly into the filling area
- o bottom dumping into a rehandling basin and hydraulic transport to the fill area from the rehandling basin
- o unloading of barges
  - using a barge unloading dredger and hydraulic transport to the fill area
  - by crane grab loading into trucks.

- o dumping into an unconfined stockpile area and hydraulic transport to the fill area.
- o "rainbowing" or jetting into the fill area
- o hydraulic transport from a dredger with a pump ashore facility.

Predicted Impacts

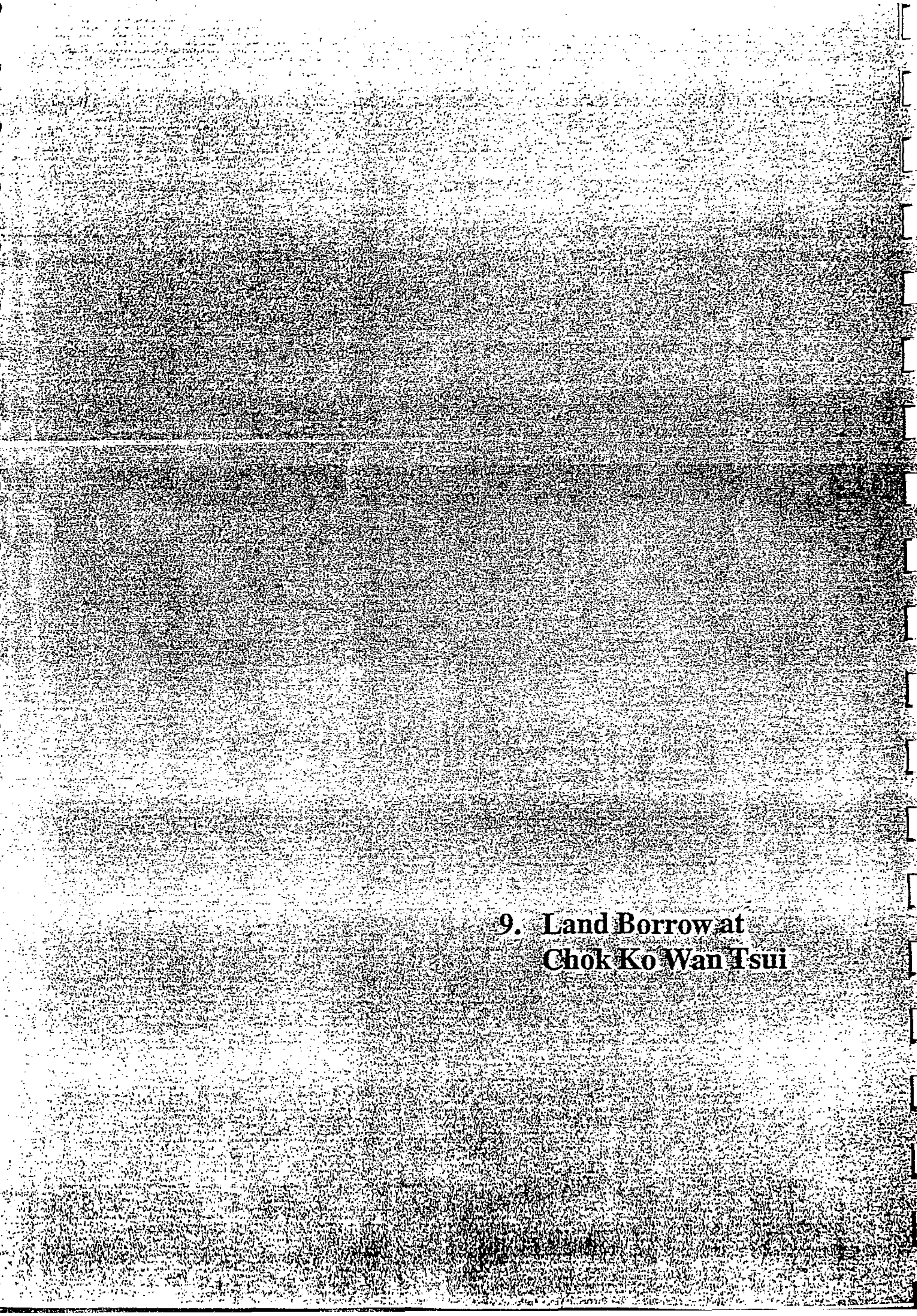
8.61 Placing granular material by any of the methods described above will result in the release of fine material into the marine environment. The material will be stripped off the discharged load in the case of bottom dumping, separated during descent from rainbowed material in shallow water and washed out of the immediate filling area in the discharge waters flowing from areas above water level.

8.62 Suspended sediment arising in this fashion is likely to be clean with a very low fines content, since the sand winning operations at the borrow area are likely to result in some beneficiation of the fill quality in terms of grain size. In view of the lack of currents in the reclamation areas and the bunding which will be in place, virtually all the fines will be deposited in thin layers within the reclamation area. Environmental effects are thus unlikely to be significant, although it will naturally be important to ensure, from the engineering aspect, that there are no large accumulations of fines.

Discharge Water Control

8.63 Discharge waters from the reclamation area do not generally pose an environmental threat when the reclamation is being built up from the sea since the saline water does not usually enter or percolate to fresh water areas. However, when areas have been raised to near or above finished levels there is always the danger that poor drainage in the working area may lead to egress of water to existing land, or to newly completed areas. In the first case the saline water could enter fresh water areas or cause damage to local property, and in the second case there is a danger that ground water levels will rise and cause trouble by affecting adjacent development, e.g. by the flooding of service trenches etc.

8.64 Most of the above problems can be eliminated by good work programming and working practices on the site. In particular final reclamation works should be confined to central or seaward edges of the site to facilitate drainage material being moved to other areas by land-based plant.



9. Land Borrow at Chok Ko Wan Tsui

9. LAND BORROW AT CHOK KO WAN TSUI

Introduction

9.01 It is anticipated that the northern section of the WKR will require approximately 0.6 Mm^3 of land sourced fill and material for seawall construction. A site has been identified at Chok Ko Wan Tsui on the north east of Lantau Island which will provide sufficient material for both the north and south sections of the reclamation, in addition to supplying material for other projects.

9.02 The following section describes the existing environment at Chok Ko Wan Tsui and outlines the nature of projects currently in progress in the area, together with proposed developments other than at the quarry area. The proposed development and operation of the quarry itself are then described, followed by an indication of the likely impacts associated with the works.

Chok Ko Wan Tsui Environment

9.03 The nature of the baseline environment at Chok Ko Wan Tsui will be fundamentally changed by the onset of PADS related developments towards the end of this decade. It is against the background of this change that the impact on the environment attributable to the quarry development should be considered.

9.04 The developments include the new airport at Chek Lap Kok, associated roads and rail links along the north Lantau coast, and extensive port and port related facilities proposed under N. Lantau Port Development around Chok Ko Wan Tsui and Penny's Bay to the west. The first phase of the PADS developments to be completed before the end of the century will involve extensive excavation and reclamation works in the area that will result in a complete change in the character of the surrounding environment. The present rural environment is already being altered by the development of China Light and Power Limited's gas turbine plant at Penny's Bay, the site boundary of which borders the quarry location to the west. To the east lies the proposed borrow area for Container terminal 8. As a result of proposed developments the area is intended ultimately to support about 900 ha of port related facilities and light industry.

Existing Environmental Conditions

9.05 The existing environmental conditions are summarised below.

- **Topography and Vegetation :**

  The area is rural with hilly terrain reaching 120 metres at a distance about 300 metres north of the shore. There are no official footpaths in the area but the catchment of a stream which runs west into Penny's Bay will be affected by the northern-most extent of the quarry works. The shoreline consists mainly of low sea cliffs, the tops of which support a few trees. The remainder of the vegetation at the site is grassy scrubland of the type found on exposed rural hillsides throughout Hong Kong.

- **Residential Development :**

  The closest settlements to the site are at Pa Tau Kwu just to the east of the site, Fa Peng about 500 metres to the northeast and Mong Tung Hang to the northwest. It is unclear whether any of these are inhabited or not. The closest confirmed habitation consists of approximately 20 squatter huts to the north of the shipyard in Penny's Bay. The only major residential developments are approximately 3 km away at Peng Chau and 3.25 km at Discovery Bay.

- **Industry :**

  The only existing industry in the area is the Cheoy Lee Shipyard, located along the northern coast of Penny's Bay at approximately 0.75 km from the site. CLPs gas turbine plant is currently under development adjacent to the proposed site.

- **Agriculture :**

  There is no known agricultural land use in the area. The nearest mariculture site is at Ma Wan, some 3 km away. Apart from this there is no recognized fishing operation along this part of the coast although it is possible that informal fishing may occur.

- **Cultural Heritage :**

  A Site of Special Archaeological Interest is located adjacent to the northern boundary of the site. The site is known to contain some Ming dynasty "blue and white" porcelain. The Antiquities and Monuments Office should be informed of the proposed quarry development as certain investigations may be required if it is affected by the site.

- **Recreation**

  The only recreational beaches within 4 km of the quarry site are at Discovery Bay (approx 3.7 km) and Peng Chau (3.9 km). In addition to bathing, associated water sports such as sailing, wind-surfing and water skiing take place, particularly at Discovery Bay where there is a sports and leisure club for the use of residents.

  The Lantau Country Park lies to the west of the site, the easternmost boundary of which is some 7 km distant.

- **Population :**

  Territory Planning Units (TPU) 973 and 974 cover the area of land to the north of the site. The combined population of the two areas is 220, and this is forecast to fall to about 170 by 1993.

Discovery Bay and Peng Chau have populations of 4,480 and 4,870 respectively. It is intended that Discovery Bay will expand towards Nim Shue Wan to the south which will greatly increase the population to a total of about 8,060 by 1998. The population of Peng Chau is forecast to increase slightly to about 5,110 by 1998.

The Cheoy Lee shipyard employs about 250 staff, 8 of whom remain on site overnight. Should the PADS proposals for Penny's Bay go ahead, the shipyard will be relocated.

o **Existing Air Quality :**

No air quality monitoring data for the area are available, however, it is likely that air quality is generally good with some seasonal variation.

During the summer months it is likely that relatively clean air is brought off the ocean by southerly to westerly winds. During the rest of the year easterly winds predominate, and the emissions from Hong Kong Island and Kowloon probably result in a general deterioration in air quality, although this is unlikely to cause the Air Quality Objectives to be approached.

o **Existing Water Quality**

The water quality of southern Lantau is generally good. The only existing source of potential water pollutants is the Cheoy Lee Shipyard which could give rise to some contamination of waters in the immediate vicinity with oil and/or other chemicals. The water quality at Discovery Bay is of an acceptable standard for recreational purposes and represents the nearest sensitive receiver for water quality impacts in this respect. Table 9.1 present summary statistics relevant to water quality in this area.

o **Existing Noise Environment**

Existing noise levels are low and typical of a rural environment. Activities at the Cheoy Lee Shipyard do not give rise to noise levels that could be regarded as intrusive at residential receivers other than those immediately behind the shipyard itself. Discovery Bay is too far away to be affected.

Proposed Development

9.06 It is intended that four separate quarrying operations be run at Chok Ko Wan Tsui, in order to supply four separate projects. The intention to operate the quarry in this way has implications for the extent of environmental impact. The operation of four quarries instead of one larger unit will inevitably lead to duplication of effort, and a duplication of activities with the potential to cause noise, air and water quality impacts.

Table 9.1

Selected Summary Statistics of 1988
Water Quality Data of Southern Water Control Zone

Determinand		Lantau South
Temperature (°C)	surface	23.3 (16.8 - 29.5)
	bottom	22.4 (16.9 - 29.1)
Salinity (ppt)	surface	30.1 (22.2 - 32.8)
	bottom	31.3 (27.8 - 33.7)
D.O. (% satn.)	surface	100.9 (69.2 - 143.4)
	bottom	87.1 (24.4 - 108.3)
pH		8.34 (8.15 - 8.74)
Turbidity (NTU)		7.4 (3.2 - 18.1)
SS (mg/L)		7.9 (2.8 - 27.7)
BOD - 5 (mg/L)		1.2 (0.6 - 3.0)
TN (mg/L)		0.505 (0.209 - 0.704)
TP (mg/L)		0.037 (0.02 - 0.09)
Chlorophyll - aa (ug/L)	surface	7.7 (1.0 - 33.0)
E. coli (no./100ml)		9.0 (0 - 1993)

Note: 1. Except as specified, data presented are depth average data.

2. Data presented are annual medians except for E. coli data which are geometric means.

3. Data enclosed in brackets indicate the ranges.

Source Marine Water Quality in Hong Kong. EPD 1989

Quarry Operation

9.07 The anticipated location and development of the borrow area is indicated on Figure 9.1. As shown, four separate quarries will be progressively developed northwards in the following manner :

- o Overburden will be removed and used to develop barging points for each of the four quarries. The barging points will extend into the sea for a sufficient distance to provide water depth for barge egress when laden.
- o A short section of seawall (20m) will be required for each quarry to allow barges to make fast and to enable laden trucks to tip directly into barges.
- o Material will be excavated using a combination of drilling and blasting.
- o Material will be transported to barges using a combination of bulldozers and lorries.

9.08 The intention to operate the borrow area as four quarries instead of one will mean that four barging points are required and four sets of blasting operations will be necessary. In addition, there will be a larger number of all types of mechanised plant on site than would be the case with one large operation that served the needs of all four projects. The sources of impact outlined in para. 9.07 therefore, are larger than they need to be, as a result of duplicating operations.

Sources of Impact

9.09 Noise impacts and impacts on air and water quality will result from a number of the activities associated with quarry formation and operation. These are considered in turn :

- o **Noise :**

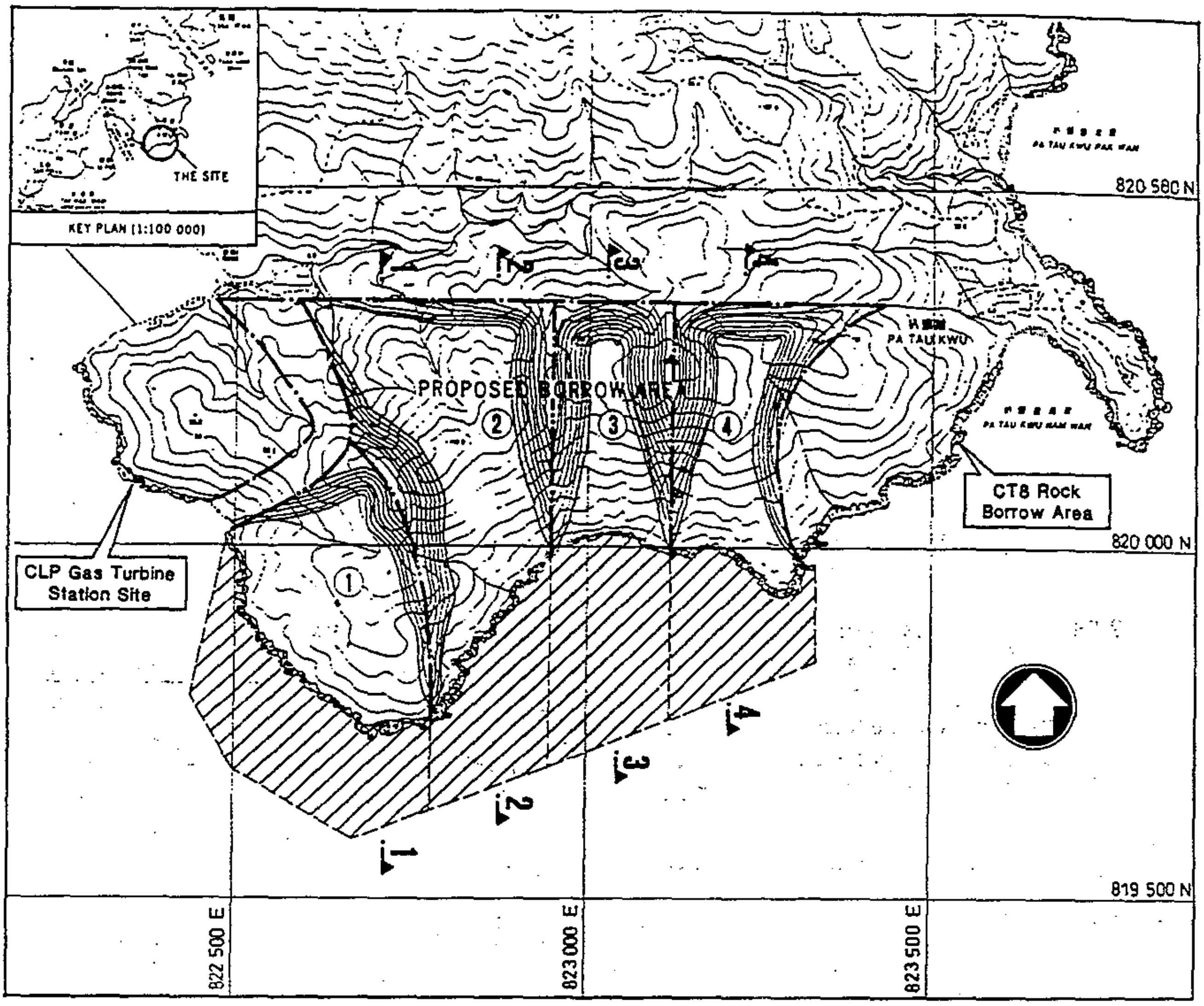
  Noise will be generated as a result of the following activities :

  - blasting and drilling of rock
  - operation of motorised plant such as bulldozers and lorries
  - loading of barges
  - marine traffic.

- o **Air Quality :**

  Air quality will be affected by the following :

  - blasting and drilling leading to dust generation
  - operation of motorised plant, producing dust and black smoke
  - loading of barges producing dust.



Rock Fill Requirements for the First Contracts of the Projects

Project Name	Contract No.	Rockfill Requirement (Mm^3)	Period Required
West Kowloon Reclamation South	CV/90/09	0.80	3/91 to 3/93
Central and Wanchai Reclamation	Phase I	2.00	6/91 to 6/93
West Kowloon Reclamation North	Contract 1	0.42	4/91 to 12/92
To Kwa Wan	59 AA/AB	0.75	4/91 to 10/92

Volume of Material in Mm^3

Area	Total	Est. Rock	Est. Soft
1	2.92	1.75	1.17
2	4.52	2.71	1.81
3	2.50	1.50	1.00
4	2.86	1.72	1.14

Scale 0 200 400 600m

GOVERNMENT OF HONG KONG
TERRITORY DEVELOPMENT DEPARTMENT
URBAN AREA DEVELOPMENT OFFICE

WEST KOWLOON RECLAMATION

FIG. 9.1

PROPOSED BORROW AREA AT CHOK KO WAN TSUI

Consultants
Mott MacDonald Hong Kong Ltd.
in association with
L.G. Mouchel & Partners (Asia)
Urbis Travers Morgan Ltd.
ERL (Asia) Ltd., MVA Asia, Leigh & Orange Ltd.,
Dredging Research Ltd., First Pacific Davies (Hong Kong) Ltd.

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Scale 1 : 10 000

Sketch No. 285/E/SK/045

Rev.

o Water Quality :

Water quality will be affected initially during site formation, when the quantity of suspended solids will be increased due to the construction of the barge area and seawall. Thereafter, the potential impacts on water quality are minimal.

Prediction of Impacts

9.10 The activities occurring on site during quarrying operations must be judged against the existing rural background in which they occur. The final landform that will result from this operation can be considered against a background of anticipated PADS development, although it should be noted that the development of this quarry will accelerate the change of the area's character from rural to industrial.

9.11 It should further be noted that the on-going development of the CLP gas turbine site, in conjunction with the CT8 Borrow area has already begun to affect the site. The significance of the impacts associated with the borrowing activity is dependent on the magnitude of the potential impact sources, and the proximity of sensitive receivers. The likely impacts on each environmental component are now considered:

o **Noise and Vibration :**

Sensitive receivers of noise impact are located at over 3 km distant from the site, at Peng Chau and Discovery Bay. As such it is considered unlikely that routine operation of the quarry will cause disturbance. It may be the case, however, that blasting activities are audible, even at these distances. Other settled areas to the north of the quarries may experience noise impact but the development of the quarry headwalls will act as a sound barrier such that impacts are unlikely to be significant. With the possible exception of blasting, therefore, it is considered that noise impacts will not be significant. The vibration produced by blasting, however, may have the potential to affect CLP's gas turbine plant operation.

o **Air Quality :**

Sensitive receptors of air quality impacts will be confined to the workforce operating the quarries. The steep slopes that will be developed and the fact that the quarries face south will result in reduced air-flow and the creation of a hot dusty working environment.

It is possible that some of the operations at the CLP Gas Turbine plant will be affected due to dust impacts.

- **Water Quality :**

Site formation activities will increase suspended solid levels. The nature of the benthic community in this area is not known but will be affected by loss of habitat due to site formation, and possible "smothering" effects adjacent to the site. The distance to the nearest sensitive receivers at Discovery Bay is too great for significant water quality impacts to be expected during site formation. In order to ensure that site formation and operation should not have a significant effect on water quality away from the site it is proposed that monitoring should be carried out by the contractor:

- once per week for four weeks prior to start of site works, to establish baseline conditions;

- three times per week during site formation (construction of seawall and jetties); and
- once per week during site operation.

At these times, samples should be taken at a point 100 metres south west of the site frontage, from 1m below the surface and 1 m above the sea bed. Samples should be analysed for suspended solids using APHA 17th ed. 2540D. In the event that suspended solids levels exceed pre-project conditions by more than 30% on two consecutive occasions, a review of working practices should then be instigated to determine the cause of elevated levels of suspended solids. Working practice should then be modified to ensure that the effects are reduced such that samples comply with the 30% criterion.

- **Other Effects :**

Of particular concern is the need to ensure safe working practices. Four blasting operations occurring within a relatively small area may constitute a potential risk to the workforce and the adjacent gas turbine plant. The potential risk to marine traffic will also need to be considered. Safety is also an issue with respect to the maintenance of temporary slopes within the quarry areas. It must be established that the material is capable of supporting the temporary slopes that are anticipated within the quarry.

- **Landscape :**

It is evident that quarrying activities on this scale will produce a visual impact; at their greatest extent the quarry headwalls will be 120 metres high. This will, however, decline as development proceeds northwards. The effect will be most marked on any marine-traffic passing the Chok Ko Wan Tsui peninsula.

As with any activity of the type, the resulting landscape scar will have a marked impact. In this case, however, it should be considered that the developments of the CLP plant and the CT8 borrow area will already have changed the visual character of the site. In addition, PADS developments towards the end of the century will have a far more marked effect. The impact of the borrow activities therefore, will be to accelerate the loss of a rural landscape resource.

Mitigation

9.12 Recommended mitigation measures for the predicted impacts are outlined below :

- **Noise and Vibration :**

  Blasting activities may be audible at Peng Chau and Discovery Bay. In this event, blasting should be timed to periods of the day when it will cause least offence. The vibration levels produced by blasting should be the subject of discussions between the quarry operators and the contractors and operators of CLP's gas turbine plant, in order to ensure that any potential conflicts can be avoided.

- **Air :**

  Site watering to reduce dust during routine operation should be implemented. Liaison with CLP plant constructors and operators and with the operators of adjacent quarries will be required during blasting operations.

- **Water Quality :**

  Site drainage should occur via a sump or settling tank to reduce the run off of suspended solids. Diesel tanks should be stored in bunded areas of adequate size (110% of the tank capacity) to ensure water pollution does not occur in the event of tank failure.

Summary

9.13 Due to the relatively large distance to sensitive receivers/receptors, the potential impacts resulting from quarrying activities are low. It should be noted, however, that the requirement for four separate quarrying activities substantially increases the potential sources of impact and has significant implications, for health and safety that require adequate consideration.

10. Conclusions and Recommendations

10. CONCLUSIONS AND RECOMMENDATIONS

10.01 Predicted environmental impacts associated with the construction of the WKR are associated with the site itself, with remote sites that are anticipated to act as sources of fill material and at sites for the disposal of marine sediments. Impacts associated with each of these sites are considered in turn below.

West Kowloon Reclamation

Water Quality

10.02 The construction of the WKR will result in significant temporary water quality impacts. Upon completion of the works, however, it is anticipated that water quality will recover, contingent upon full implementation of resewerage works currently planned for the West Kowloon area.

10.03 As a result of the form and phasing of early parts of the reclamation, semi-enclosed bodies of water will be created at the waterfronts of Cheung Sha Wan, Sham Shui Po and Tai Kok Tsui. In addition, the flushing potential for the Yau Ma Tei typhoon shelter will be reduced. Existing sewage discharges and contaminated storm drainage will continue to flow, untreated, into these water bodies with the result that the already poor water quality in these areas will deteriorate significantly. The situation will be further exacerbated when dredging and filling operations begin in the semi-enclosed areas, as turbidity will be further increased.

10.04 Bad water quality on a general level will be difficult to mitigate. The use of aerators has been considered, but with the presence of large numbers of faecal coliforms predicted, the potential exists for the formation of aerosols and consequent potential health effects. Channelling existing outfalls to beyond the line of the proposed seawall does not seem to be a feasible option as it would involve the creation of an obstacle to dredging and filling activities.

10.05 In such circumstances the alternative is to protect sensitive receivers. Water intakes should be provided with silt-curtains to maintain the suspended solids level at the intake to an acceptable level. These will require regular inspection and maintenance. In addition it is recommended that waterfront security should be increased to ensure that members of the public cannot gain access to areas of water adjacent to the reclamation.

10.06 Two consequences emerge for consideration : Water quality adjacent to the existing waterfront and in the typhoon shelter will deteriorate to the extent that it may constitute a public health risk and it is possible that residents adjacent to the waterfront and operators of certain reprovisioned activities, such as the interim market, will experience odour problems; conversely, the result of confining the pollution within these water bodies will mean that water quality seawards of the limit of the reclamation will be safeguarded to some extent.

10.07 Conditions are likely to be at their worst towards the end of 1992 when embayments are complete and polluting discharges are continuing. Thereafter, the implementation of the North West Kowloon Sewage Master Plan (NWKSMP) will mean that sewage is diverted to the treatment plant at Stonecutters Island. In addition, from this time onwards stormwater drains will be extended to the line of the new seawall. The long-term quality of water at West Kowloon is dependent on the full implementation of sewage plans, the making good of expedient connections so that storm drains are no longer contaminated with sewage and industrial effluent and the vigorous enforcement of the Water Pollution Control Zone Technical memorandum, which will require pre-treatment at, for example, industrial premises at Cheung Sha Wan and agricultural premises such as the abattoir and wholesale markets.

Air Quality

10.08 The air quality impact assessment indicates that dust from most activities on site should not constitute a significant impact providing that standard dust suppression techniques are employed. Dust from concrete batching will be unacceptable within 400 metres of the site, but this distance can be reduced to 100 metres, with the implementation of routine mitigation measures. Mitigation measures that are recognized as "good housekeeping" should be implemented as a matter of course. Details of such measures are presented in Annex E.

Noise

10.09 Daytime construction noise impacts will be significant unless the mitigation measures outlined in Section 5 are implemented. Piling activities associated with the construction and reprovisioning of ferry piers will produce significant noise impacts but will be restricted to certain times of the day by permit conditions.

10.10 Other construction work such as dredging and fill placement will produce significant noise impacts when occurring close to existing sensitive receivers. However, this will be for relatively short periods of time. It is not anticipated that 24 hour working is likely be required in these areas. If it became necessary, however, work would be controlled by a construction noise permit under the provisions of the Noise Control Ordinance.

West Kowloon Hinterland

10.11 A number of roads in the West Kowloon hinterland will be severely affected by drainage relaying works. Impacts will be associated with the creation of noise and a deterioration in air quality as a result of dust and black smoke effects. Progress rates make it likely that sensitive receivers may be affected, all be it to a different extent, for a number of months. General disruption to everyday routines and in particular to traffic circulation on what are already congested roads, may be severe. At this stage of the project sufficient data do not exist for specific impact prediction. The areas to be affected are listed in table 2 Annex A. The importance of supplying bulk materials to the reclamation by sea in order to reduce impacts on the West Kowloon road network is evident.

10.12 Specification of 'quiet' plant should be adopted for the drainage relaying works. Close liaison with the Highways Department and the Royal Hong Kong Police Force will be necessary to ensure the implementation of effective traffic management schemes.

Marine Borrow Areas at Tung Lung Chau and South Tathong Channel

10.13 Operations to obtain marine fill at these two areas are not anticipated to cause significant environmental effects. A potential does exist for water quality to be affected by an increase in turbidity which will result from fill winning and load consolidation. Fine material will be discharged from barges and may remain in suspension for up to 80 days in extreme cases. It is considered, however, that current movements, generally in a north-east : south-west direction will not result in a pronounced effect.

10.14 A potential does, however, exist for noise impacts at the South Tathong Channel borrow site. The use of trailer suction hopper dredgers at night may be audible at residential waterfront properties at Chai Wan.

Disposal of Marine Sediments

10.15 Disposal of uncontaminated marine sediments at the gazetted dumping areas of Cheung Chau or East of Ninepins, is not anticipated to cause an unacceptable level of impact. The uncontaminated nature of the sediments will mean that water quality impacts should be confined to an increase in turbidity in the vicinity of the dump site.

10.16 For the most part, toxic metal levels in sediments in the West Kowloon area do not exceed to Deep Bay Guideline values that have been adopted in this study as the criteria for assessing the significance of contamination levels. Sediment samples taken from within Yau Ma Tei typhoon shelter, however, indicate severe toxic metal contamination, in particular mercury and lead. Mercury levels at a site at the south of the typhoon shelter (S5) were three times the guidelines limit values. Lead levels throughout the typhoon shelter were very high and in many cases over 50% greater than the guideline limits. Whilst it is acknowledged that samples taken earlier in the course of the study do not record such high levels, the fact that such levels can be found at all is of great concern.

10.17 Given these levels, it is not possible to recommend the disposal of Yau Ma Tei sediments at gazetted dumping grounds. Ideally, the material should be left in place and isolated as part of the reclamation. In this event it will be necessary to carry out an assessment of the leachate produced during the consolidation process and arrange for appropriate treatment and disposal. Failing this, contained disposal such as lagooning with collection and treatment of any leachate produced, or landfilling with similar provision for leachate disposal should be employed.

10.18 Survey results obtained during the study indicate a high likelihood that discharges from a large stormwater drain at the south of Yau Ma Tei typhoon shelter may be responsible for the elevated metal levels. Current plans to extend the outfall to a point on the new seawall mean that, unless controlled, significant pollution of West Kowloon sediments and the waters of Victoria Harbour will continue. The relatively low level of industrial premises in the catchment area served by this drain suggests that the metals discharged may originate at a small number of locations. It is strongly recommended that the source of these discharges is pursued by EPD in order to ensure that the discharge requirements of the Victoria Harbour Water Control Zone as outlined in the Technical Memorandum on Effluent Limits are met.

Land Borrow Area at Chok Ko Wan Tsui

10.19 The winning of land sourced fill from the borrow area at Chok Ko Wan Tsui will accelerate the loss of a rural landscape resource. It should, however, be noted that the development of CLP's gas turbine plant to the west of the site and the intention to develop a borrow area for container terminal 8 already constitutes a change in the character of the area. It should also be recognized that PADS related developments towards the end of the century will alter the nature of this area completely, from rural to industrial. Against this background it may be considered that the landscape impact is acceptable in the long term.

10.20 The potential impacts of concern are related to the safe operation of the borrow area. Four separate quarrying operations will result in larger numbers of plant and a larger workforce than would be necessary with one large quarry. Blasting operations necessary to remove material will be replicated and will require careful liaison between quarry operators and the contractors and operators of CLP's plant to ensure that a safe working environment is maintained.

10.21 The potential for vibration effects to the CLP plant, resulting from blasting operations, should be the subject of discussion between quarry operators and the plant contractors and operators.

10.22 The proximity of the northernmost boundary of the site to a Site of Special Archaeological Interest will require liaison between the quarry operators and the Antiquities and Monuments Office.

Annex A
Sensitive Receptors In West Kowloon

Table 1 Details of the Recognized Sensitive Receptors Within the Sensitive Areas

Institutions

Sensitive Receptor	Distance from waterfront (m)	Remarks
Delia Memorial School in Mei Foo Sun Chuen	50	air-conditioned
Haking Wong Technical Institute in Cheung Sha Wan	0	
A kindergarten on the 2nd floor in Tai Yik House at Wong Tai Street	10	
Sharon Luthern School, Ming Kei College and a library in Cherry Street	20-30	schools not air-conditioned
Yaumatei Catholic Primary school in Ferry Street	60	not air-conditioned
Canton Road Government Medical Clinic and Dental Clinic, Police Primary School, Government School and Lai Chack Middle School	125	

Recreational Area

Sensitive Receptor	Distance from waterfront (m)	Remarks
A community centre and podium recreational area of Mei Foo Sun Chuen Estate	10	podium partly shielded by apartment block
Sham Shui Po Swimming Pools	300	separated from the seafront by Fat Tseung Street THA and Open Storage Area
Seafront recreational area in Nam Cheong Estate	10	
Tung Chau Street District Park	0	
King George V Park	200	
Kowloon Park	250	

Table 1 (cont)

Residential Areas

Sensitive Receptor	Height (storey)	Distance from waterfront (m)	Remarks
. Mei Foo Sun Chuen	21	4	with balconies facing the waterfront
. Lai Chi Kok THA	1	100	
. Fat Tseung Street THA	2	100	
. Nam Cheong Estate	16	10	with a home for the elderly inside the estate
. Wong Tai Street	13-20	10	
. Hoi King Street	4-5	100	
. Cherry Street (60-68)	4-5	20-30	
. Ferry Street	some 27-30 some 10-12	40-60	
. Man Cheong Street	19	20-30	
. Canton Road Police Quarter	8	125	
. Harbour City	15	5	hotels

Table 2 Sensitive Receivers/Receptors to the Noise and Air Pollution of Stormwater Drainage Works

Package I Drainage Improvement

Residential Area

- Wai Man Tsuen
- Sheung Fi Cheong UK Estate
- Yen Chow Street
- Shek Kip Mei Estate
- Nam Cheong Street (between Ki Lung Street and Tung Chau Street between Berwick Street and Tai Po Street)
- 1C-3E Nelson Street Waterloo Road (between Pui Ching Road and Dundas Street)
- Public Square Street (between Nathan Road and Ferry Street)
- Saigo Street (between Ferry Street and Nathan Road)
- Nam Cheong Street

Institutions

- Tack Ching Girls' Middle School
- Heep Tung Primary School
- St Francis of Association College
- Pui Ching Primary School
- Sham Shui Po Clinic
- Jockey Club Clinic
- Wong Tai Shan Memorial School

Package II Drainage Improvement

Residential Areas

- Lower Pak Tin Estate
- Tai Hang Tung Estate
- Yau Yat Chuen
- 3-12 Nullah Road
- Chung Wong Road
- 269-251 Portland Street
- Shan Tung Street (No. 74 to Shanghai Street)
- 210-175 Portland Street
- Soy Street (Nathan Road to waterfront)
- Waterloo Road (Tung Fong Street to Waterfront)
- Nathan Road (between Mau Lam Street and Nanking Street)

Institutions

- Kow Kong Commercial Association Primary School
- Sham Shun School
- Yau Yat Chuen College
- Saint Too Girls' College

- Po On Commercial Association School
- HK Sze Yap Commercial and Industrial Association School
- Christian Alliance Primary School
- Kowloon Wah Yan College
- Lutheran Middle School
- YMCA English College and Evening School
- Chi Kit School
- Kei Wing School
- Kwong Wah Hospital

Recreational Areas

- Tai Hang Tung Playground
- Mongkok Stadium

Package III Drainage Improvement

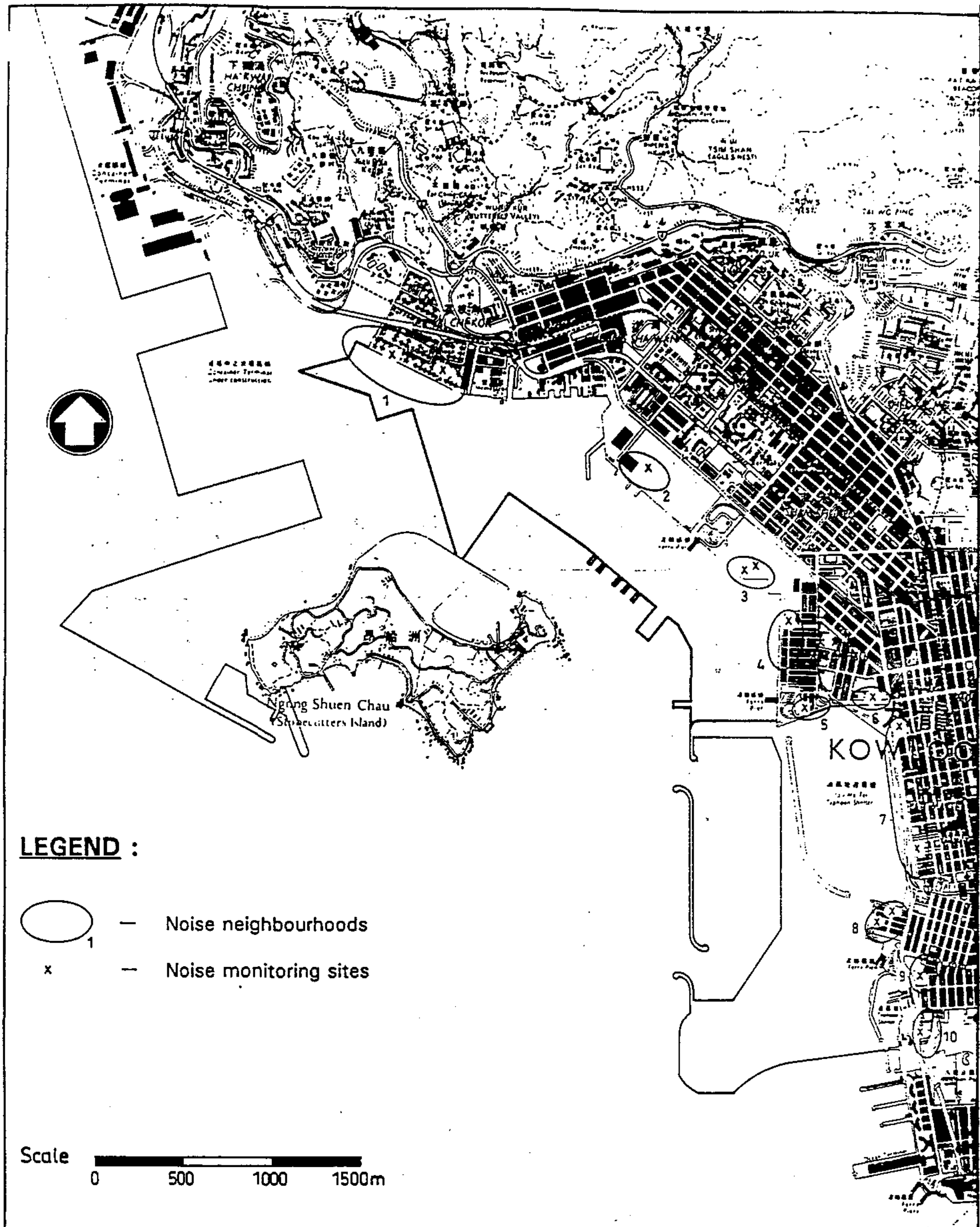
Residential Area

- So Uk Estate
- Nam Cheong Street (between Tai Po Street and Ki Lung Street)
- 154-213, Sai Yee Street
- Argyle Street (between Fat Kwong Street and Fa Yuen Street)

Institutions

- Lock Tao Secondary School
- Lock Tao Hospital

Annex B
Noise Impacts: Supporting Information



GOVERNMENT OF HONG KONG TERRITORY DEVELOPMENT DEPARTMENT URBAN AREA DEVELOPMENT OFFICE	Consultants Mott MacDonald Hong Kong Ltd. in association with L.G. Mouchel & Partners (Asia) Urbis Travers Morgan Ltd. ERL (Asia) Ltd., MVA Asia, Leigh & Orange Ltd., Dredging Research Ltd., First Pacific Davies (Hong Kong) Ltd.
WEST KOWLOON RECLAMATION	
FIG. 1 _ LOCATION OF NOISE MONITORING SITES AND NOISE NEIGHBOURHOODS	Mott MacDonald Tel. No. 575 7108 Fax No. 834 5523 Scale 1 : 30 000 Sketch No. 285/E/SK/049 Rev.

Table 1 West Kowloon Reclamation

Sites for assessing the Ambient Noise Level along the reclamation boundary

Site Number	Address	Date
1.	Roof, Block 64, Mei Foo Sun Chuen	29/8 to 30/8 (Wed) (Thu)
2.	Roof, Block 66, Mei Foo Sun Chuen	30/8 to 31/8 (Thu) (Fri)
3.	2/F, Room 13, Block 23, Fat Tseung Street THA	27/7 to 28/7 (Fri) (Sat)
4.	Roof, 16/F, Cheong Yat House, Nam Cheong Estate	14/8 to 15/8 (Tue) (Wed)
5.	Roof, 16/F, Cheong Chung House, Nam Cheong Estate	15/8 to 16/8 (Wed) (Thu)
6.	Roof, 13/F, Tai Ying House, 48 Wong Tai Street	31/8 to 1/9 (Fri) (Sat)
7.	Roof, 4/F, 60-62 Cherry Street	13/8 to 14/8 (Mon) (Tue)
8.	Roof, 5/F, Sharon Luthern School	6/8 to 7/8 (Mon) (Tue)
9.	Roof, 27/F, Shun King Building, 317 Ferry Street	3/9 to 4/9 (Mon) (Tue)
10.	4/F, Yau Ma Tei Catholic Primary School	23/8 to 24/8 (Thu) (Fri)
11.	Roof, 19/F, Man Cheong House, Man Cheong Street	9/8 to 10/8 (Thu) (Fri)
12.	Roof, 19/F, Man Fai House, Man Cheong Street	10/8 to 11/8 (Fri) (Sat)
13.	Roof, 3/F, Public Convenience, King George V Park	8/8 to 9/8 (Wed) (Thu)
14.	Roof, 8/F, Block B, 182 Canton Road	7/8 to 8/8 (Tue) (Wed)

Table 2 Noise Monitoring Sites : Details of 24 Hour Noise Monitoring

Site No.: 1

Location: Roof, 21/F, Block 66, Mei Foo Sun Tseun, Lai Chi Kok
(G.R.: 832 250E 821 860N)

Period of Measurement: 29/8/90 (Wed, 15:00) - 30/8/90 (Thu, 15:00)

Characteristics of Measuring Location:

The measuring point was at the roof-top of a 21-storey block in Mei Foo Sun Tseun. The facade was directly exposed to sea-front activities which were comparatively quiet. To the west of the estate was a major reclamation work of the extension project for the Kwai Chung Container Terminal, dredging and filling were on-going here.

Major noise sources in the area were from:

(i) airplane traffic (at a frequency of 1 plane per 5-10 mins.) between 0800 and 2300;

(ii) distant constructional noises created by the new container terminal reclamation works (this involved the use of grab dredgers and barges, etc.);

(iii) residential activities (including the possibility of interference by nearby air-conditioners);

(iv) some distant marine traffic.

Site No.: 2

Location: Roof, 21/F, Block 64, Mei Foo Sun Tseun, Lai Chi Kok.
(G.R.: 832 275E 821 920N)

Period of Measurement: 30/8/90 (Thu, 15:15) - 31/8/90 (Fri, 15:15)

Characteristics of Measuring Location:

The measurement was made at the interior of the Estate. The facade was facing to a relatively confined environment with a minor street, the Broadway, below the position of measurement and with other blocks surrounding the area. This location was comparatively quiet though it was still below the flight path of airplane traffic.

Noise was mainly from:

(i) airplane traffic;

(ii) minor street traffic; and

(iii) residential activities.

Table 2 (cont)

Site No.: 3

Location: 2/F, Room 13, Block 23, Fat Tseung Street THA, Sham Shui Po
(G.R.: 833 763E 821 175N)

Period of Measurement: 27/7/90 (Fri, 10:15) - 28/7/90 (Sat, 10:00)

Characteristics of Measuring Locations:

The measurement was made on the 2/F of an empty apartment in Fat Tseung Street Temporary Housing Area. The apartment was on the left of the Wholesale Fish Market which on operation was very noisy (loud-hailers were used). The monitoring reciever was located at a point 1 m away from a partially opened window facade and was at least 1 m below the roof. 2 m away from the facade was a fence with a height comparable with that of the reciever. Three piers were in operation on the other side of the fence.

Noise was mainly from:

(i) airplane traffic (at a frequency of about 1 plane per 5-10 mins.);

(ii) constructional activities on the other side of the fence which operate mainly in day-time;

(iii) Wholesale Fish Market which operate from 8:00 to 10:00 in the morning and from around 16:00 in the afternoon;

(iv) residential activities in the THA (the receiver was only about 2 m above ground level).

Site No.: 4

Location: Roof, 16/F, Cheong Yat House, Nam Cheong Estate
(G.R.: 834 190E 820 790N)

Period of Measurement: 14/8/90 (Tue, 10:00) - 15/8/90 (Wed, 10:00)

Characteristics of Measuring Location:

The measurement was made at the roof top of the 16-storey Cheong Yat House in Nam Cheong Estate. The building was only several metres behind a busy Cargo Working Area whose activities dorminated the noise sources in the area. To the right of the Cargo Working Area were Sham Shui Po Ferry Pier, Bus Terminus and construction work which contributed to the rest of the surrounding noise.

Noise was mainly from:

(i) airplane traffic (at a frequency of about 1 plane per 5-10 mins.)

(ii) cargo loading activities (heavy lorries, barges and cranes were involved) which stopped operation temporarily at lunch time (around 12:00 noon);

(iii) distant noise of ferries and buses from Sham Shui Po Ferry Pier, as well as noise from the construction activities.

Table 2 (cont)

Site No.: 5

Location: Roof, 16/F, Cheong Chung House, Nam Cheong Estate
(G.R.: 834 380E 820 710N)

Period of Measurement: 15/8/90 (Wed, 11:00) - 16/8/90 (Thu, 11:00)

Characteristics of Measuring Location:

This measurement was at the roof top of another 16-storey block in Nam Cheong Estate. The facade of the measurement faced directly to the Sham Shui Po District Park with HK Dockyard at the far end (about 100 m away). To the north-east was West Kowloon Corridor which gave a very heavy traffic flow (noise from this source may have been shielded by the other block on the left). Flight path of airplanes was to the rear side of the facade.

Noise was mainly produced by:

(i) ship-repairing from HK Dockyard;

(ii) residential activities in the Sham Shui Po District Park;

(iii) airplane traffic;

(iv) traffic flow from distant West Kowloon Corridor.

Site No. 6

Location: Roof, 13/F, Tai Ying House , 48 Wong Tai Street, Tai Kok Tsui
(G.R.: 834 535E 820 300N)

Period of Measurement: 31/8/90 (Fri, 16:15) - 1/9/90 (Sat, 16:15)

Characteristics of Measuring Location:

The measuring point was at the roof top of a 13-storey building (Tai Ying House) in Wong Tai Street, a minor street serving only several residential blocks. The facade of this measurement exposed directly to the seafront and was within about 300 m from HK Dockyard and the nearby Tai Kok Tsui Ferry Pier.

Noise was mainly from:

(i) airplane traffic;

(ii) marine traffic (including ferries and barges);

(iii) ship-repairing works from HK Dockyard; and

(iv) minimal traffic noise of Wong Tai Street.

Table 2 (cont)

Site No.: 7

Location: Roof, 4/F, 60-62 Cherry Street, Tai Kok Tsui
(G.R.: 834 720E 819 922N)

Period of Measurement: 13/8/90 (Mon) - 14/8/90 (Tue)

Characteristics of Measuring Location:

The measurement was made at a point only 4 stories above the main entrance of the Tai Kok Tsui Ferry Pier and Buses Terminus (western end of Cherry Street). Across the street was Yau Ma Tei Typhoon Shelter which was also the main exit for barges and other marine vehicles. Cargo loading (crane lifting, etc.) at a point only about 50 m away from the facade was going on during the period of monitoring.

Main sources of noise were:

(i) traffic noise created by buses passing right under the reciever to the bus terminus;

(ii) cargo lifting activities in the typhoon shelter; and

(iii) possibility of residential interference.

Site No.: 8

Location: Roof, 5/F, Sharon Luthern School, Tai Kok Tsui
(G.R.: 835 030E 819 980N)

Period of Measurement: 6/8/90 (Mon, 11:45) - 7/8/90 (Tue, 11:55)

Characteristics of Measuring Location:

The measurement was taken at the southern facade of Sharon Luthern School exposed directly to Cherry Street. The reciever was located at a distance about 125 m away from a major junction of Ferry Street and Cherry Street. On the eastern side of Cherry Street was Yau Ma Tei Typhoon Shelter.

Noise was mainly from:

(i) heavy traffic flow in Cherry Street which later led to Tai Kok Tsui Bus Terminus and Tai Kok Tsui Road (The latter eventually joined with the West Kowloon Corridor. A combination of these traffic sources made up the substantial noise level at this location);

(ii) barges and marine traffic in the typhoon shelter also contribute to the rest of the noise measured here.

Table 2 (cont)

Site No.: 9

Location: Roof, 27/F, Shun King Building, 317 Ferry Street
(G.R.: 835 215E 819 750N)

Period of Measurement: 3/9/90 (Mon, 14:00) - 4/9/90 (Tue, 14:00)

Characteristics of Measuring Location:

The point of monitoring was located at the roof-top of a 27-storey building in the northern end of the busy Ferry Street. The facade exposed immediately to the street (which was close to the busy Mong Kok market) and to the typhoon shelter with a public cargo working area in between. Some small machine making workshops were on the ground floors of this building as well as those nearby. For safety reasons and other constraints, the measuring microphone could only be located at a recess point between two projecting blocks (about 3 m behind the frontier).

Noise was mainly from:

(i) nearby cargo working area (barges and crane, etc. were used);

(ii) heavy traffic flow (about 3000 veh./hr, >30% were heavy vehicles);

(iii) road maintaining activities (pneumatic concrete breaker was used at a point about 200 m from the building);

(iv) operation noise of machine workshops.

Site No.: 10

Location: 4/F, Yau Ma Tei Catholic Primary School, Ching Ping Street, Yau Ma Tei
(G.R.: 835 325E 819 160N)

Period of Measurement: 23/8/90 (Thu, 8:10) - 24/8/90 (Fri, 8:10)

Characteristics of Measuring Location:

The monitoring location in this school was on the eastern side of Ferry Street. Next to the school to the north is the Wholesale Fruit and Vegetable Market which generated a lot of heavy lorry traffic in Ching Ping Street. The Position of the reciever was located such that projections of the school building were avoided (by standing it out from a small window about 1 m from projection). Yau Ma Tei Typhoon Shelter was on the western side of Ferry Street.

Major noise sources were:

(i) lorry traffic generated from the Wholesale Fruit and Vegetable Market;

(ii) heavy traffic noise of Ferry Street (about 3000 veh./hr);

(iii) distant traffic noise from the nearby flyover;

(iv) noise generated from market activities in the early morning (e.g. shouting, loud hailers).

Table 2 (cont)

Site No.: 11

Location: Roof, 19/F, Man Cheong House, Man Cheong Street, Yau Ma Tei
(G.R.: 835 145E 818 805N)

Period of Measurement: 9/8/90 (Thu, 15:00) - 10/8/90 (Fri, 15:00)

Characteristics of Measuring Location:

The measuring point was at the southern exit of Yau Ma Tei Typhoon Shelter in a minor street (Man Cheong Street) branched from the major Ferry Street. Along Man Cheong Street were some small machine manufacturing workshops which may contribute to some of the noise in the area. Ferry Street flyover was about 200 m away from the monitoring location.

Noise was mainly from:

(i) barges and cargo loading activities in the typhoon shelter;

(ii) flyover traffic;

(iii) residential activities (likely to be affected by nearby air-conditioners);

(iv) machine workshops.

Remarks: The slant feature of the upper part of the building may shield some of the immediate noise from the street.

Site No.: 12

Location: Roof, 19/F, Man Fai House, Man Cheong Street, Yau Ma Tei
(G.R.: 835 095E 818 730N)

Period of Measurement: 10/8/90 (Fri, 16:00) - 11/8/90 (Sat, 16:00)

Characteristics of Measuring Location:

This location directly exposed to the sea-front on the western side of Man Cheong Street. The monitoring point was only 50 m from the Vehicular Ferry Pier on the south which may be quite busy during rush hour. Road traffic was only minimal while marine traffic could be substantial.

Noise was mainly from:

(i) barge traffic (as the measuring position was only about 50 m from the southern exit of Yau Ma Tei Typhoon Shelter);

(ii) vehicular ferry traffic.

Table 2 (cont)

Site No.: 13

Location: Roof, 3/F, Public Convenience, King George V Memorial Park
(G.R.: 835 370E 818 505N)

Period of Measurement: 8/8/90 (Wed, 14:05) - 9/8/90 (Thu, 14:05)

Characteristics of Measuring Location:

The location was at a low level at the roof of a public convenience in the park facing the northern end of Canton Road. 200 m away from the monitoring point to the west is Jordon Road Ferry Pier and Bus Terminus. To the north was Jordon Road which was only about 10 m away.

Major noises were:

(i) traffic noise from Canton Road and Jordon Road;

(ii) noises generated by park visitors.

Remarks: Monitoring results may be affected by screening effects due to the nearby trees as the position of the reciever was not very high.

Site No.: 14

Location: Roof, 8/F, Block B, 182 Canton Road
(G.R.: 835 385E 818 130N)

Period of Measurement: 7/8/90 (Tue, 12:55) - 8/8/90 (Wed, 12:55)

Characteristics of Measuring Location:

The monitoring point was at the roof top of a 8-storey governmental block immediately adjacent to the east of the busy Canton Road. Constructional works were in progress on the western side of the road and also at the rear end of the building.

Major noise sources were:

(i) heavy traffic noise in Canton Road; and

(ii) constructional and road repairing noises.

Figure 2 a-n : 24-hour Noise Monitoring Results

Figure 2a

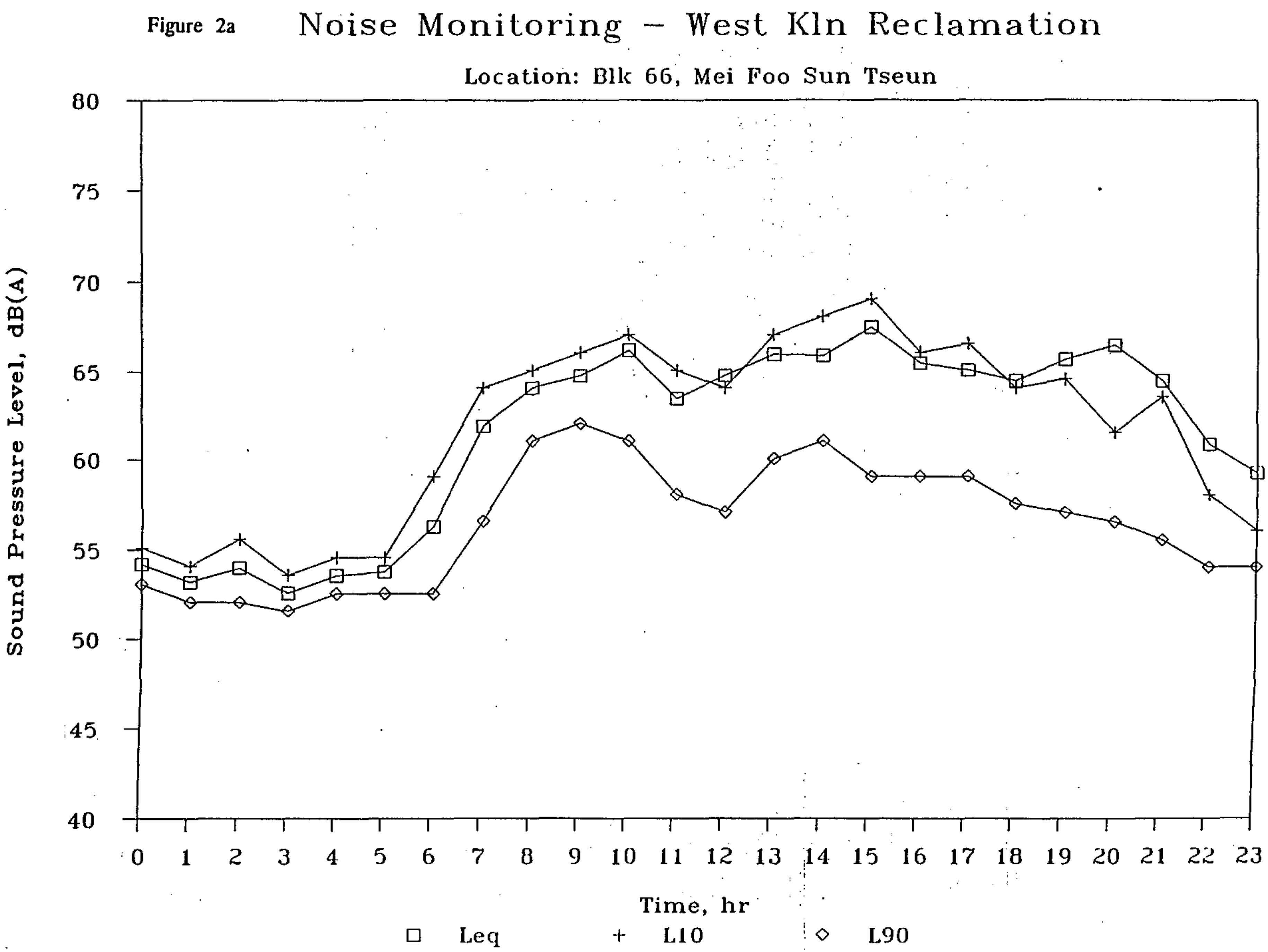
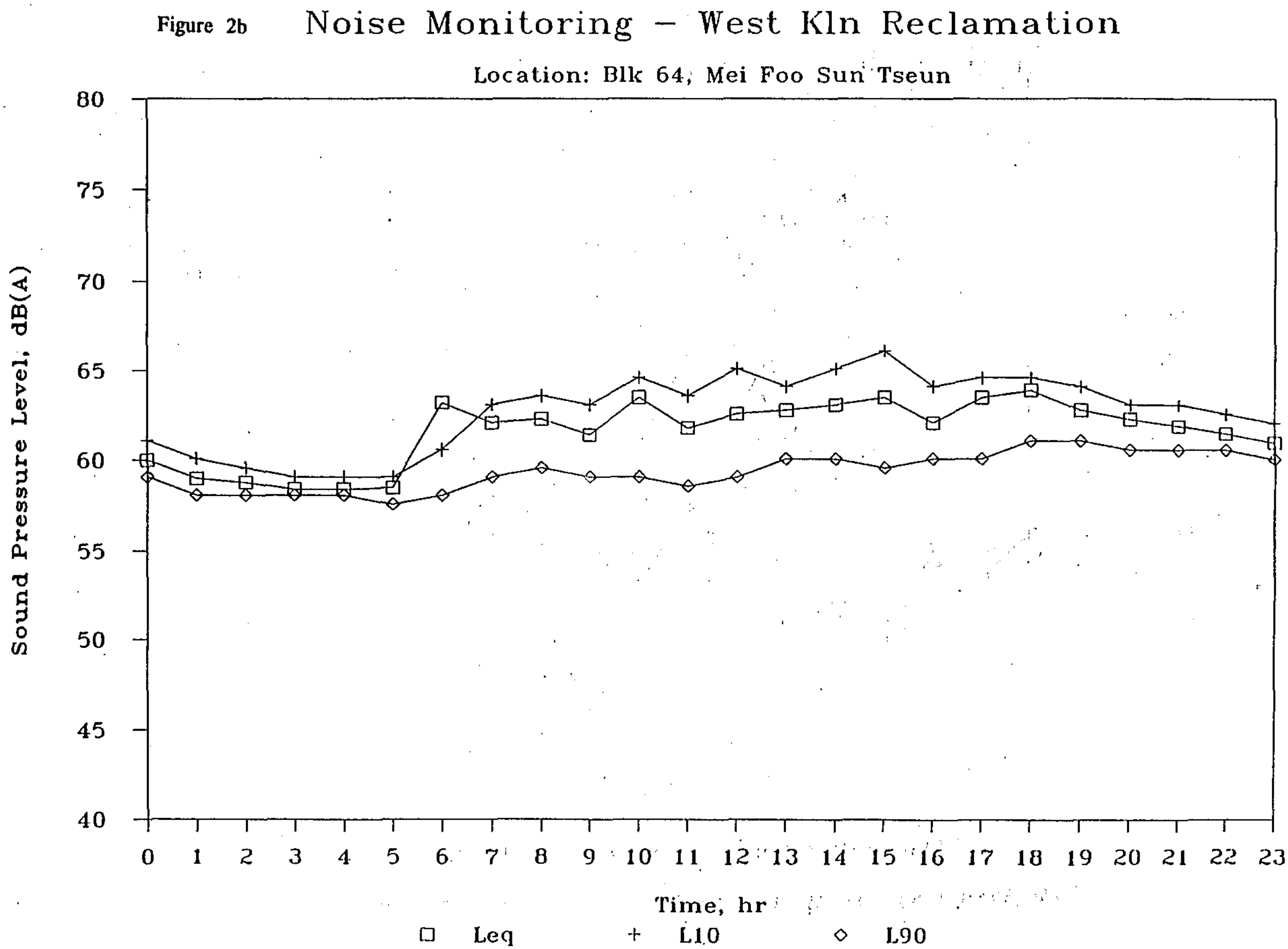

Noise Monitoring - West Kln Reclamation
Location: Blk 66, Mei Foo Sun Tseun
Sound Pressure Level, dB(A)
80
75
70
65
60
55
50
45
40
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time, hr
□ Leq
+ L10
◇ L90

Figure 2b



Noise Monitoring - West Kln Reclamation
Location: Blk 64, Mei Foo Sun Tseun
Sound Pressure Level, dB(A)
80
75
70
65
60
55
50
45
40
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time, hr
Leq
L10
L90

Figure 2c

Noise Monitoring – West Kln Reclamation

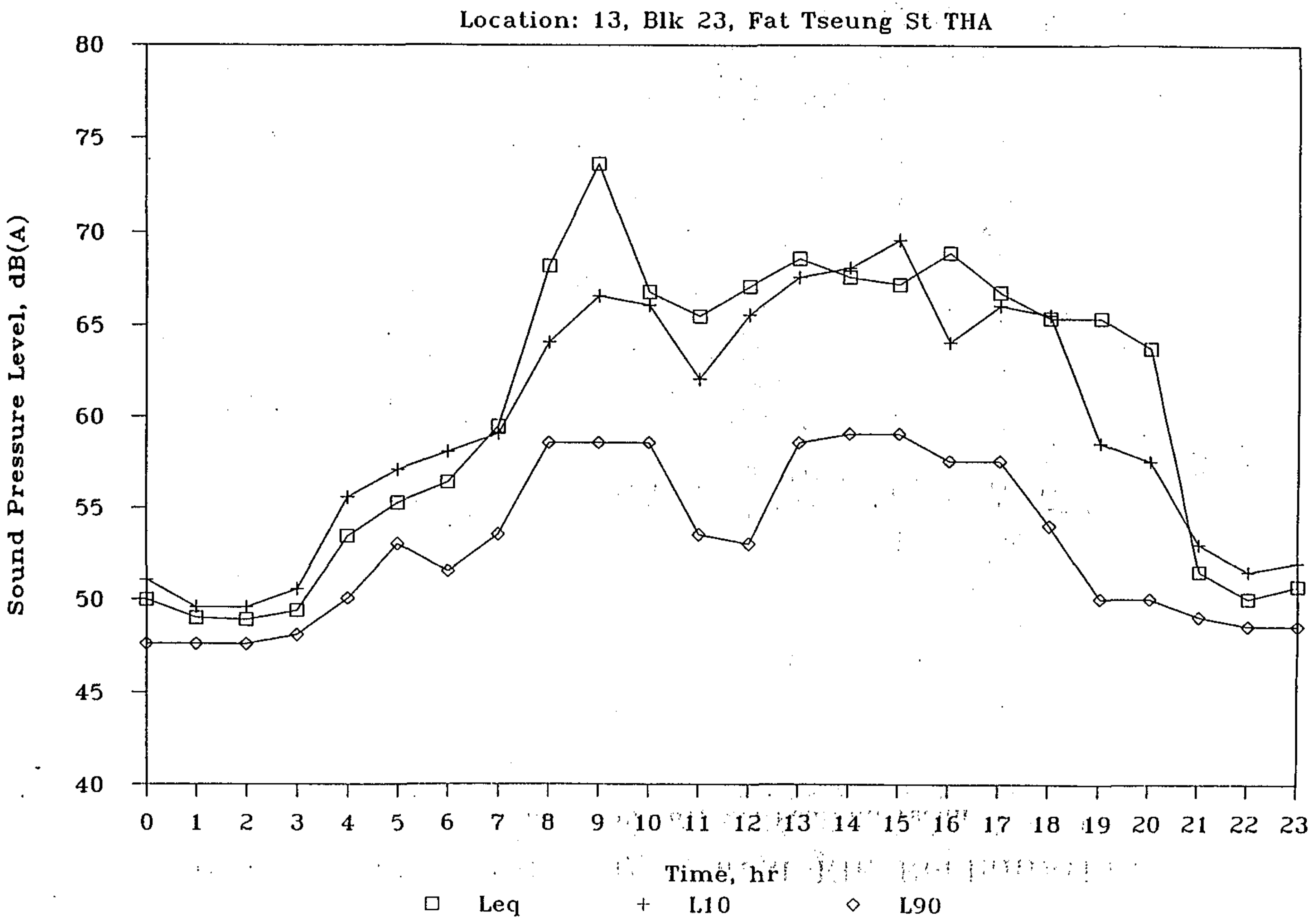


Figure 2d

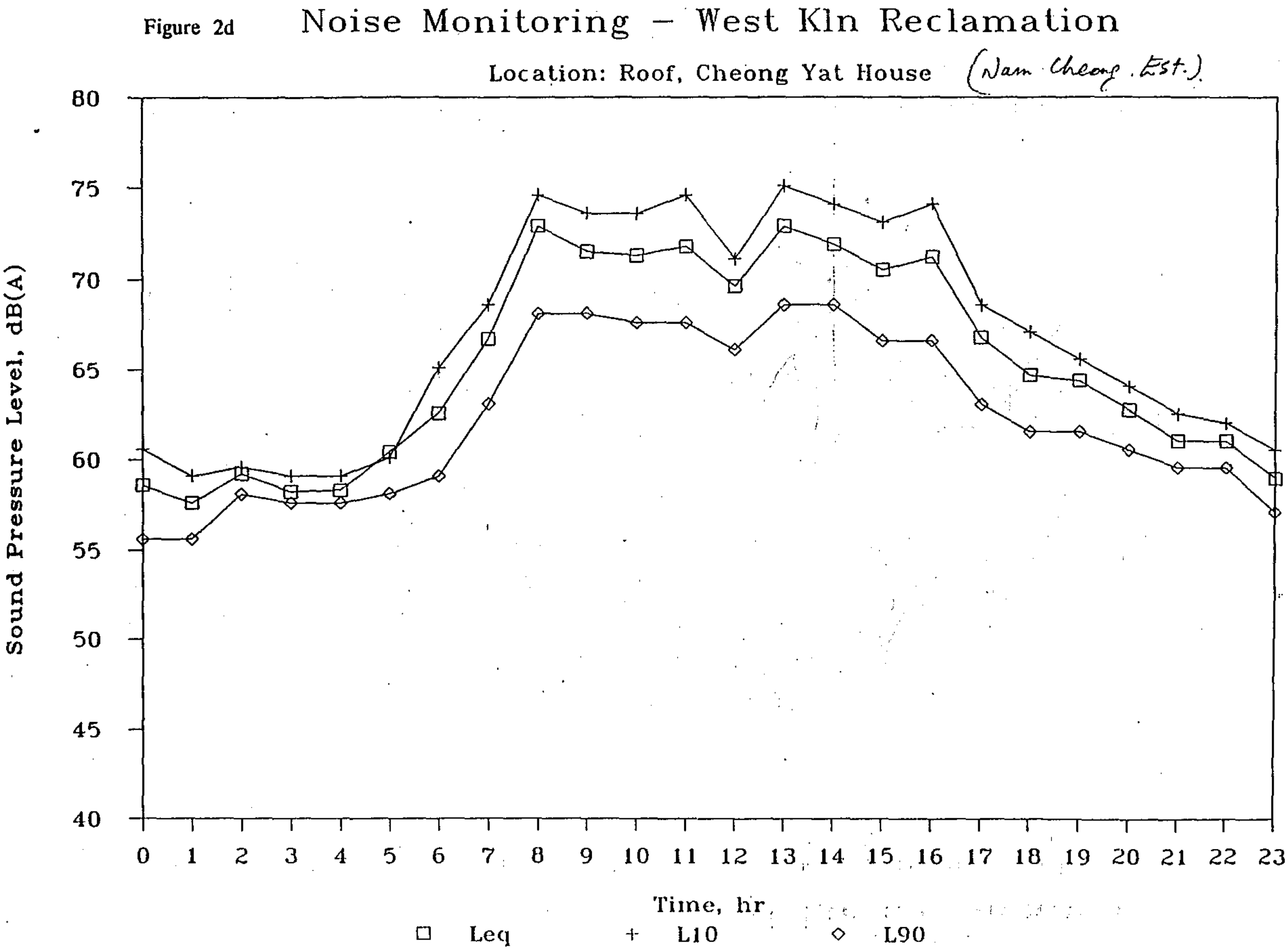

Noise Monitoring - West Kln Reclamation
Location: Roof, Cheong Yat House (Nam Cheong Est.)
Sound Pressure Level, dB(A)
80
75
70
65
60
55
50
45
40
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time, hr
Leq
L10
L90

Figure 2e Noise Monitoring - West Kln Reclamation

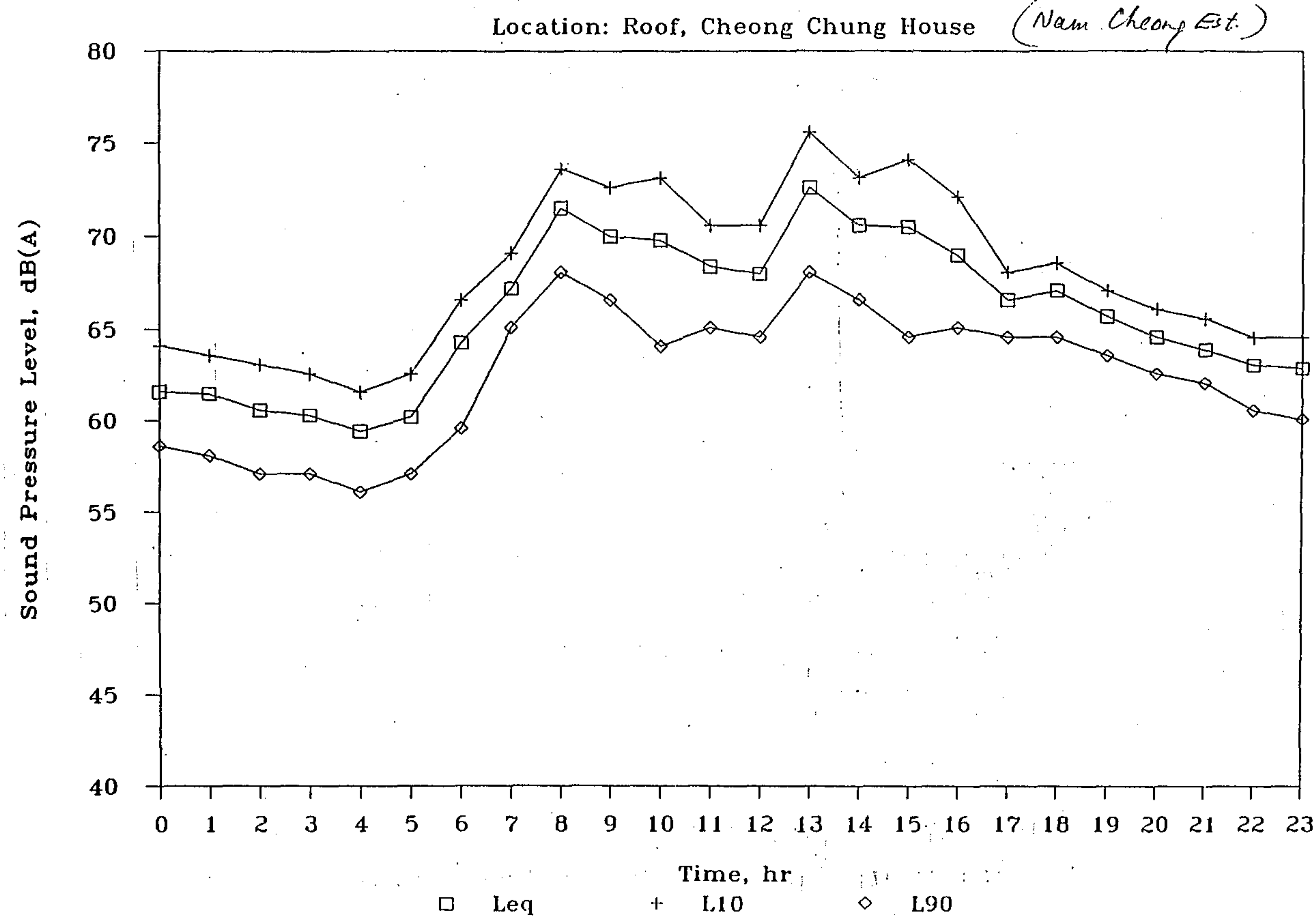


Figure 2f

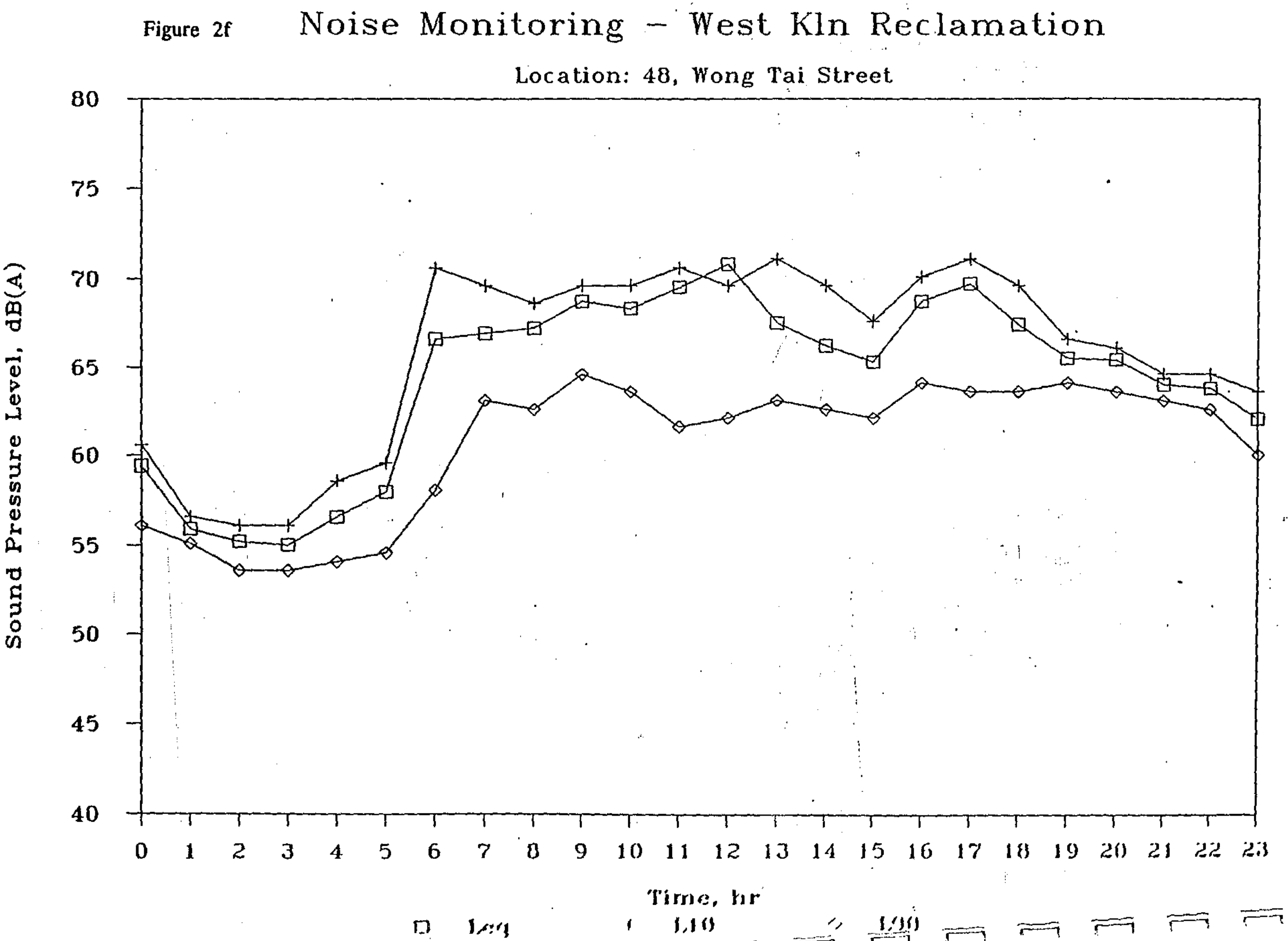
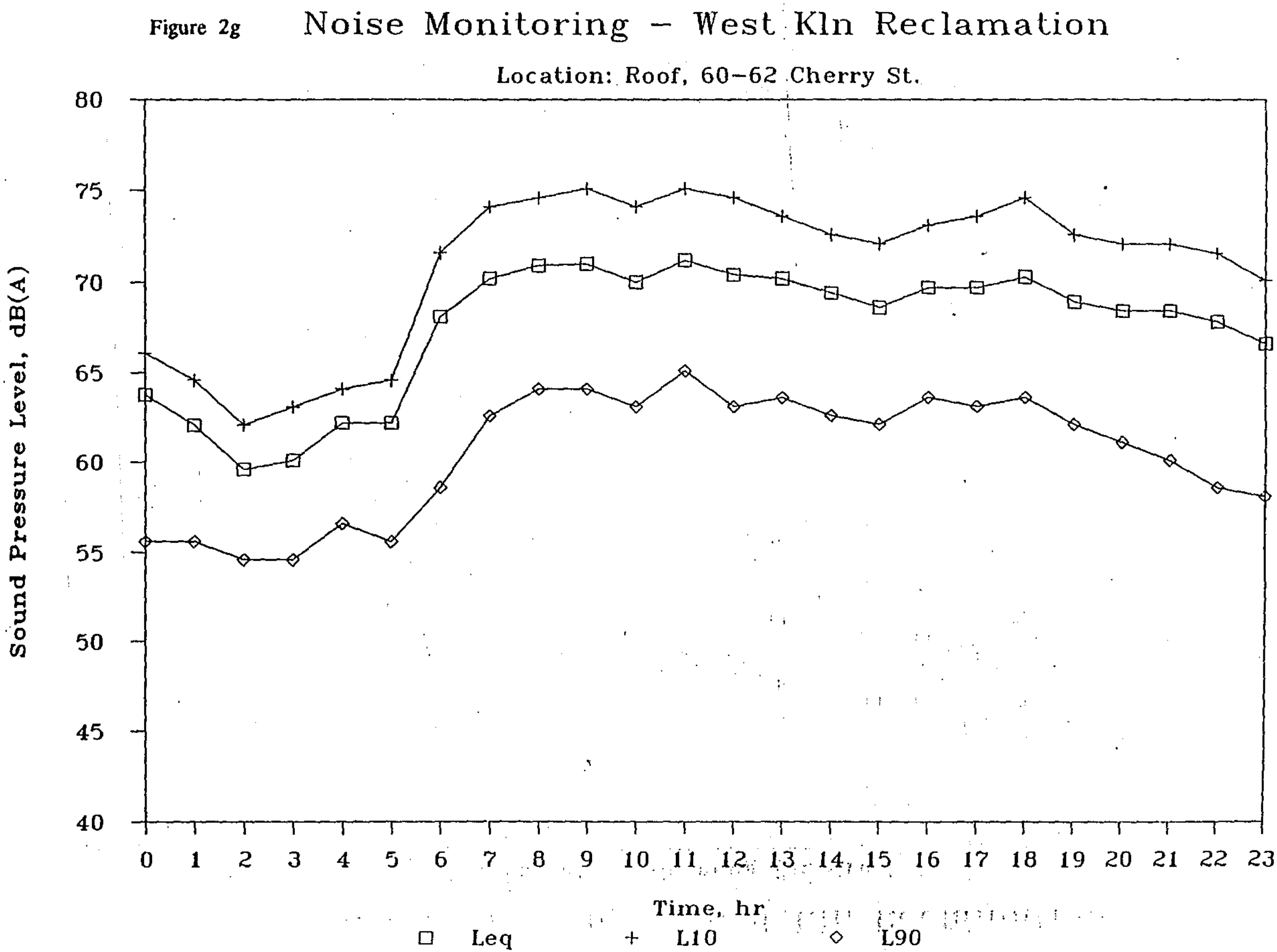
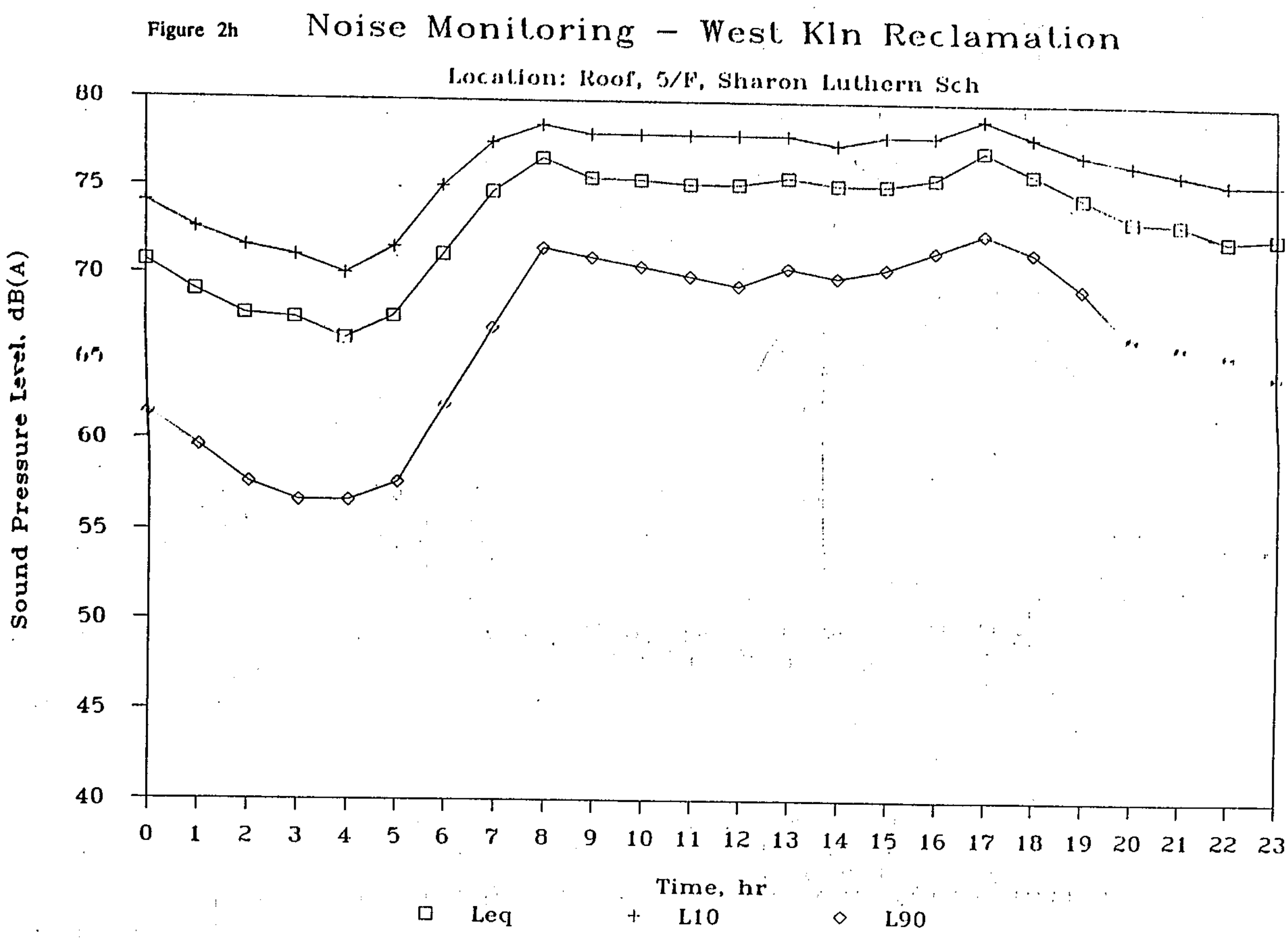

Noise Monitoring - West Kln Reclamation
Location: 48, Wong Tai Street
Sound Pressure Level, dB(A)
80
75
70
65
60
55
50
45
40
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time, hr
Leq
L10
L90

Figure 2g



Noise Monitoring - West Kln Reclamation
Location: Roof, 60-62 Cherry St.
Sound Pressure Level, dB(A)
80
75
70
65
60
55
50
45
40
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time, hr
Leq
L10
L90

Figure 2h



Noise Monitoring – West Kln Reclamation
Location: Roof, 5/F, Sharon Luthern Sch
Sound Pressure Level, dB(A)
80
75
70
65
60
55
50
45
40
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time, hr
Leq
L10
L90

Figure 2i Noise Monitoring – West Kln Reclamation

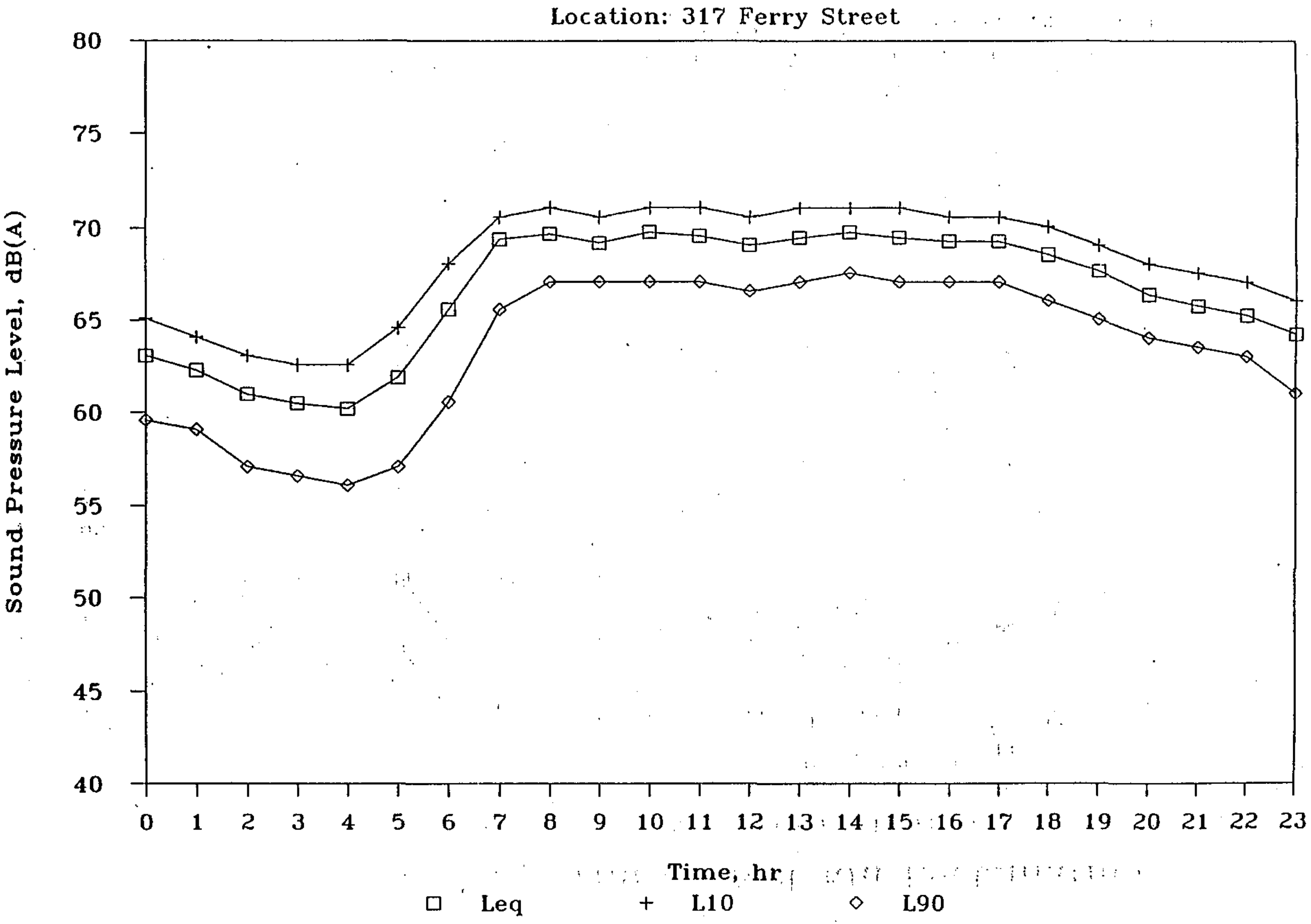
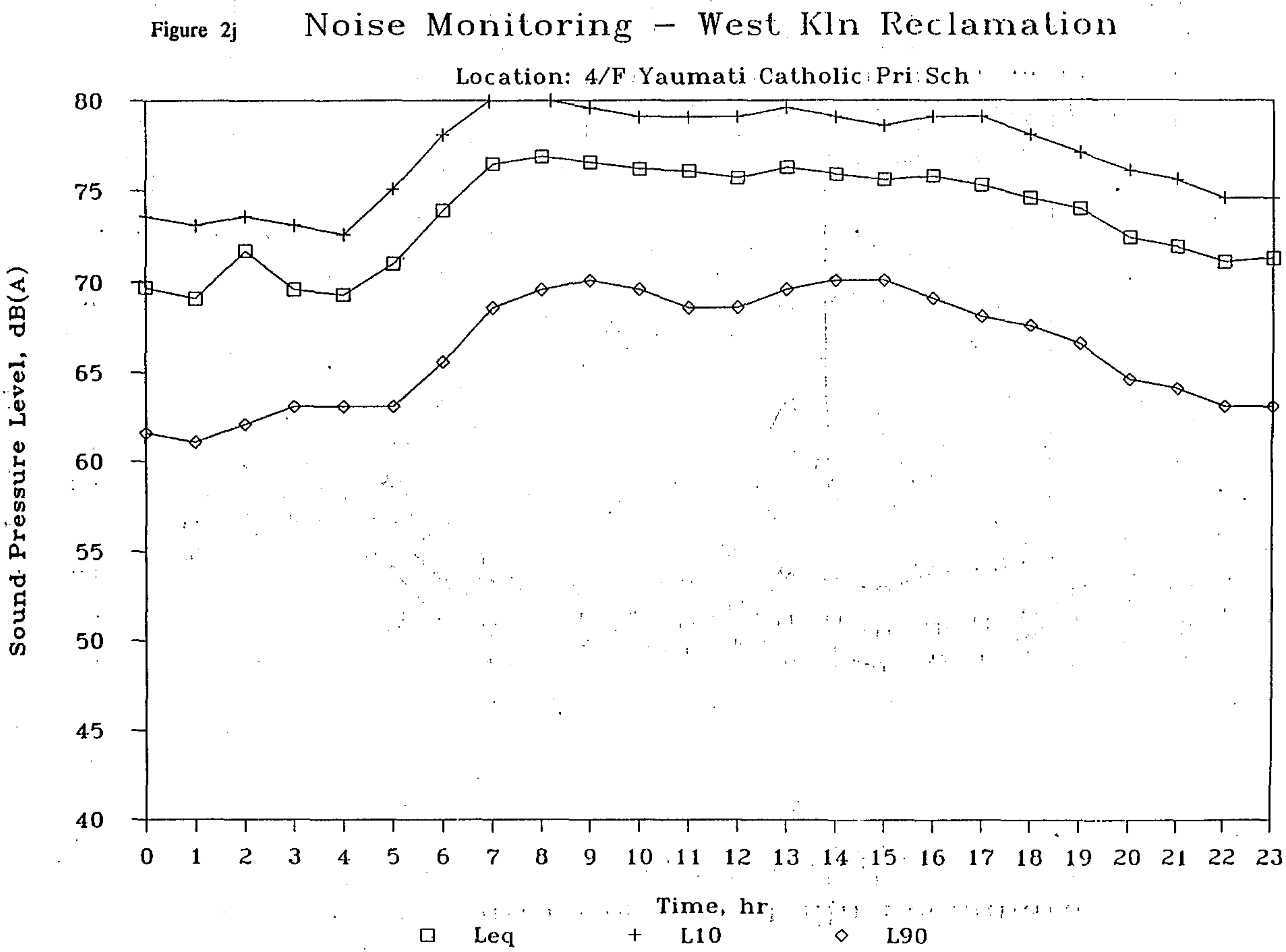


Figure 2j



Noise Monitoring - West Kln Reclamation
Location: 4/F Yaumati Catholic Pri Sch
Sound Pressure Level, dB(A)
80
75
70
65
60
55
50
45
40
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time, hr
Leq
L10
L90

Figure 2k

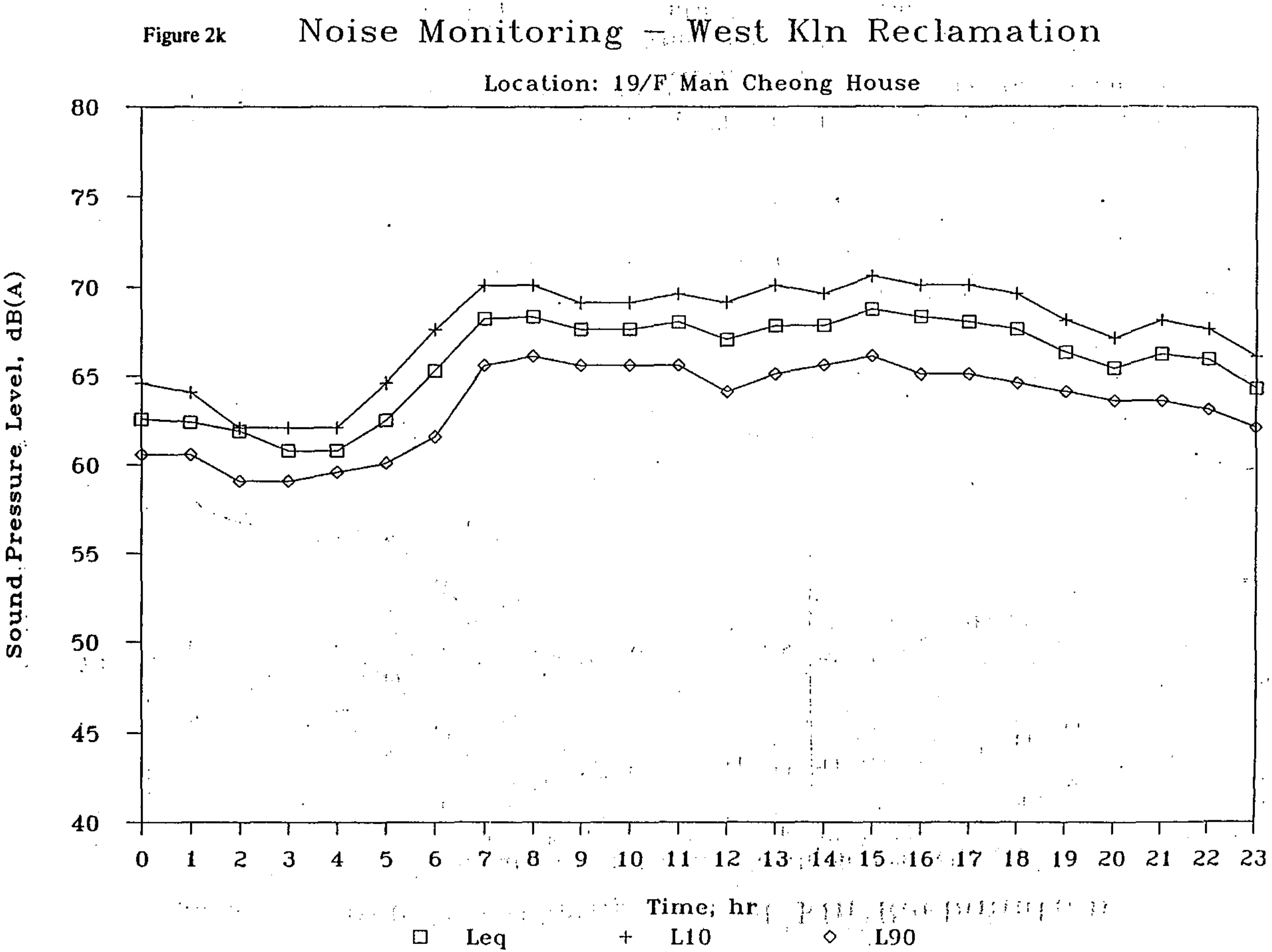

Noise Monitoring – West Kln Reclamation
Location: 19/F Man Cheong House
Sound Pressure Level, dB(A)
80
75
70
65
60
55
50
45
40
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time, hr
Leq
L10
L90

Figure 2m

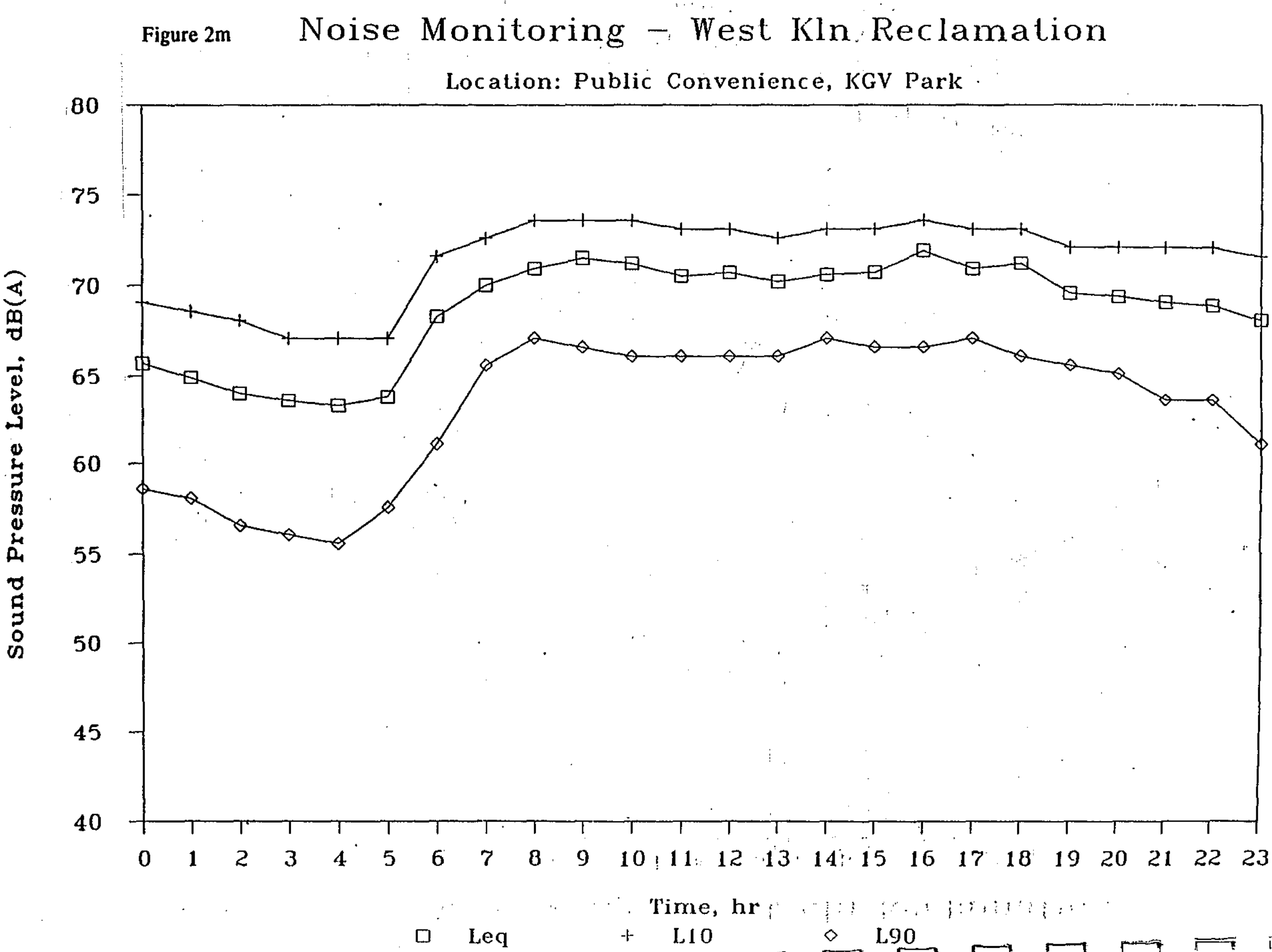
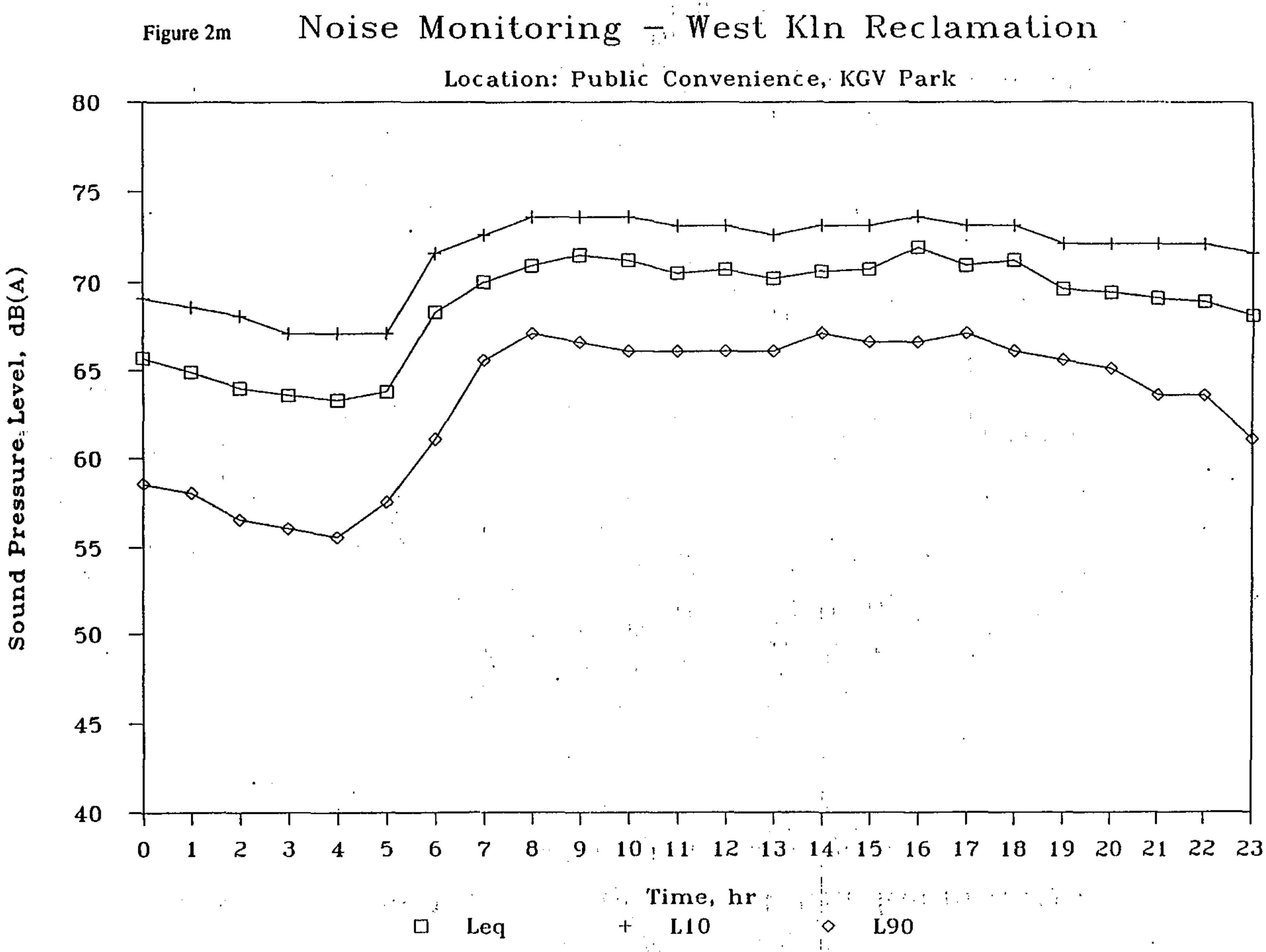
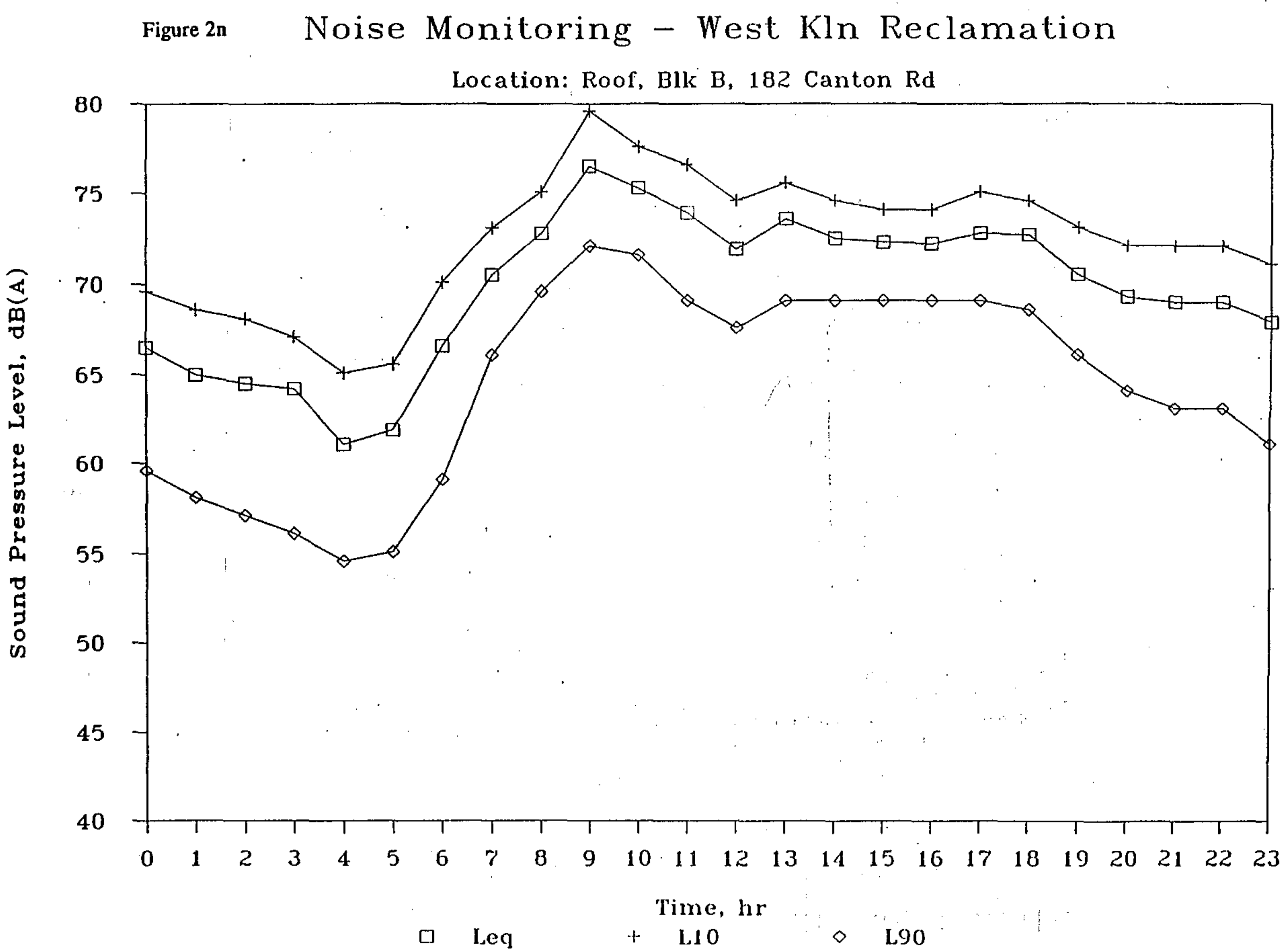

Noise Monitoring – West Kln Reclamation
Location: Public Convenience, KGV Park
Sound Pressure Level, dB(A)
80
75
70
65
60
55
50
45
40
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time, hr
Leq
L10
L90

Figure 2m



Noise Monitoring – West Kln Reclamation
Location: Public Convenience, KGV Park
Sound Pressure Level, dB(A)
80
75
70
65
60
55
50
45
40
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time, hr
Leq
L10
L90

Figure 2n


Noise Monitoring - West Kln Reclamation
Location: Roof, Blk B, 182 Canton Rd
Sound Pressure Level, dB(A)
80
75
70
65
60
55
50
45
40
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Time, hr
Leq
L10
L90

Figures 3a-j Activity Profiles

Key Sheet

Northern Section

A Dredging Sea Wall Line
B Rock Filling
C Seawall Construction
D Piling for Piers
E Demolition of Existing Piers
F Mud Dredging
G Marine Fill Placement
H Placement of Land-sourced Fill (CDG)
I Completion
J Reprovision of Piers and Hard-standing for Markets

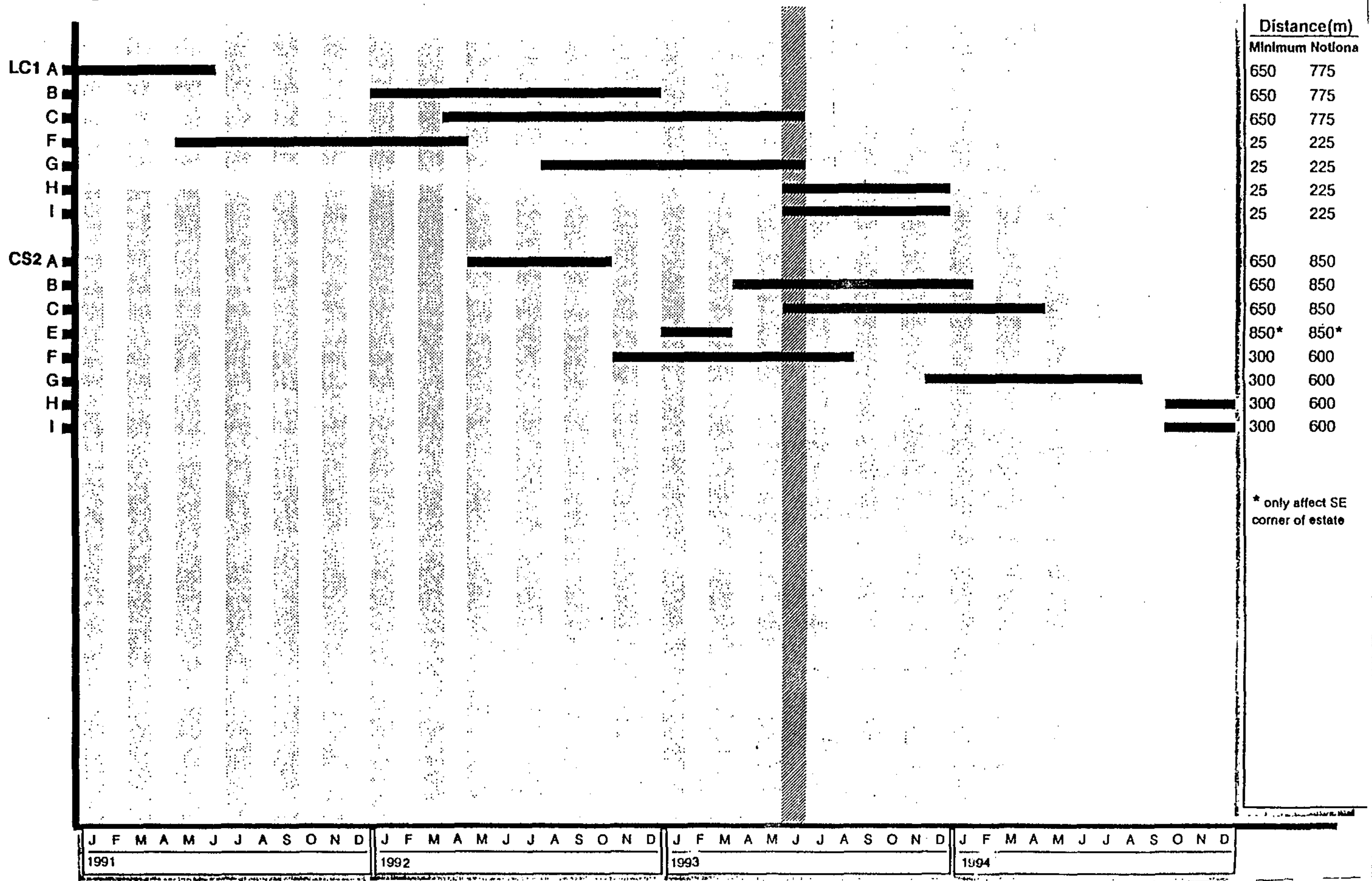
Southern Section

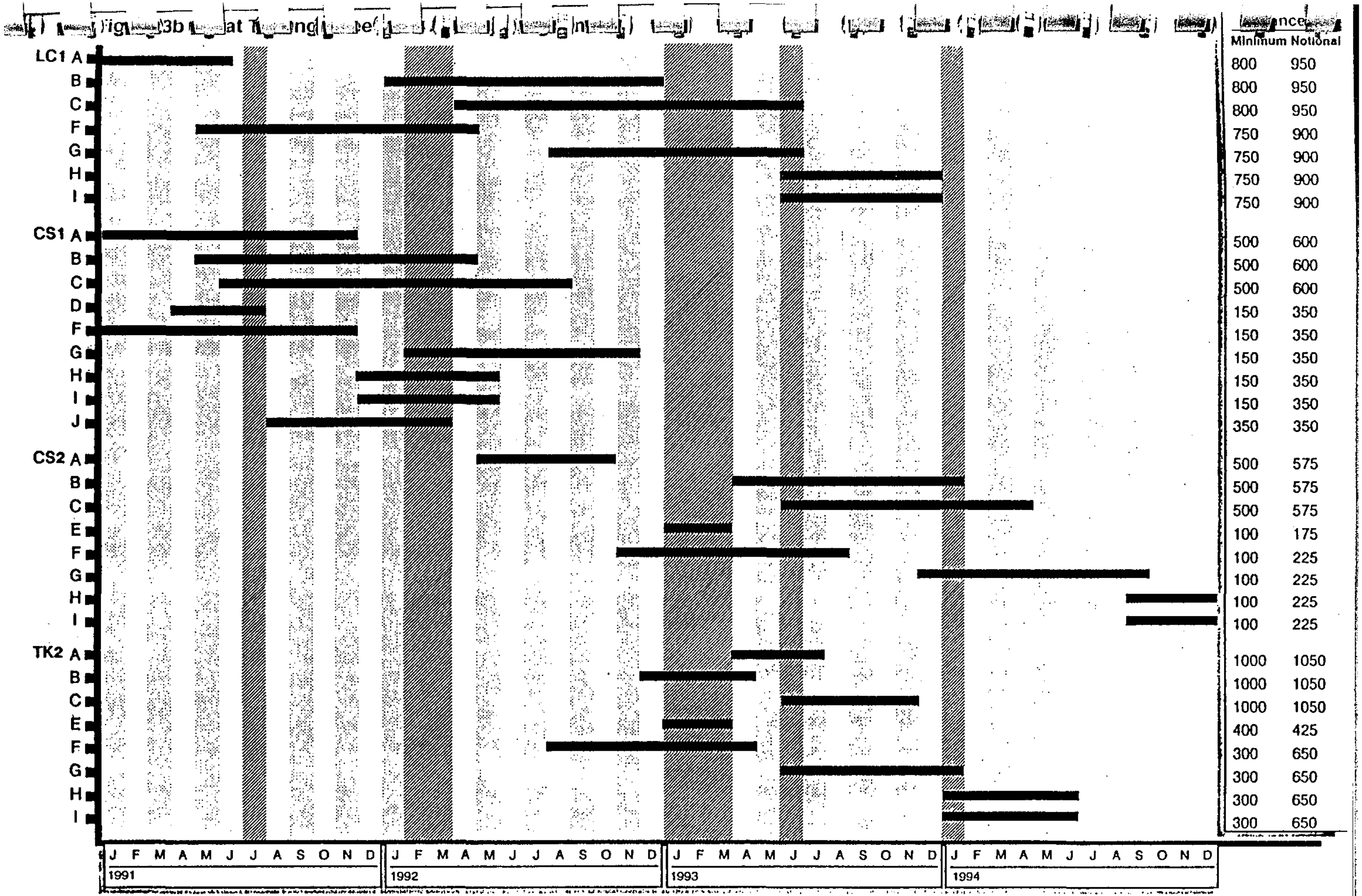
F General Dredging
B Seawall Construction
G Marine Fill Placement
O Access Road and Reprovisioning of PCWA
M Marine Dolphin Piling

[hatched box] Indicates periods of high noise activity

Note : In the southern section S2 refers to what is known generally as YM2, whilst S3 is the remainder of the southern section reclamation.

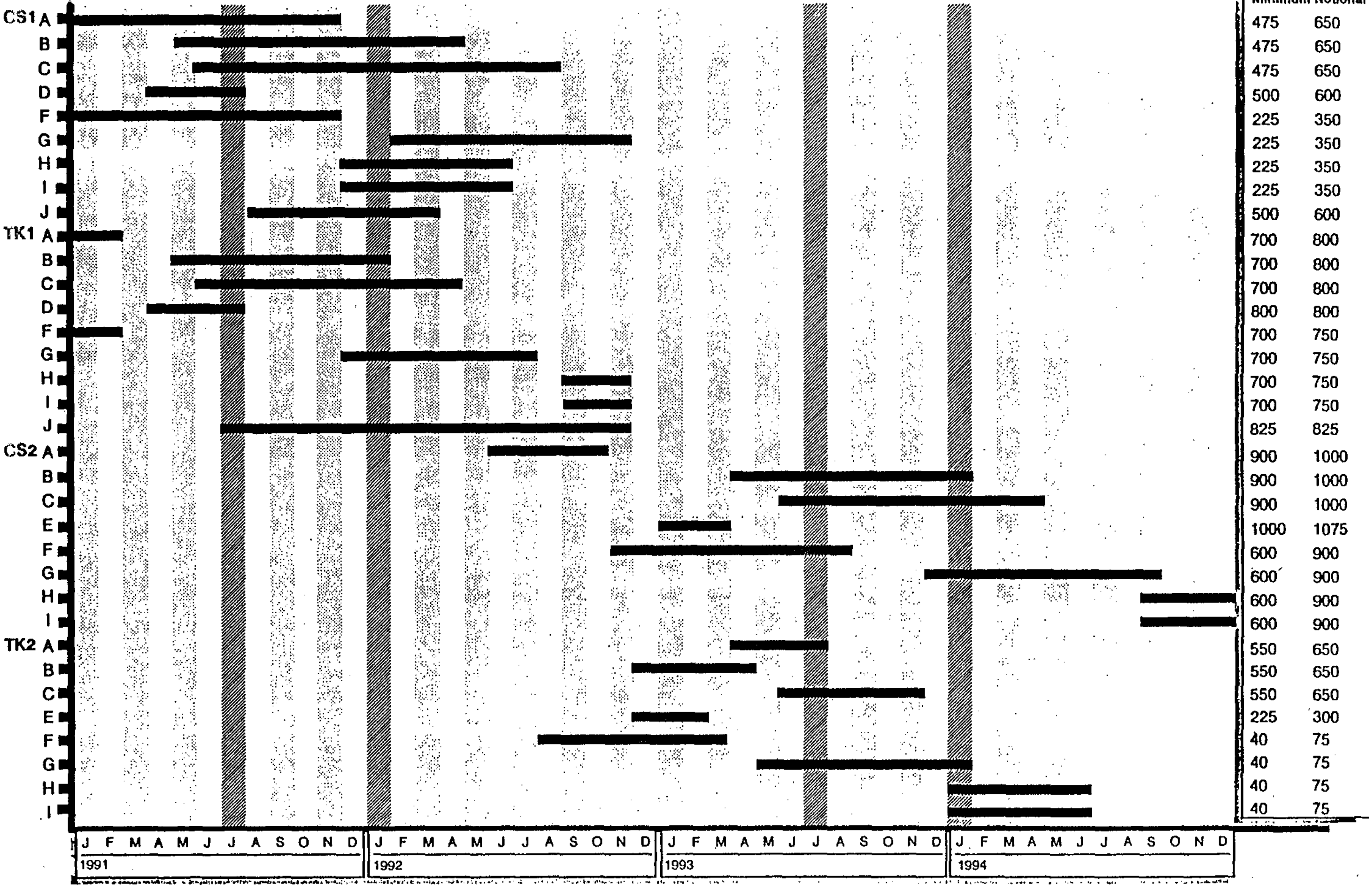
Figure 3a Mei Foo Sun Chuen - Activity Programme

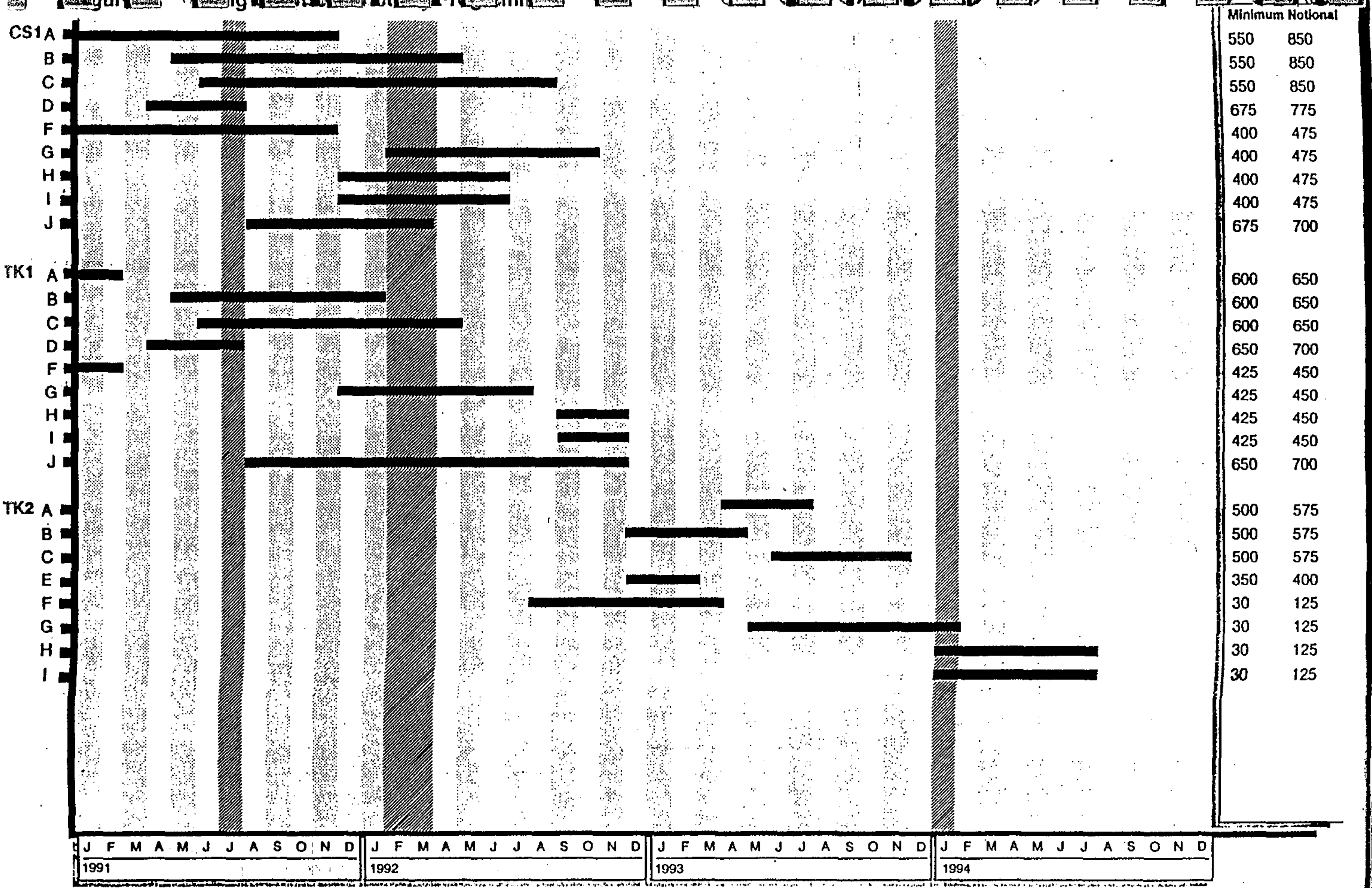




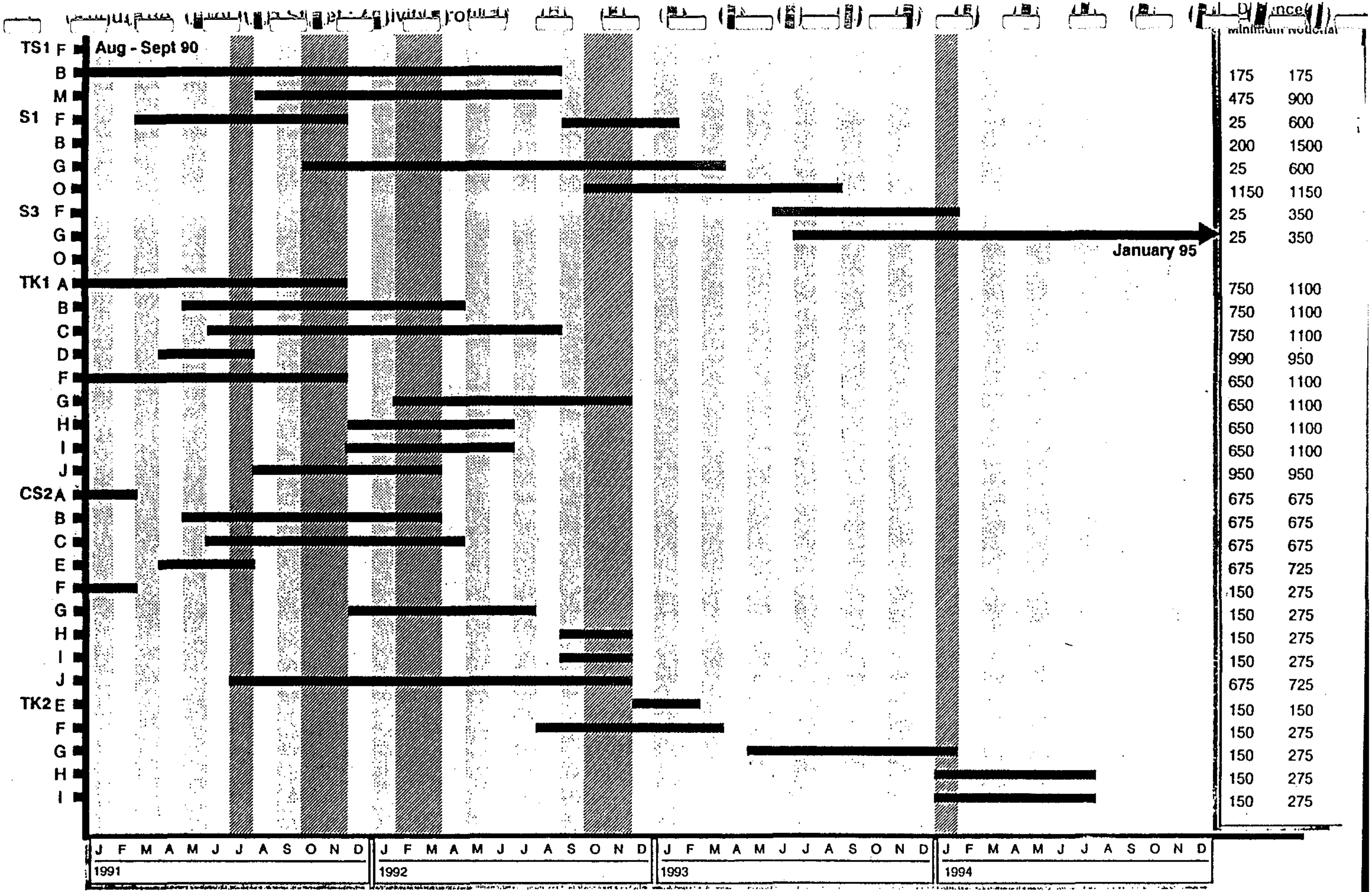
Minimum Notional
LC1 A 800 950
B 800 950
C 800 950
F 750 900
G 750 900
H 750 900
I 750 900
CS1 A 500 600
B 500 600
C 500 600
D 150 350
F 150 350
G 150 350
H 150 350
I 150 350
J 350 350
CS2 A 500 575
B 500 575
C 500 575
E 100 175
F 100 225
G 100 225
H 100 225
I 100 225
TK2 A 1000 1050
B 1000 1050
C 1000 1050
E 400 425
F 300 650
G 300 650
H 300 650
I 300 650
J F M A M J J A S O N D
1991
1992
1993
1994

Figure 3c Nam Cheong Estate : Activity Programme

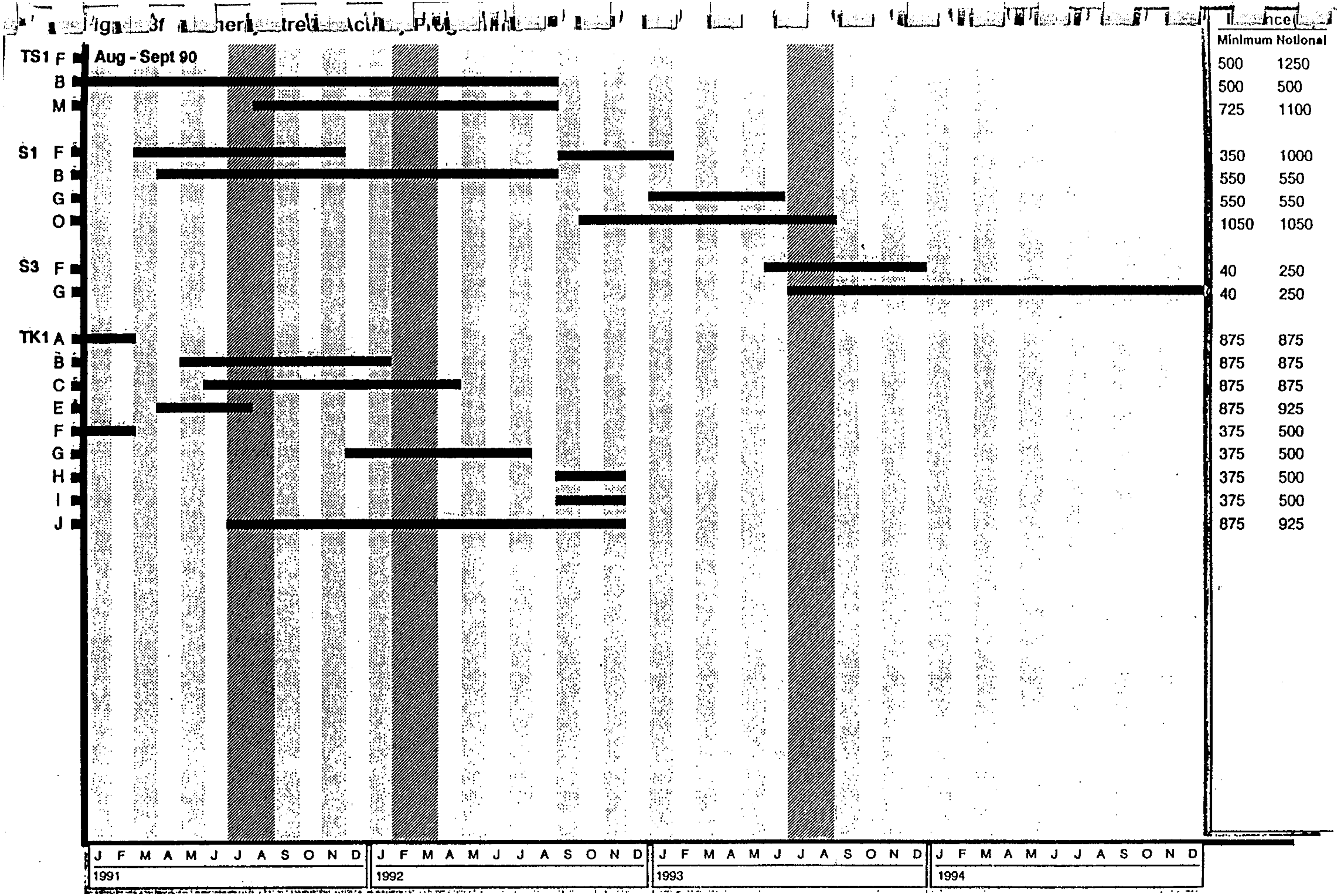




Minimum Notional
CS1 A 550 850
B 550 850
C 550 850
D 675 775
F 400 475
G 400 475
H 400 475
I 400 475
J 675 700
TK1 A 600 650
B 600 650
C 600 650
D 650 700
F 425 450
G 425 450
H 425 450
I 425 450
J 650 700
TK2 A 500 575
B 500 575
C 500 575
E 350 400
F 30 125
G 30 125
H 30 125
I 30 125
J F M A M J J A S O N D
1991
1992
1993
1994

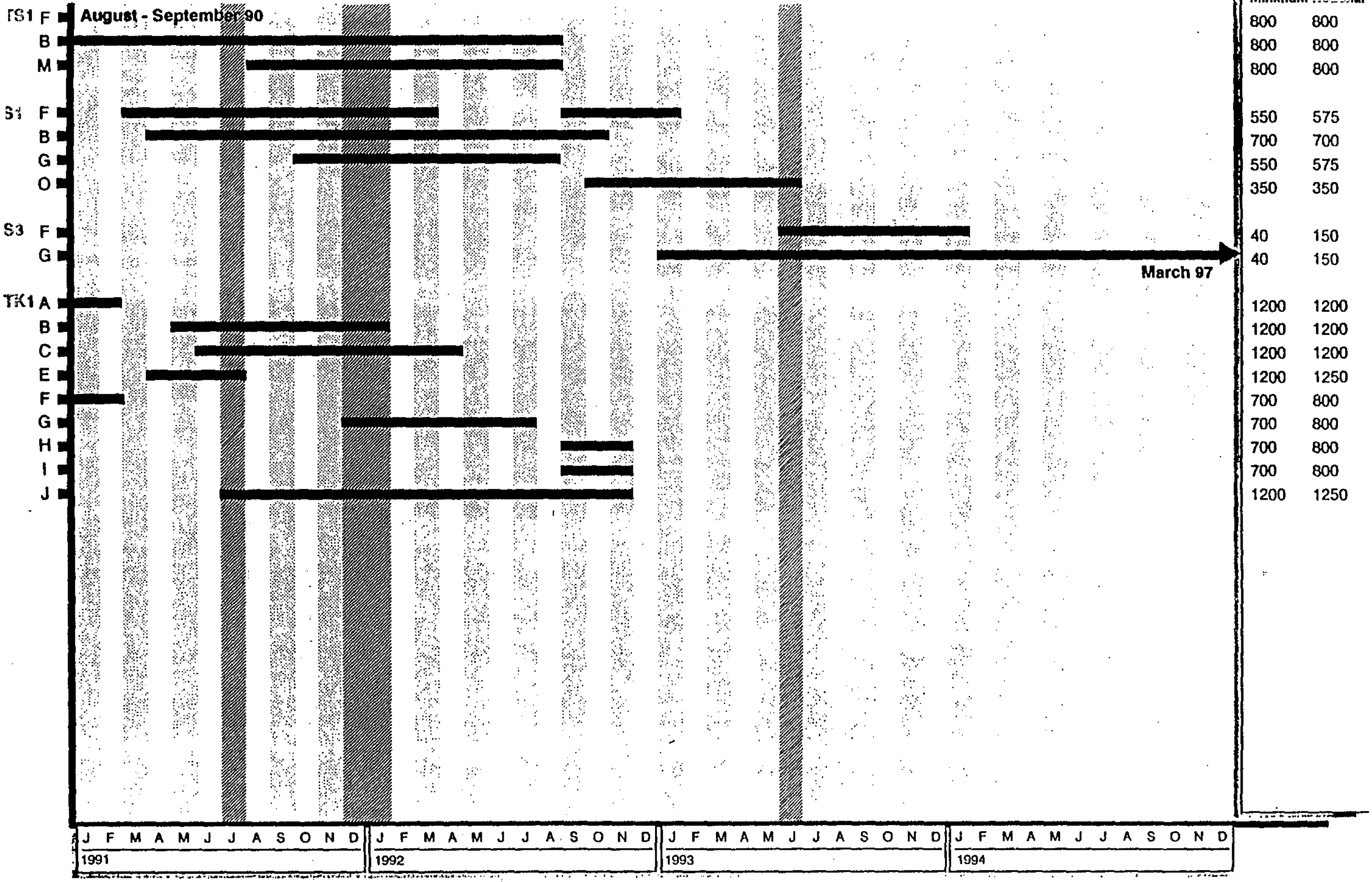


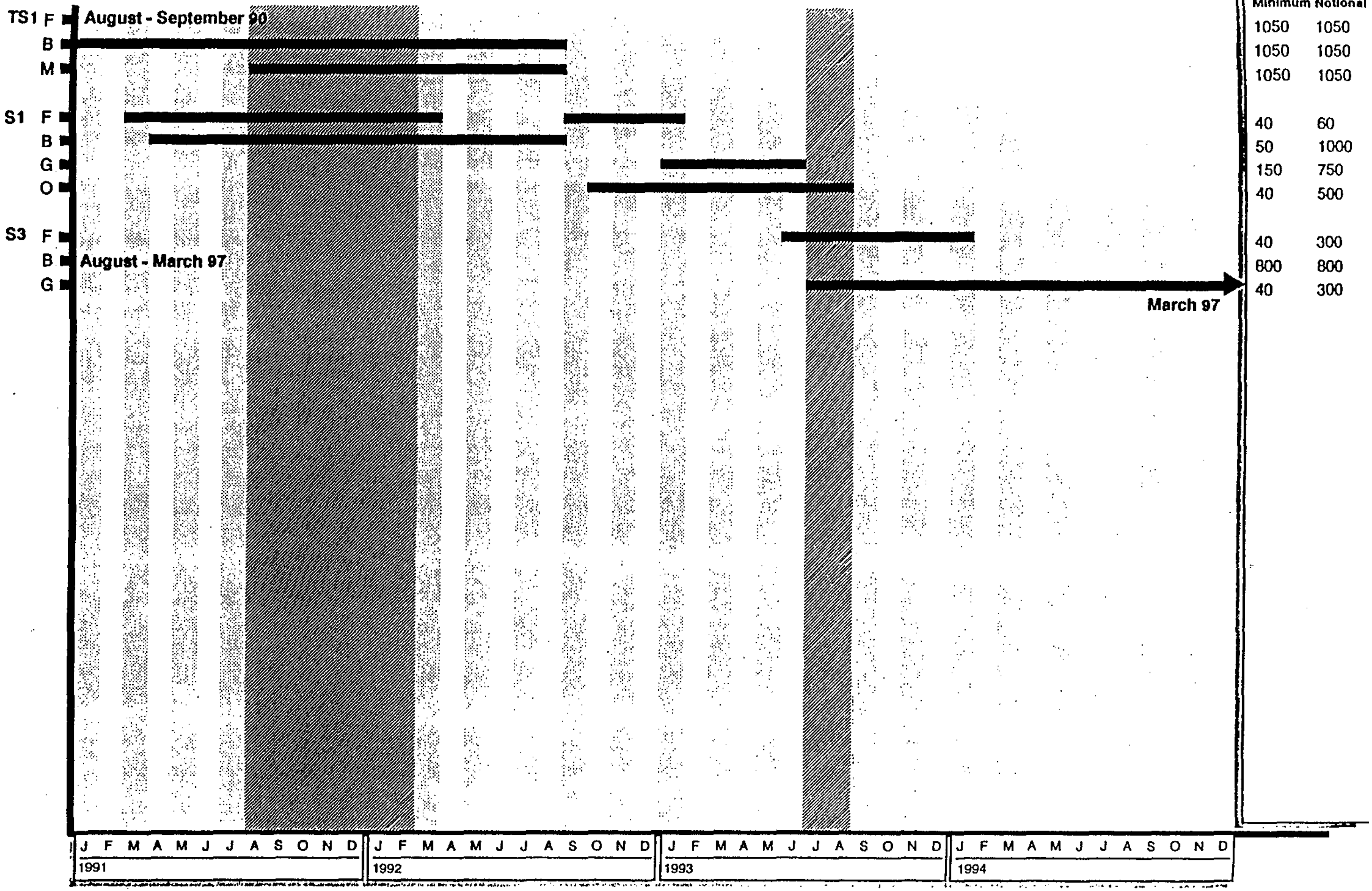
Aug - Sept 90
TS1 F
B
M
S1 F
B
G
O
S3 F
G
O
TK1 A
B
C
D
F
G
H
I
J
CS2 A
B
C
E
F
G
H
I
J
TK2 E
F
G
H
I
January 95
175 175
475 900
25 600
200 1500
25 600
1150 1150
25 350
25 350
750 1100
750 1100
750 1100
990 950
650 1100
650 1100
650 1100
650 1100
950 950
675 675
675 675
675 675
675 725
150 275
150 275
150 275
150 275
675 725
150 150
150 275
150 275
150 275
150 275
J F M A M J J A S O N D
1991
1992
1993
1994



Minimum Notional
TS1 F
Aug - Sept 90
500 1250
B
500 500
M
725 1100
S1 F
350 1000
B
550 550
G
550 550
O
1050 1050
S3 F
40 250
G
40 250
TK1 A
875 875
B
875 875
C
875 875
E
875 925
F
375 500
G
375 500
H
375 500
I
375 500
J
875 925
J F M A M J J A S O N D
1991
J F M A M J J A S O N D
1992
J F M A M J J A S O N D
1993
J F M A M J J A S O N D
1994

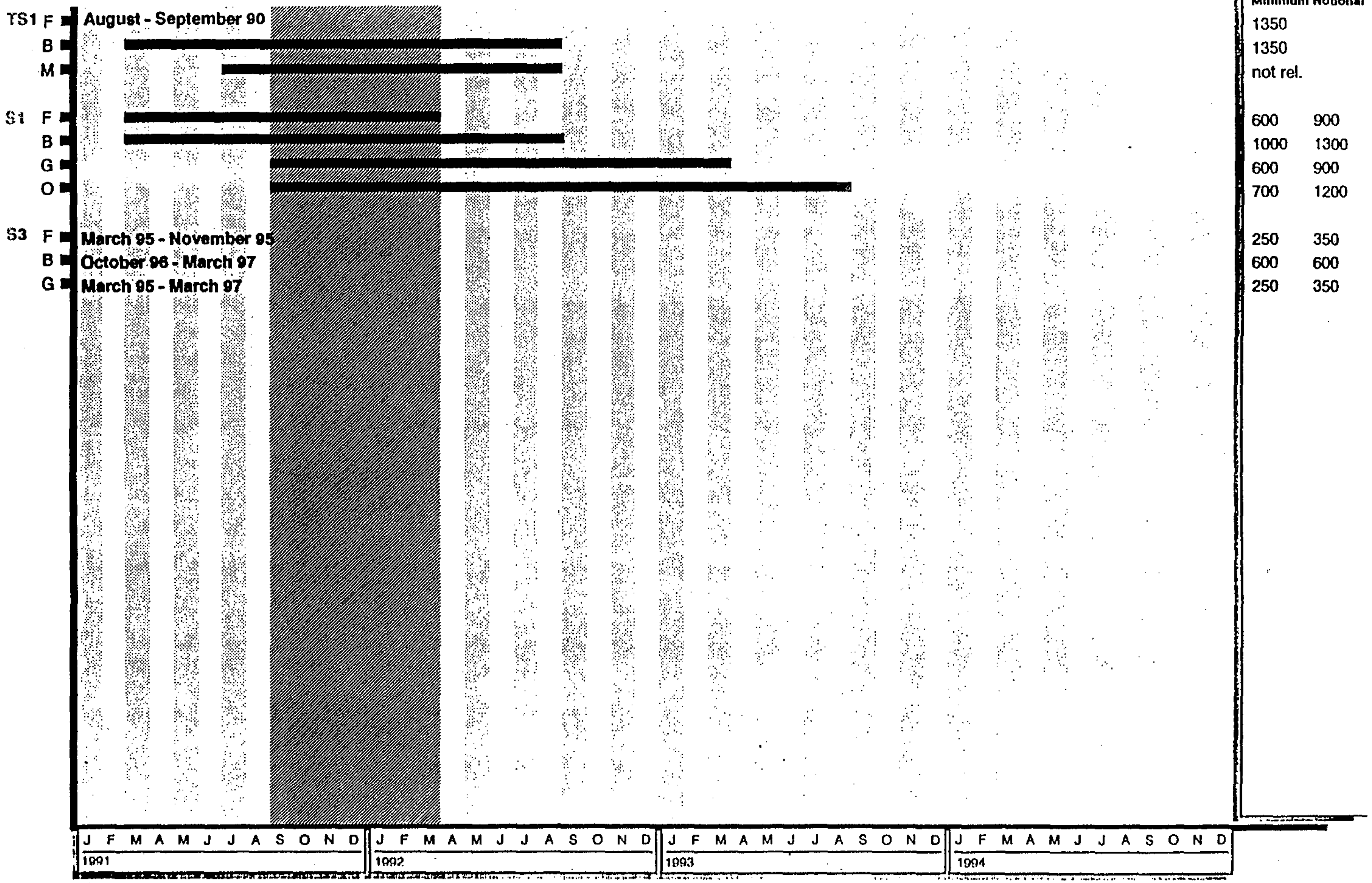
Figure [illegible] Ferry Street Activity Programme

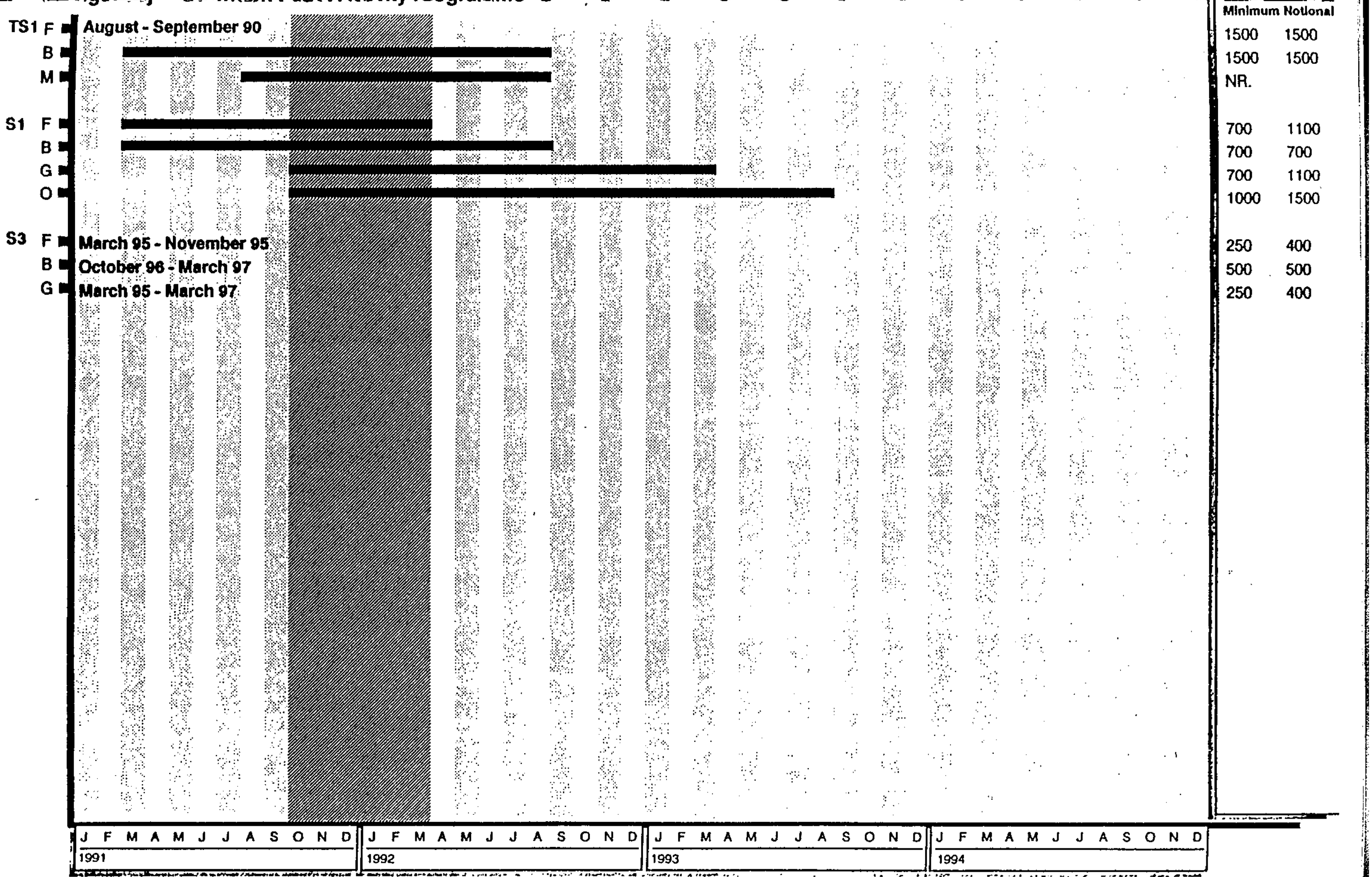




TS1 F
B
M
S1 F
B
G
O
S3 F
B
G
August - September 90
August - March 97
March 97
Minimum Notional
1050 1050
1050 1050
1050 1050
40 60
50 1000
150 750
40 500
40 300
800 800
40 300
J F M A M J J A S O N D
1991
1992
1993
1994

Figure 3l King George V Park and School: Activity Programme





Minimum Notional
TS1 F
August - September 90
B
M
S1 F
B
G
O
S3 F
March 95 - November 95
B
October 96 - March 97
G
March 95 - March 97
1500 1500
1500 1500
NR.
700 1100
700 700
700 1100
1000 1500
250 400
500 500
250 400
J F M A M J J A S O N D
1991
1992
1993
1994

Table 4 : Critical Construction Noise Predictions for Sensitive Receivers Affected by WKR.

Neighbourhood	Period (weeks)	Estimated No. of people affected	Time of Day	Predicted Noise Level dB(A)	Daytime Background Noise Level dB(A)	Noise Source and Location
Mei Foo Sun Chuen	1/6/93 - 1/7/93 (4)	4,200	Daytime	65 - 82	57 - 62	placement of land-sourced fill on LC1 and others
	1/8/92 - 1/7/93 (48)	4,200	Daytime	53 - 78	57 - 62	placement of marine fill on LC1
	1/7/93 - 1/1/94 (26)	4,200	Daytime	63 - 82	57 - 62	placement of land-sourced fill on LC1
Fat Tseung Street THA	1/7/91 - 1/8/91 (4)	500	Daytime	61 - 68	50 - 59	mud dredging on CS1
	1/2/92 - 1/4/92 (8)	500	Daytime	63 - 70	50 - 59	placement of land-sourced fill on CS1
	1/1/93 - 1/4/93 (13)	500	Daytime	75 - 80	50 - 59	demolition of present piers on CS2
	1/1/94 - 1/2/94 (4)	500	Daytime	62 - 69	50 - 59	placement of marine fill on CS2 and land-sourced fill on TK2
Nam Cheong Estate	1/7/91 - 1/8/91 (4)	2500	Daytime	62 - 65	62 - 69	mud dredging on CS1
	1/1/92 - 1/2/92 (4)	2500	Daytime	63 - 67	62 - 69	placement of marine fill on CS1
	1/8/92 - 1/4/93 (34)	2500	Daytime	74 - 79	62 - 69	mud dredging on TK2
	1/5/93 - 1/2/94 (38)	2500	Daytime	68 - 74	62 - 69	placement of marine fill on TK2
	1/1/94 - 1/2/94 (4)	2500	Daytime	74 - 80	62 - 69	placement of marine fill and land-sourced fill on TK2
	1/2/94 - 1/7/94 (22)	2500	Daytime	72 - 78	62 - 69	placement of land-sourced fill on TK2

Table 4 : Critical Construction Noise Predictions for Sensitive Receivers Affected by WKR. (Con't)

Neighbourhood	Period (weeks)	Estimated No. of people affected	Time of Day	Predicted Noise Level dB(A)	Daytime Background Noise Level dB(A)	Noise Source and Location
Cherry Street	1/7/91 – 1/9/91 (8)	500	Daytime	58 – 81	63 – 73	general dredging and sea wall construction on S2
	1/2/92 – 1/4/92 (8)	500	Daytime	58 – 61	63 – 73	general dredging and sea wall construction on S2 and TK1
	1/7/93 – 1/2/94 (30)	500	Daytime	61 – 77	63 – 73	general dredging and filling on S3
Ferry Street	1/7/91 – 1/8/91 (4)	3000	Daytime	56 – 57	66 – 70	general dredging and sea wall construction on S2
	1/12/91– 1/2/92 (8)	3000	Daytime	58	66 – 70	general dredging and sea wall construction on S2
	1/6/93 – 1/2/94 (35)	3000	Daytime	65	66 – 70	general dredging and filling on S3
Man Cheong Street	1/8/91 – 1/4/92 (34)	2500	Daytime	71 – 74	64 – 66	general dredging on S2
	1/7/93 – 1/2/94 (35)	2500	Daytime	77 – 81	64 – 66	general dreding and filling on S3
King George V Park	1/10/91– 1/4/92 (26)		Daytime	57 – 59	66 – 67	general dredging and sea wall construction on S2
Kowloon Park	1/10/91– 1/4/92 (26)		Daytime	56 – 57	--	general dredging and sea wall construction on S2

/cont'd

Table 4 : Critical Construction Noise Predictions for Sensitive Receivers Affected by WKR. (Con't)

Neighbourhood	Period (weeks)	Estimated No. of people affected	Time of Day	Predicted Noise Level dB(A)	Daytime Background Noise Level dB(A)	Noise Source and Location
Wong Tai Street	1/7/91 – 1/8/91 (4)	1,700	Daytime	60 – 62	62 – 65	mud dredging on CS1
	1/2/92 – 1/4/92 (8)	1,700	Daytime	61 – 63	62 – 65	placement of land–sourced fill on CS1
	1/8/92 – 1/4/93 (35)	1,700	Daytime	69 – 82	62 – 65	mud dredging on TK2
	1/5/93 – 1/1/94 (35)	1,700	Daytime	64 – 76	62 – 65	placement of marine fill on TK2
	1/1/94 – 1/2/94 (4)	1,700	Daytime	70 – 82	62 – 65	placement of marine fill and land–sourced fill on TK2
	1/2/94 – 1/7/94 (22)	1,700	Daytime	68 – 81	62 – 65	placement of land–sourced fill on TK2
Hoi King Street	1/7/91 – 1/8/91 (4)	200	Daytime	63 – 78	62 – 65	general dredging on S2
	1/10/91– 1/12/91 (8)	200	Daytime	67 – 81	62 – 65	general dredging and filling on S2
	1/2/92 – 1/4/92 (8)	200	Daytime	66 – 81	62 – 65	general dredging and filling on S2
	1/10/92– 1/12/92 (8)	200	Daytime	67 – 82	62 – 65	general dredging and filling on S2
	1/7/93 – 1/2/94 (30)	200	Daytime.	58 – 81	62 – 65	general dredging and filling on S3

/cont'd ...

Table 5 : Critical Piling Noise Predictions for Sensitive Receivers Affected by WKR.

Neighbourhood	Period (weeks)	Estimated No. of people affected	Time of Day	Predicted Noise Level dB(A)	Daytime Background Noise Level dB(A)	Noise Source and Location
Fat Tseung Street THA	1/4/91 – 1/8/91	500	Daytime	76 – 78	50 – 59	piling for piers on CS1
	1/8/91 – 1/4/92	500	Daytime	79	50 – 59	reprovisioning of piers and hard-standing for markets on CS1
Nam Cheong Estate	1/4/91 – 1/7/91	2500	Daytime	73 – 74	62 – 69	piling for piers on CS1 and TK1
	1/7/91 – 1/8/91	2500	Daytime	75 – 76	62 – 69	piling for piers on CS1 and TK1, and reprovisioning of piers and hard-standing for markets
	1/8/91 – 1/4/92	2500	Daytime	76 – 77	62 – 69	reprovisioning of piers and hard-standing for markets on CS1 and TK1
	1/4/92 – 1/12/92	2500	Daytime	72	62 – 69	reprovisioning of piers and hard-standing for markets on TK1
Wong Tai Street	1/4/91 – 1/7/91	1,700	Daytime	74 – 75	62 – 65	piling for piers on CS1 and TK1
	1/7/91 – 1/8/91	1,700	Daytime	77 – 78	62 – 65	piling for piers on CS1 and TK1, and reprovisioning of piers and hard-standing for markets on TK1
	1/8/91 – 1/4/92	1,700	Daytime	76 – 77	62 – 65	reprovisioning of piers and hard-standing for markets on CS1 and TK1
	1/4/92 – 1/12/92	1,700	Daytime	73	62 – 65	reprovisioning of piers and hard-standing for markets on TK1

/cont'd

Table 5 : Critical Piling Noise Predictions for Sensitive Receivers Affected by WKR. (Con't)

Neighbourhood	Period (weeks)	Estimated No. of people affected	Time of Day	Predicted Noise Level dB(A)	Daytime Background Noise Level dB(A)	Noise Source and Location
Hoi King Street	1/4/91 – 1/7/91	200	Daytime	73 – 75	62 – 65	piling for piers on CS1 and TK1
	1/7/91 – 1/8/91	200	Daytime	76 – 77	62 – 65	piling for piers on CS1 and TK2, and reprovisioning of piers and hard–standing for markets on TK2
	1/8/91 – 1/4/92	200	Daytime	76 – 79	62 – 65	pilings of dolphins on TS1, and reprovisioning of piers and hard–standing for markets on CS1 and TK1
	1/4/92 – 1/9/92	200	Daytime	75 – 78	62 – 65	pilings of dolphins on TS1 and reprovisioning of hard –standing for markets on TK1
	1/9/92 – 1/12/92	200	Daytime	73 – 74	62 – 65	reprovisioning of piers and hard–standing for markets on TK1 and sheet piling on S2
	1/12/92 – 1/9/93	200	Daytime	66	62 – 65	sheet piling on S2
Cherry Street	1/7/91 – 1/8/91	500	Daytime	72 – 73	63 – 73	piling for piers and reprovisioning of piers and hard –standing for markets on TK1
	1/8/91 – 1/4/92	500	Daytime	73 – 75	63 – 73	pilings of dolphins on TS1 and reprovisioning of piers and hard–standing for markets on TK1
	1/9/92 – 1/9/93	500	Daytime	66	63 – 73	sheet piling on S2

/cont'd ...

Table 5 : Critical Piling Noise Predictions for Sensitive Receivers Affected by WKR. (Con't)

Neighbourhood	Period (weeks)	Estimated No. of people affected	Time of Day	Predicted Noise Level dB(A)	Daytime Background Noise Level dB(A)	Noise Source and Location
Ferry Street	1/7/91 – 1/8/91	3000	Daytime	70	66 – 70	piling for piers and reprovisioning of piers and hard –standing for markets on TK1
	1/12/91– 1/2/92	3000	Daytime	71 – 73	66 – 70	piling of dolphins on TS1 and reprovisioning of piers a hard–standing for markets on TK1
	1/9/92 – 1/7/93	3000	Daytime	75	66 – 70	sheet piling on S2
Man Cheong Street	1/10/92– 1/9/93	2500	Daytime	88	64 – 66	sheet piling on S2
King George V Park	1/10/91– 1/4/92		Daytime	74	66 – 67	piling of dolphins on TS1 and sheet piling on S2
	1/4/92 – 1/9/93		Daytime	72	66 – 67	sheet piling on S2
Kowloon Park	1/10/91– 1/4/92		Daytime	73	--	piling of dolphins on TS1 and sheet piling on S2
	1/4/92 – 1/9/93		Daytime	68	--	sheet piling on S2

Annex C
Water Quality Impacts: Supporting Information

Figure 1 : EPD Water Quality Routine Monitoring Sites

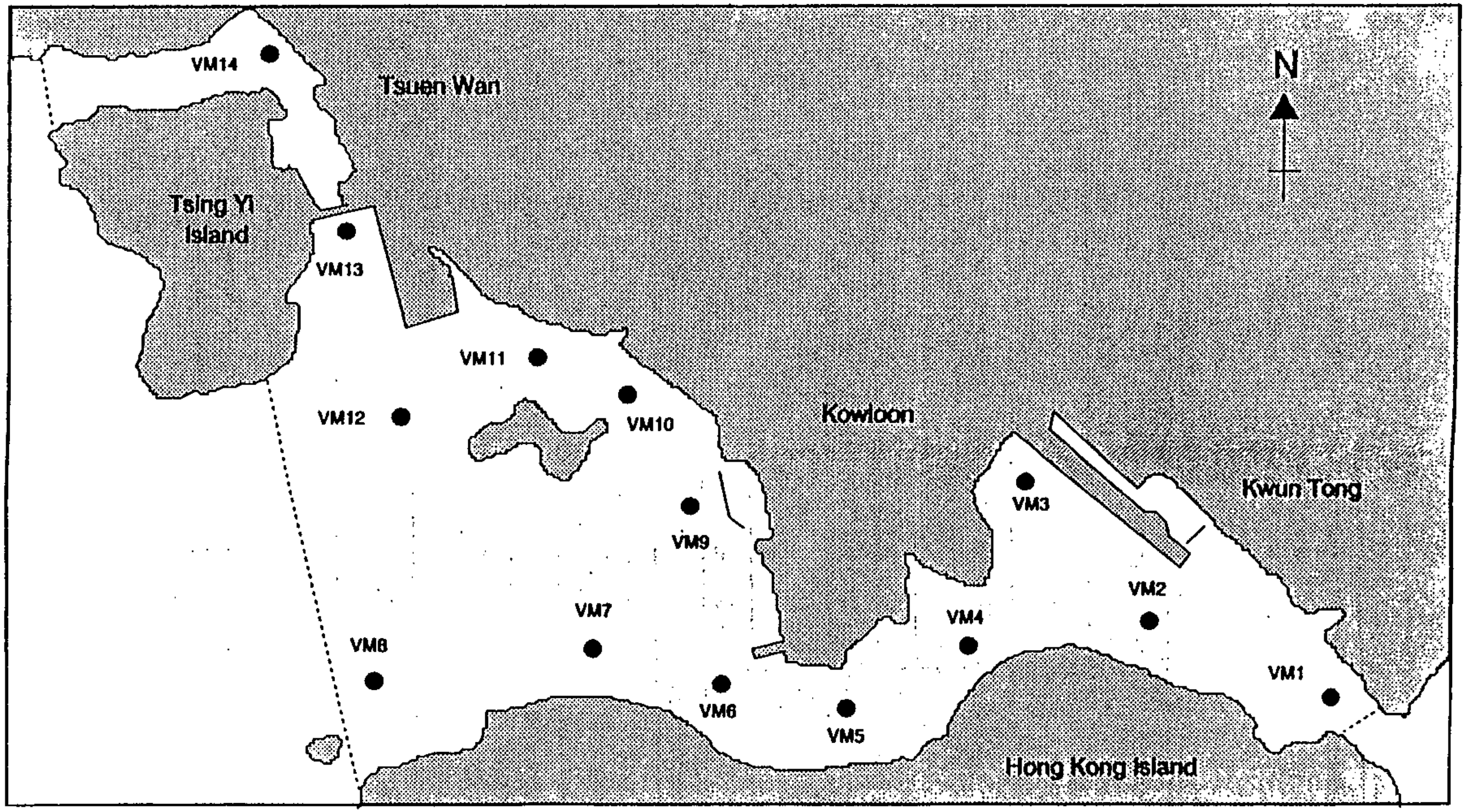


Table 1 <u>Beneficial Uses and Water Quality Objectives for Victoria Harbour Water Quality Control Zone</u>

Parameter	BU	Water Quality Objective
1. Aesthetic	3 - Marine Life 5 - Secondary Contact 6 - Domestic/Industrial 7 - Shipping 8 - Aesthetic	No objectionable odours or discolouration of the water. Tarry residues, floating wood, glass, plastic, rubber or any other substance should be absent. Mineral oil should not be visible on the surface. Surfactants should not give rise to lasting foam. There should be no recognizable sewage derived debris.
2. Bacteria	5 - Secondary Contact	E. coli not to exceed 1000/100 ml in 60% of samples taken throughout the year.
	6 - Domestic/Industrial	Not to exceed 20,000/100 ml as the annual geometric mean 90%.
3. Dissolved oxygen	3 - Marine Life	Not less than 4 mg/l or 60% saturation, column average, for 90% of sampling occasions. Not less than 2 mg/l or 30% saturation within 2 m. of bottom on 90% of occasions.
	6 - Domestic/Industrial	Not to fall below 2 mg/l at point of intake.
4. Ammonia	3 - Marine Life	Not more than 21 mg/l annual average, as un-ionised form, to protect fish.
	6 - Domestic/Industrial	As 3 above.
5. Temperature	3 - Marine Life	Not raised by more than 2°C by discharges.
6. Colour	3 - Marine Life	Not raised by more than 10 mg pt/l.
	6 - Domestic/Industrial	As above.
7. Suspended Solids	3 - Marine Life	Not raised by more than 30% by discharges.
	6 - Domestic/Industrial	As above.
8. Salinity		Not changed more than 10% by discharges.
9. pH	3 - Marine Life	Between 6.5 and 8.5. Discharges not to extend range ± 0.2 units.
	5 - Secondary Contact 6 - Domestic/Industrial	Between 6.0 and 9.0 for 95% of samples - Discharges not to extend range by more than ± 0.5 units.
10. Dangerous Substances	3 - Marine Life 5 - Secondary Contact 6 - Domestic/Industrial	No quantitative values but Sewage Strategy Study proposes that : - Concentrations should not exceed levels as to produce toxic effects in humans, fish or marine organisms. - Due regard should be paid to bio-accumulation and synergy of dangerous substances when assessing risk to humans, fish or marine organisms. - Due regard should be paid to Environmental Quality Standards invoked by other nations when assessing risk to humans, fish and marine life.

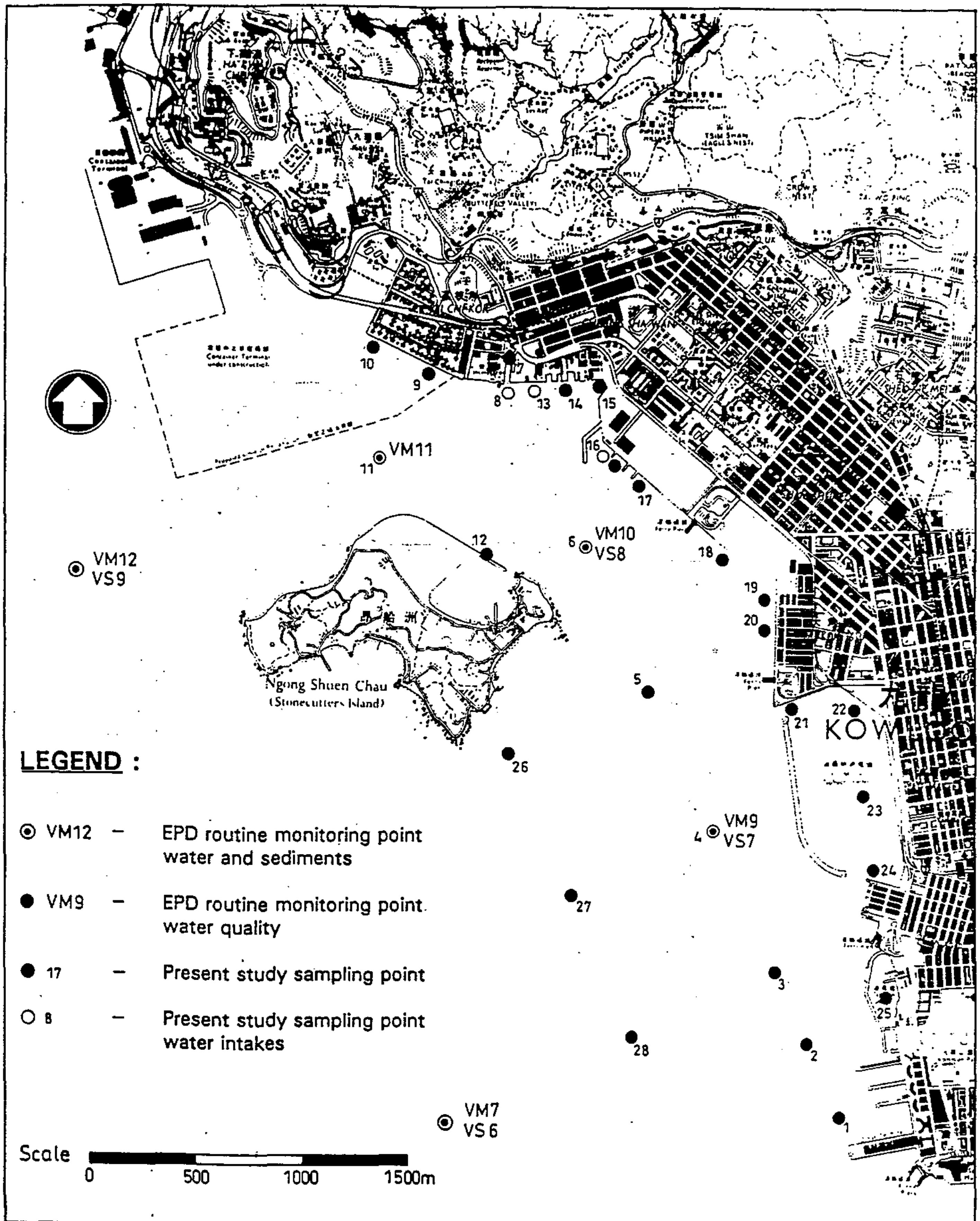


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FIG. 2 -
WATER QUALITY SAMPLING STATIONS USED IN THE STUDY

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Table 2 WATER QUALITY SAMPLING STATIONS

Station No.	Location	Station Type	Local Coor. E	Local Coor. N	Gov. Coor. E	Gov. Coor. N	Catchment/ Area
1	Transect 1	Offshore	7500	68600	834800	817500	Offshore
2	Transect 1	Offshore	7400	69000	834700	817900	"
3	Transect 1	Offshore	7200	69400	834500	818300	"
4	Transect 1	Offshore	6800	70200	834100	819100	"
5	Transect 1	Offshore	6500	71000	833800	819900	"
6	Transect 1	Offshore	6100	71900	833400	820800	"
7	Waterboat Dock	Stormdrain	5700	72900	833000	821800	Cheung Sha Wan
8	Lai Chi Kok Pumphouse	Intake	5700	72700	833000	821600	"
9	Mei Foo	Outfall	5200	72900	832500	821800	Lai Chi Kok
10	Mei Foo	Outfall	4900	73000	832200	821900	"
11	EPD Stn VM11	Offshore	4900	72400	832200	821300	Offshore
12	Naval Dockyard	Offshore	5500	71800	832800	820700	"
13	MTR Pumphouse	Intake	5800	72700	833100	821600	Cheung Sha Wan
14	Cheung Sha Wan	Outfall	5900	72700	833200	821600	"
15	Hing Wah Street	Outfall	6200	72800	833500	821700	"
16A	Market Landing	Outfall	6300	72300	833600	821200	"
16B	WSD Pumphouse	Intake	6200	72300	833500	821200	"
16C/D		Outfall	6200	72400	833500	821300	"
17	Tonkin Street	Outfall	6400	72200	833700	821100	"
18	Yen Chau Street	Outfall	6900	71800	834200	820700	Sham Sui Po
19	Cheung Wai Street	Outfall	7100	71500	834400	820400	"
20	Tai Kok Tsui	Outfall	7100	71400	834400	820300	Tai Kok Tsui
21	Hoi Kong Street YMT	Outfall	7300	70900	834600	819800	Yau Ma Tei
22	Nelson Street	Outfall	7700	70900	835000	819800	"
23	Dundas Street	Outfall	7700	70400	835000	819300	"
24	Man Sing Street	Outfall	7800	70000	835100	818900	"
25	Camber Typhoon S.	Govt. Harbour	7800	69300	835100	818200	Offshore
26	Transect 2	Offshore	5600	70700	832900	819600	"
27	Transect 2	Offshore	6000	69900	833300	818800	"
28	Transect 2	Offshore	6400	69100	833700	818000	"

Table 3 West Kowloon Water Quality - 25/6/90

STATION	T°C	pH	DISSOLVED OXYGEN (mg/l)	INORGANIC NITROGEN (mg/l)	CHLOROPHYLL (A) (ug/l)	BOD5 (mg/l)	FAECAL COLIFORM (per 100 ml)	TOTAL SUSPENDED SOLIDS (mg/l)
1A	28.5	8.2	5.85		40	2	930	
1B	28.0	7.7	5.06		60	1	2300	
2A	28.2	7.7	6.40		60	1	4300	
2B	28.1	7.9	5.82		34	2	2300	
3A	28.3	8.3	6.99		60	1	430	
3B	28.1	7.9	6.54		33	2	9300	
4A	28.3	8.2	6.65	0.21	33	2	2300	32
4B	28.1	8.1	6.25	0.12	13	2	4300	40
5A	28.4	8.1	6.69	0.19	33	3	23000	35
5B	28.2	8.1	5.99	0.11	20	1	930	39
6A	28.3	7.7	5.95		40	8	23000	
6B	28.4	8.0	4.39		54	6	21000	
7A	28.5	7.7	1.25	1.67	60	50	460000	110
7B	28.4	8.1	2.87	0.53	40	60	23000	80
8A	28.9	8.2	4.60	0.59	33	6	9300	58
8B	28.4	8.0	5.05	0.14	60	3	23000	48
9A	28.8	8.1	7.60	0.17	60	7	9300	28
9B	28.7	8.1	4.96	0.23	20	4	43000	58
10A	28.6	8.0	7.49	0.16	47	5	230000	39
10B	28.6	8.0	5.75	0.16	80	3	23000	39
11A	28.6	8.2	7.72	0.17	50	3	2300	34
11B	28.4	8.2	6.42	0.15	27	3	1200	37
12A	28.9	8.2	7.39	0.24	20	5	400	26
12B	28.2	8.2	5.03	0.10	27	5	300	38
13A	28.1	8.4	5.27	0.22	80	7	43000	32
13B	28.3	8.2	3.90	0.10	47	5	23000	–
14A	29.1	8.2	5.90	0.37	60	6	2300	35
14B	28.3	8.1	4.15	0.15	53	5	1500	91
15A	28.7	8.1	3.62	0.6	47	5	43000	66
15B	28.3	8.0	3.04	0.32	20	6	7500	110
16A	28.2	8.2	5.98	0.31	100	5	4300	54
16B	28.1	8.0	4.39	0.26	150	0.3	4300	86

Table 3 (Con't)

STATION	T°C	pH	DISSOLVED OXYGEN (mg/l)	INORGANIC NITROGEN (mg/l)	CHLOROPHYLL (A) (ug/l)	BOD5 (mg/l)	FAECAL COLIFORM (per 100 ml)	TOTAL SUSPENDED SOLIDS (mg/l)
16C	29.2	8.0	4.67	—	80	8	230000	—
16D	28.1	8.1	2.20	—	110	51	4300	—
17A	28.6	7.7	1.94	0.55	110	89	—	46
17B	28.3	8.0	4.02	0.35	130	7	4300	69
18A	28.5	8.1	3.03	0.23	90	8	430000	37
18B	28.2	8.1	2.18	0.26	73	24	900	260
19A	29.2	8.1	4.48	0.27	130	56	23000	54
19B	28.3	8.2	2.98	0.26	130	6	23000	61
20A	28.3	8.3	4.72	0.12	100	28	4300	34
20B	28.4	8.3	3.18	0.11	120	31	2300	35
21A	29.1	8.0	2.29	0.59	130	40	21000	44
21B	29.1	8.0	2.09	0.18	87	34	9300	39
22A	30	7.1	0.93	0.24	100	54	—	48
22B	29.4	7.2	0.64	0.18	80	8	43000	47
23A	28.7	7.5	0.39	0.73	120	31	43000	44
23B	28.3	7.5	0.10	0.25	87	24	43000	45
24A	28.5	7.4	0.23	—	100	39	90000	—
24B	28.5	7.4	0.11	—	80	61	230000	—
25A	28.7	8.5	6.49	—	127	4	43000	—
25B	28.5	8.5	3.52	—	130	5	1500	—
26A	29.1	8.7	10.70	—	100	5	NIL	—
26B	29.1	8.3	7.8	—	130	1	NIL	—
27A	29.2	8.4	10.46	—	110	5	NIL	—
27B	29.1	8.3	7.8	—	110	4	1500	—
28A	29.2	8.4	10.6	—	110	4	NIL	—
28B	29.1	8.2	9.6	—	130	4	NIL	—
TOTAL $\bar{x}$			4.86 mg/l	0.3 mg/l	75.0 ug	15 mg/l	38138	54.6 mg/l

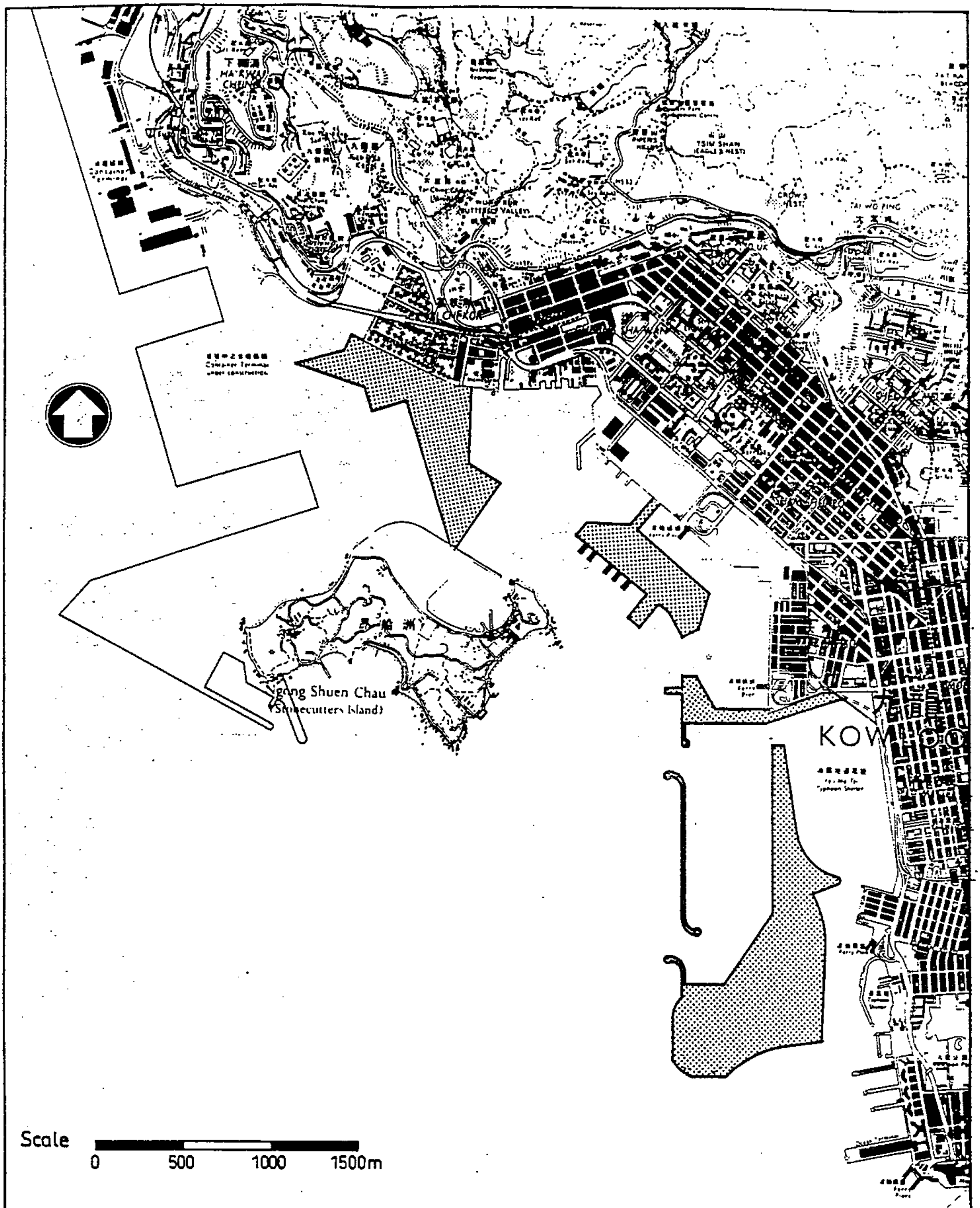

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FIG. 3 – WEST KOWLOON RECLAMATION LANDFORM DECEMBER 1992

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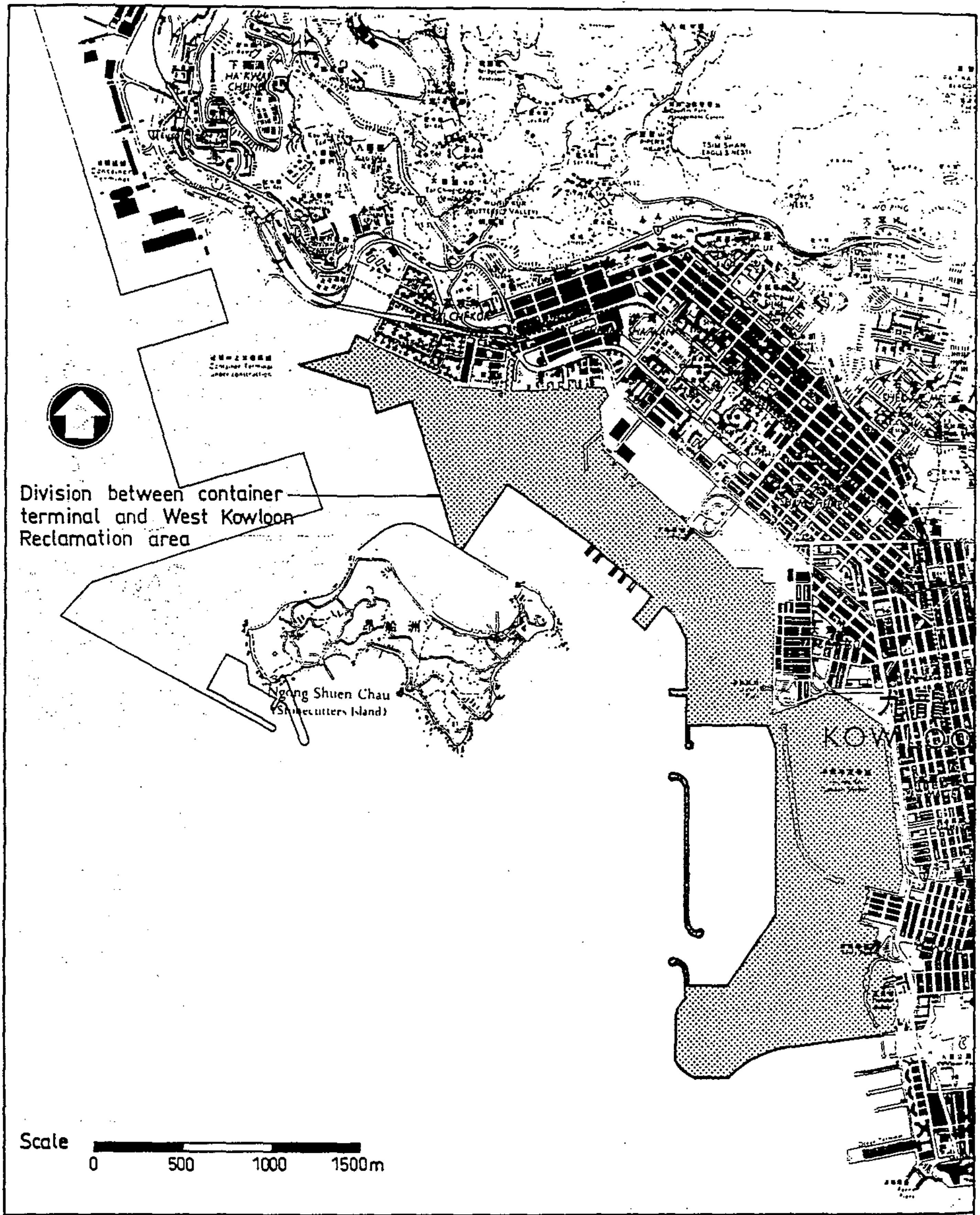

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WEST KOWLOON RECLAMATION

FIG. 4 –
WEST KOWLOON RECLAMATION
LANDFORM DECEMBER 1994

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Sketch No. 285/ E /SK/052
Rev.

Table 4 WHAMO Assumptions : Discharge Points and Pollution Loadings

	i.d.	loading point		BOD	E.C.	Org. N	Amm. N	Ox. N
		Eastings	Northings	(t/d)	10^10 (x 800)	(x 800)	(x 800)	(x 800)
1	710'	834500	820400	1.02	0.59	0.056	0.067	0.000
2	714'	835000	819800	2.40	0.82	0.066	0.086	0.000
3	715'	835100	819700	0.74	0.86	0.068	0,090	0.000
4	716'	835100	819600	0.74	0.86	0.068	0.090	0.000
5	717'	835100	819500	0.74	0.86	0.068	0.090	0.000
6	719'	835200	819200	0.72	0.86	0.068	0.090	0.000
7	720'	835000	818900	0.55	0.77	0.064	0.082	0.000
8	721'	835100	818800	0.80	0.80	0.065	0.084	0.000
9	799'	835000	819600	1.54	0.83	0.066	0.087	0.000
10	810'	833900	820750	0.30	0.77	0.064	0.081	0.000
11	811'	834100	820700	0.49	0.76	0.063	0.080	0.000
12	812'	834300	820600	0.44	0.87	0.069	0.091	0.000
13	899'	834100	820700	0.23	0.94	0.072	0.097	0.000
14	916'	832900	821550	1.80	0.26	0.040	0.032	0.000
15	917'	833200	821400	0.72	0.41	0.047	0.046	0.000
16	999'	832800	821550	0.50	0.52	0.051	0.056	0.000
17	10A01'	829900	822400	120.51	0.46	0.037	0.054	0.001
18	10A34'	830000	823200	2.42	0.08	0.026	0.018	0.000
19	10A36'	830500	822700	6.92	0.23	0.034	0.026	0.000
20	10B16'	829550	823600	0.09	0.00	0.022	0.004	0.000
21	10B17'	829600	823500	0.09	0.00	0.022	0.004	0.000
22	10B18'	829600	823500	0.19	0.00	0.022	0.004	0.000
23	10B99'	830300	821300	0.49	0.89	0.065	0.084	0.000
24	SCI'	831380	819610	75.11	0.79	0.052	0.086	0.001

Figure 5 : WHAMO Indication Points

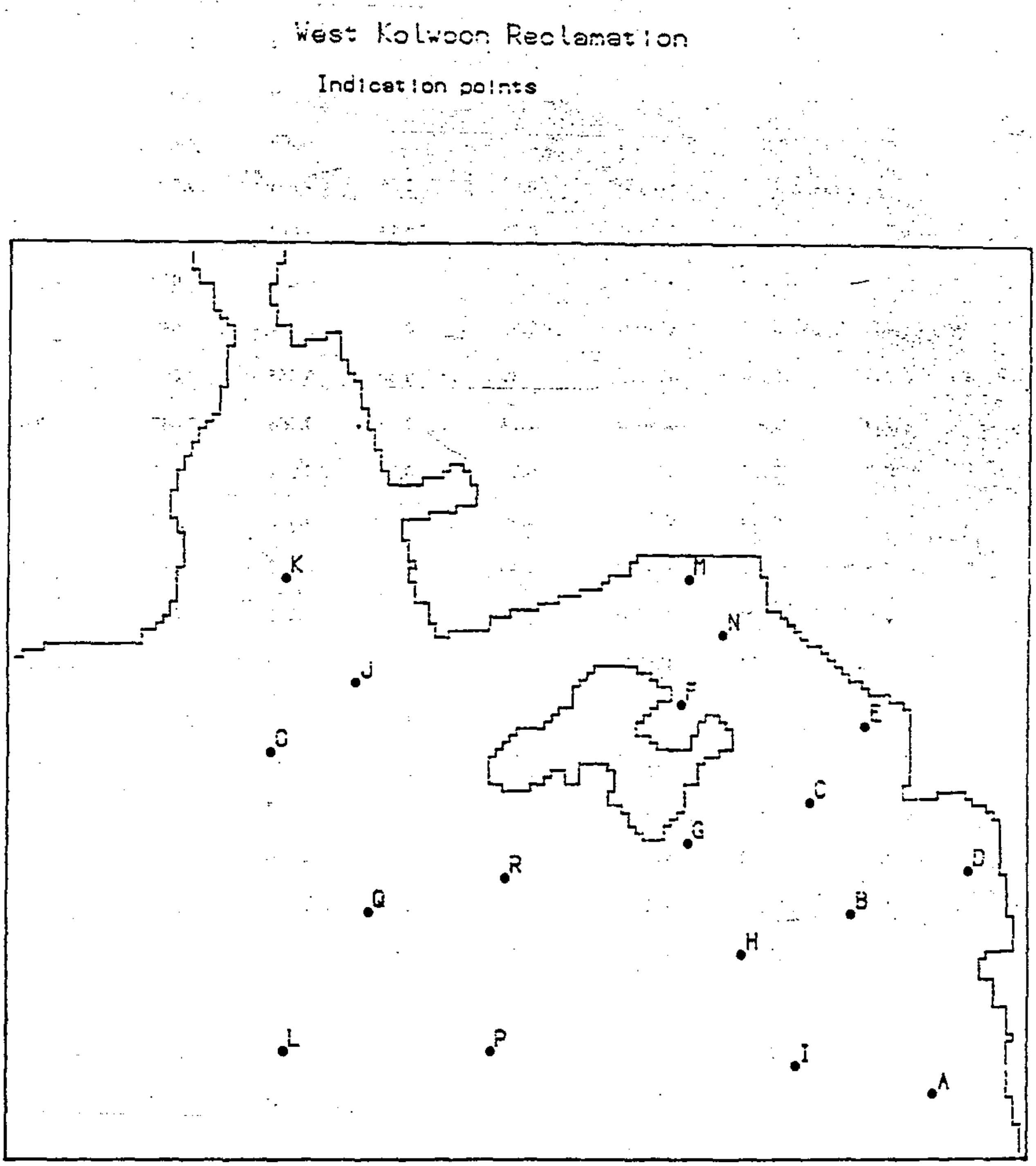


Figure 6 a-l : WHAMO Modelling Results.

Figure 6a West Kowloon Reclamation

depth-averaged model - neap tide

distribution of Dissolved Oxygen (% saturation) against time

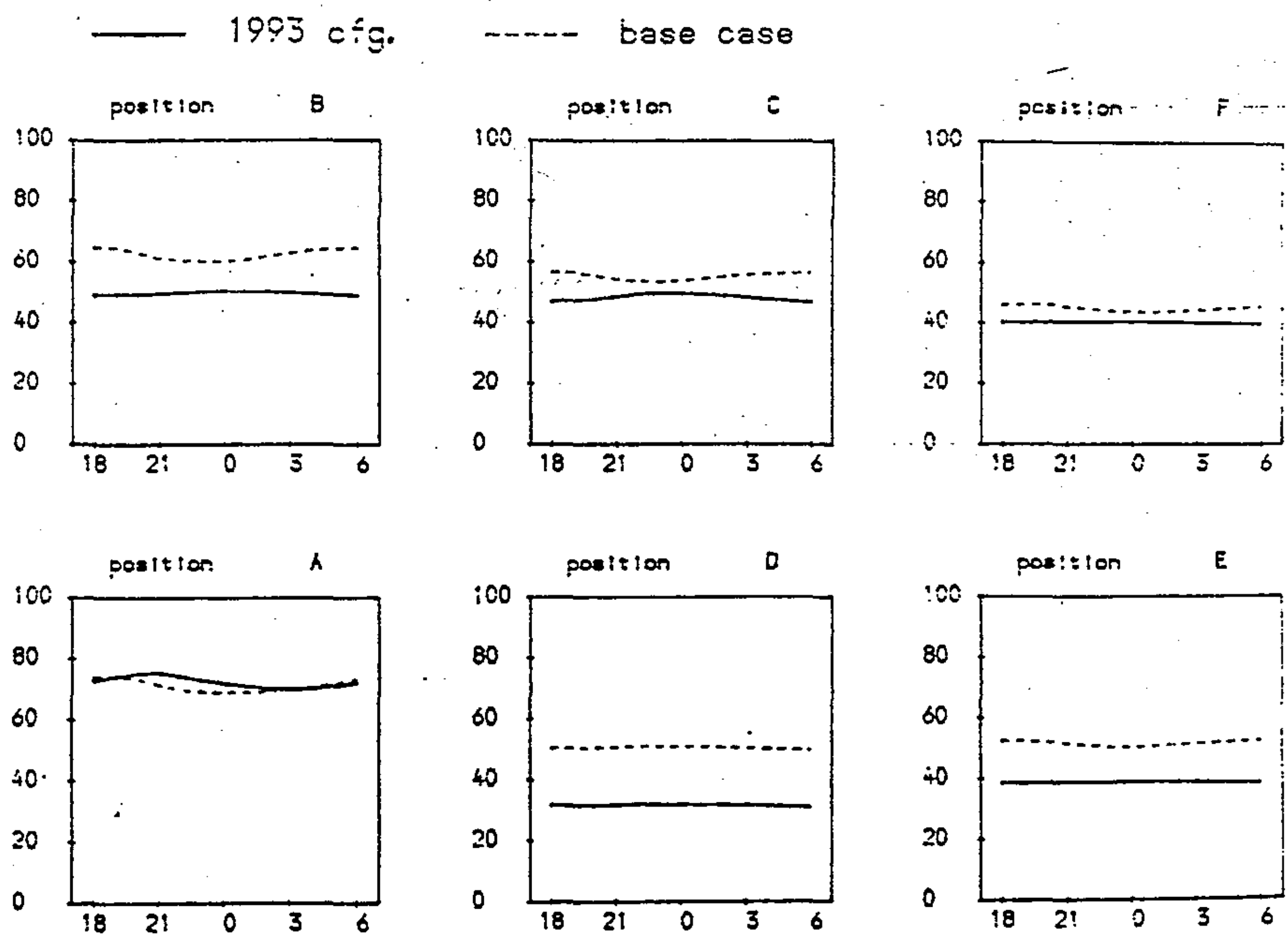


Figure 6b West Kowloon Reclamation

depth-averaged model - neap tide

distribution of Dissolved Oxygen (% saturation) against time

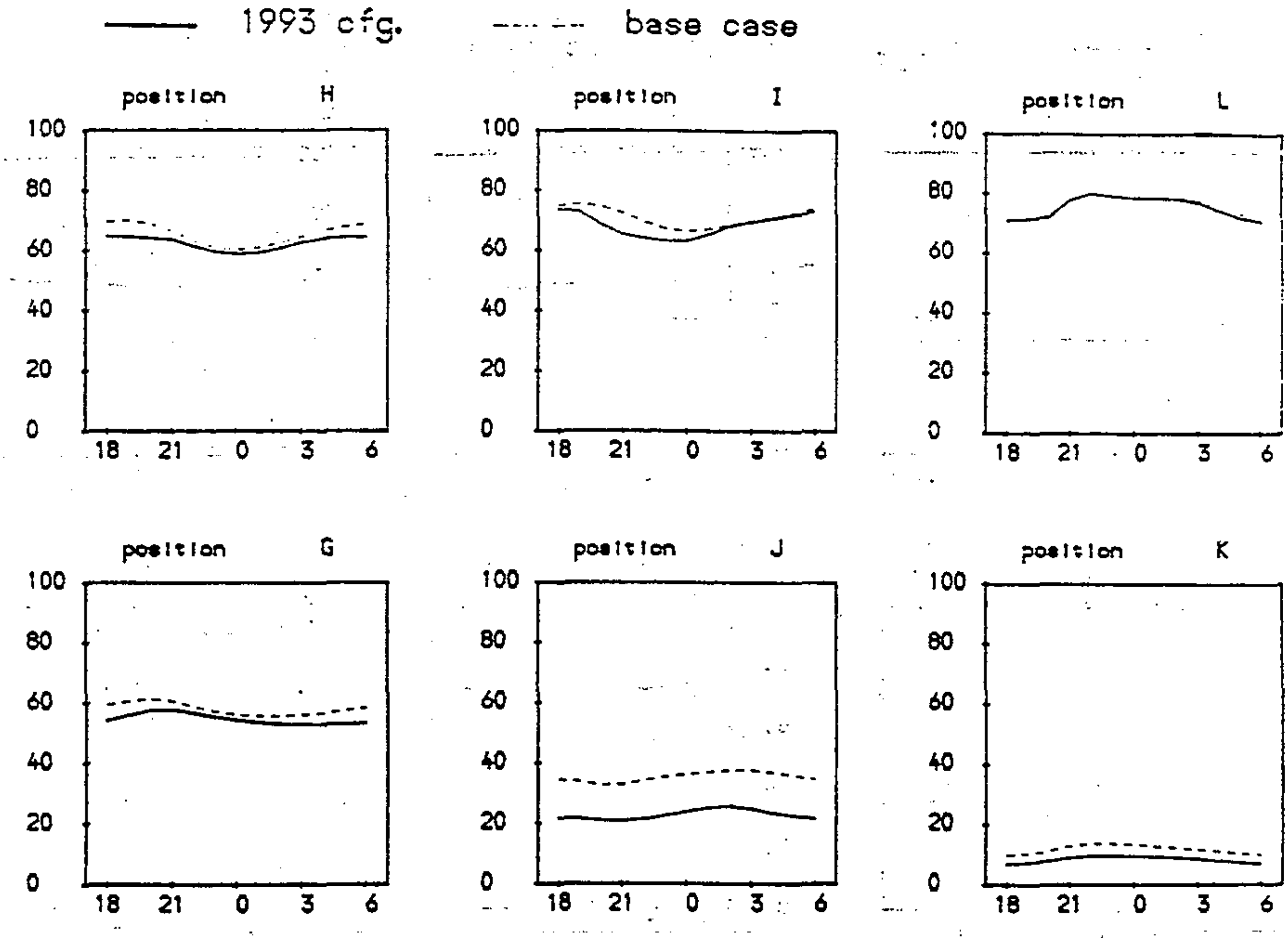


Figure 6c West Kowloon Reclamation

depth-averaged model - neap tide

distribution of Dissolved Oxygen (% saturation) against time

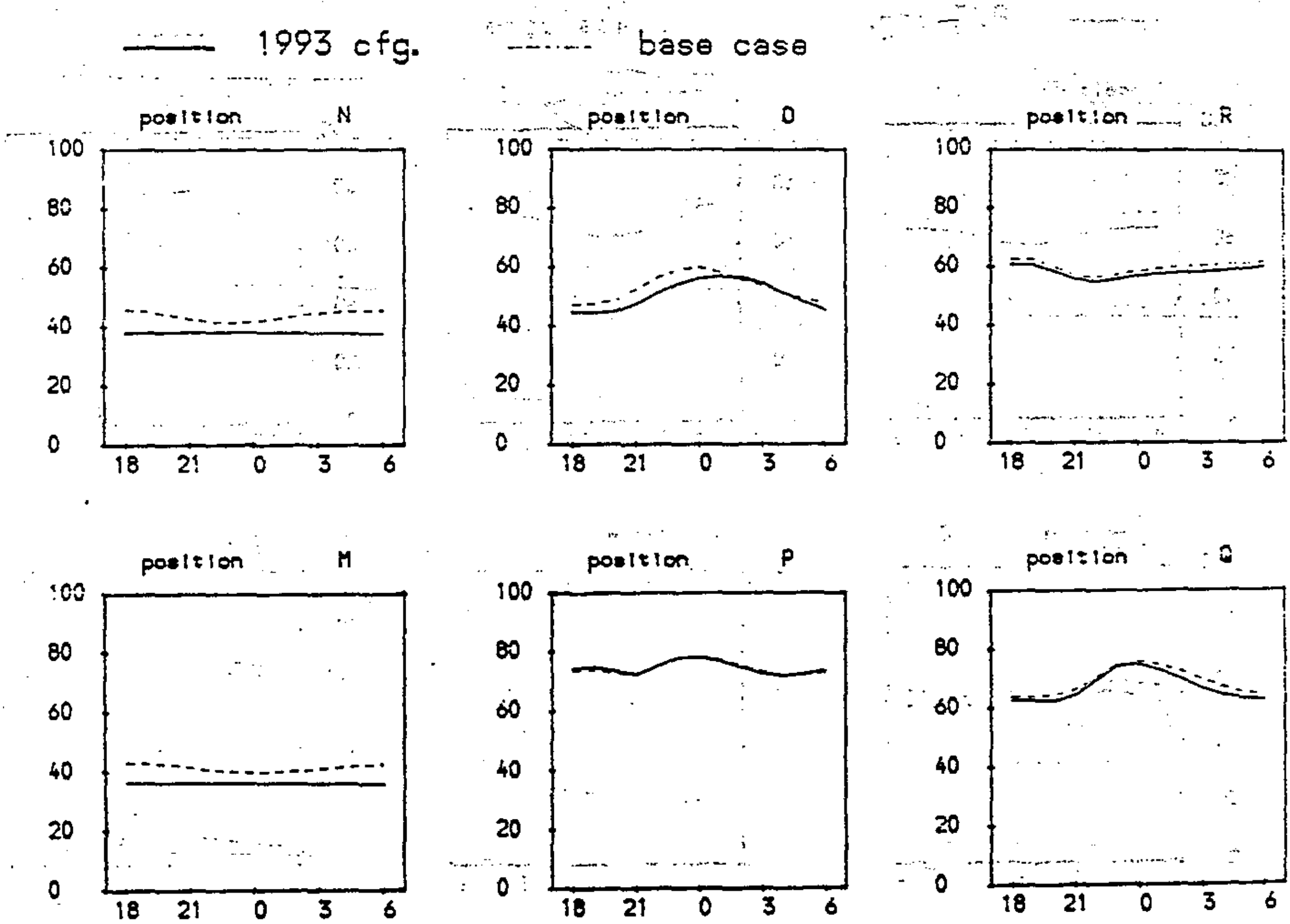


Figure 6d West Kowloon Reclamation

depth-averaged model - neap tide

distribution of BOD (mg / l) against time

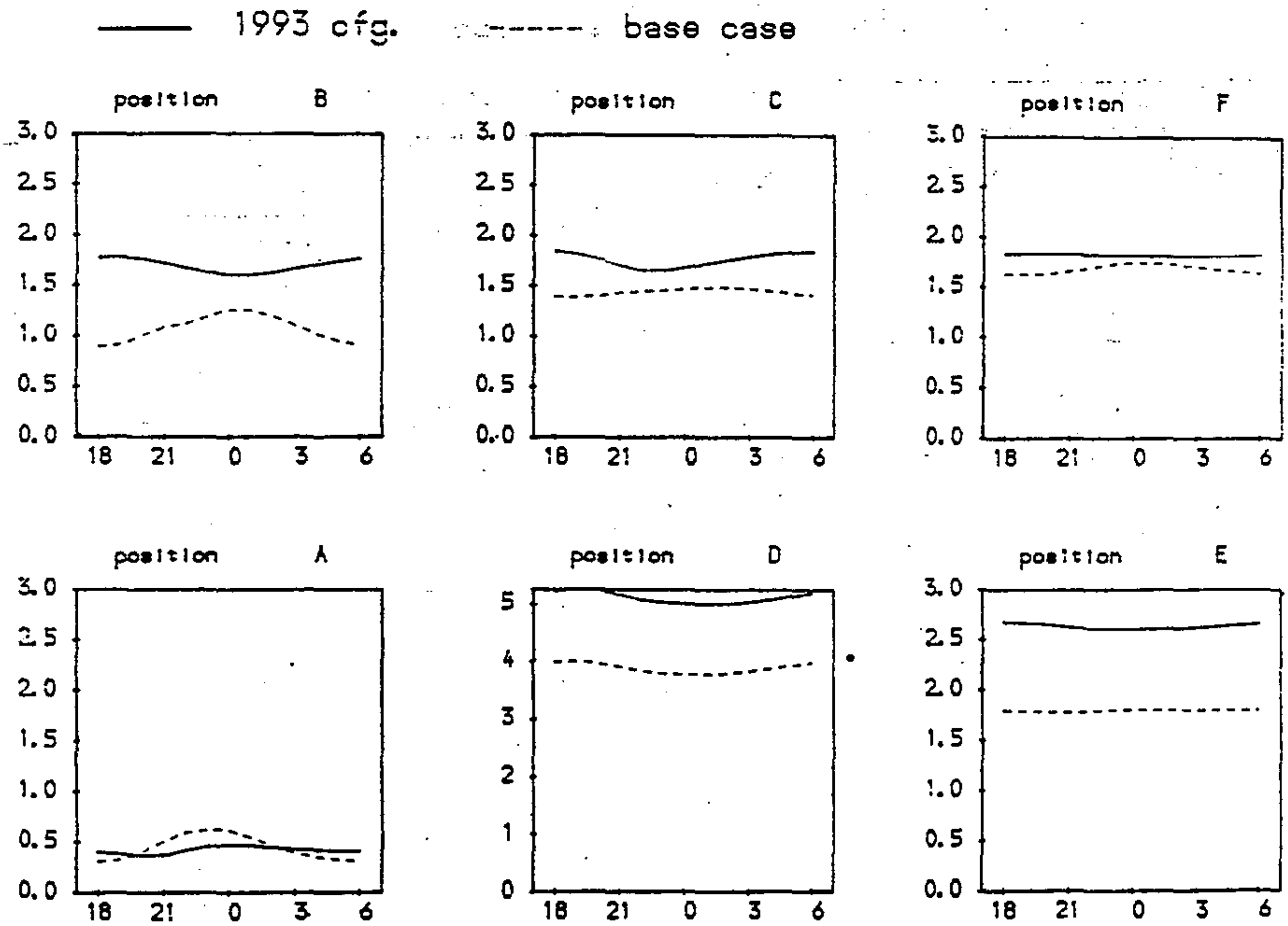


Figure 6g West Kowloon Reclamation

depth-averaged model - neap tide

distribution of Suspended Solids (mg/l) against time

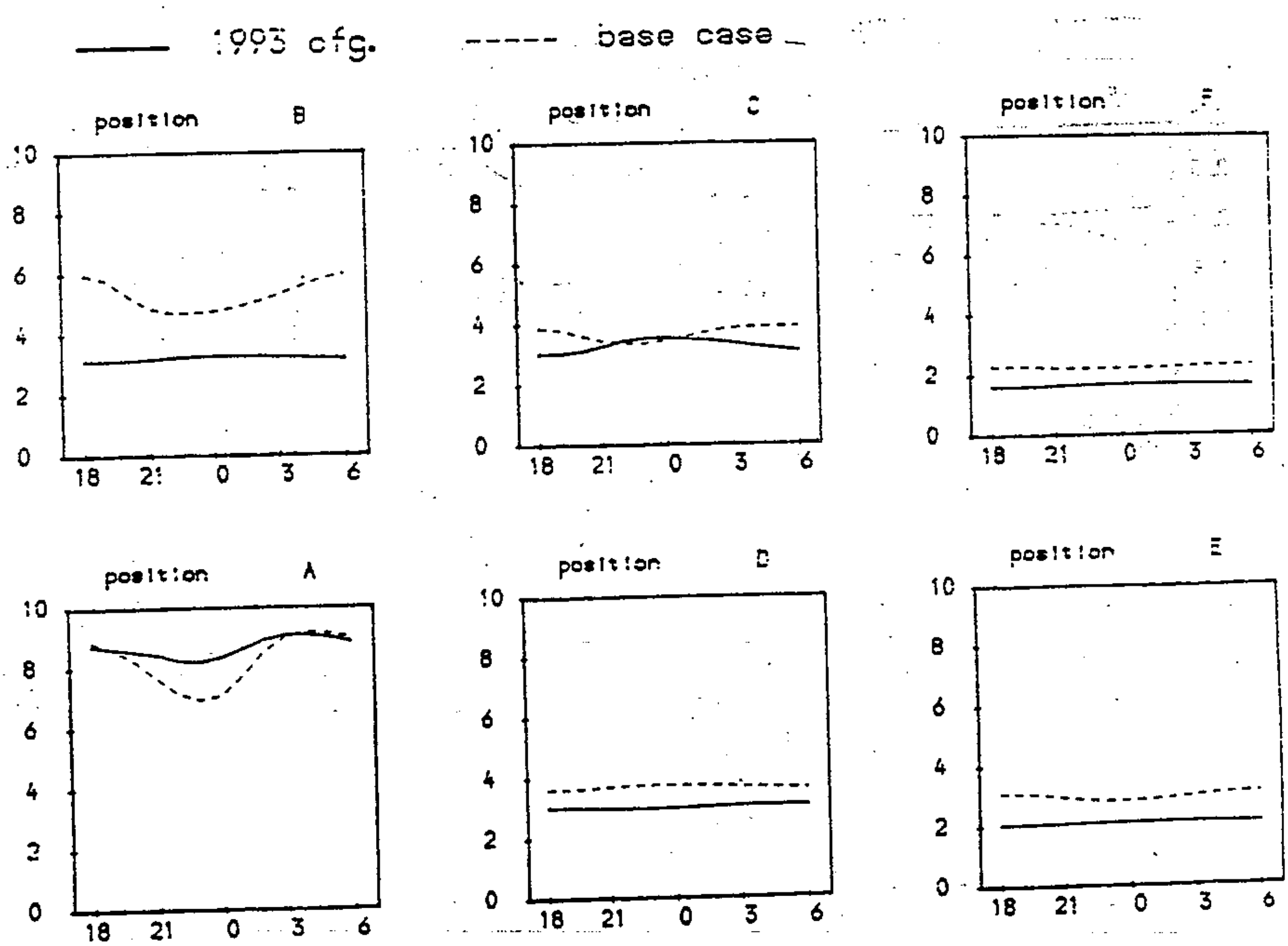


Figure 6h West Kowloon Reclamation

depth-averaged model - neap tide

distribution of Suspended Solids (mg/l) against time

—— 1993 cfg. ----- base case

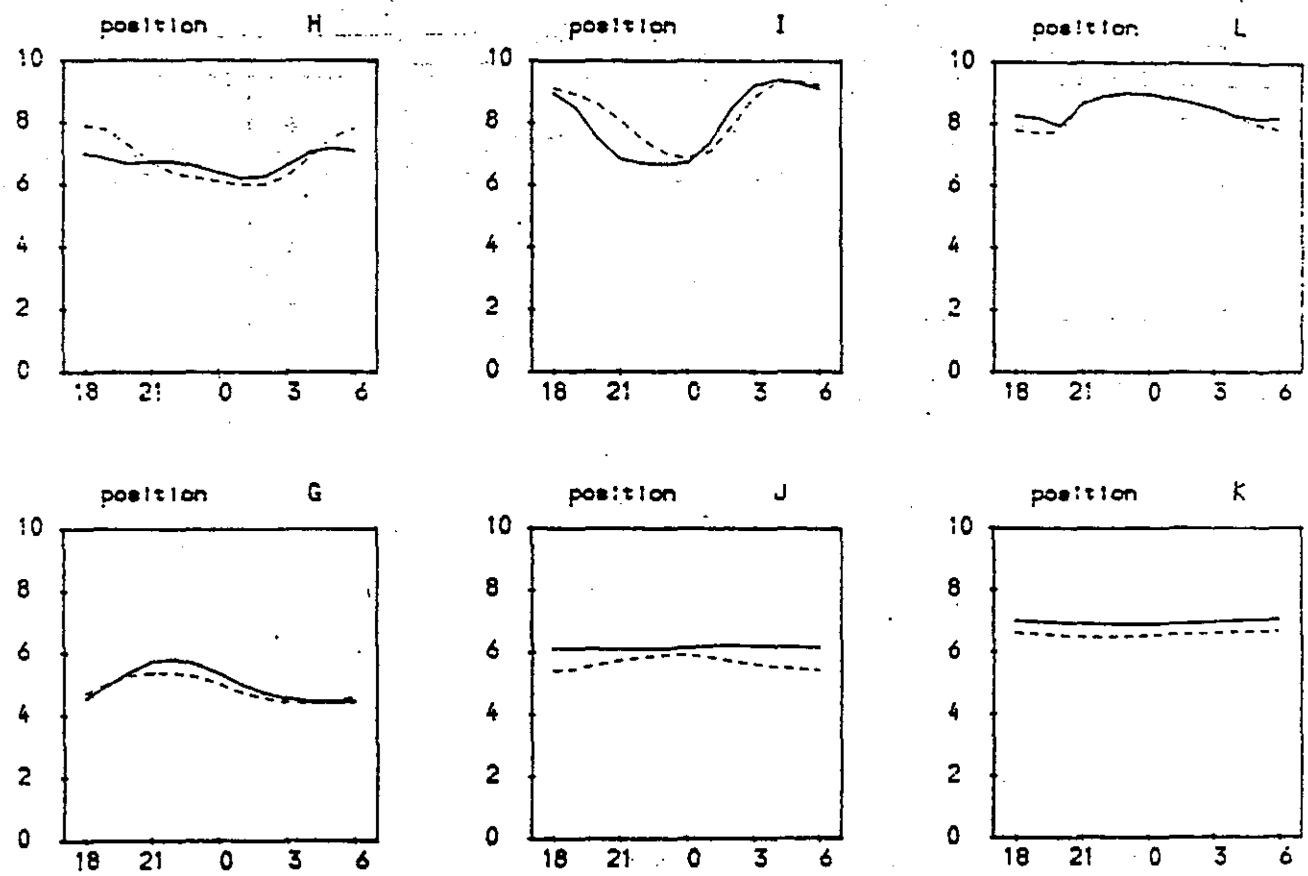


Figure 6i West Kowloon Reclamation

depth-averaged model – neap tide

distribution of Suspended Solids (mg/l) against time

——— 1993 cfg. - - - - - base case

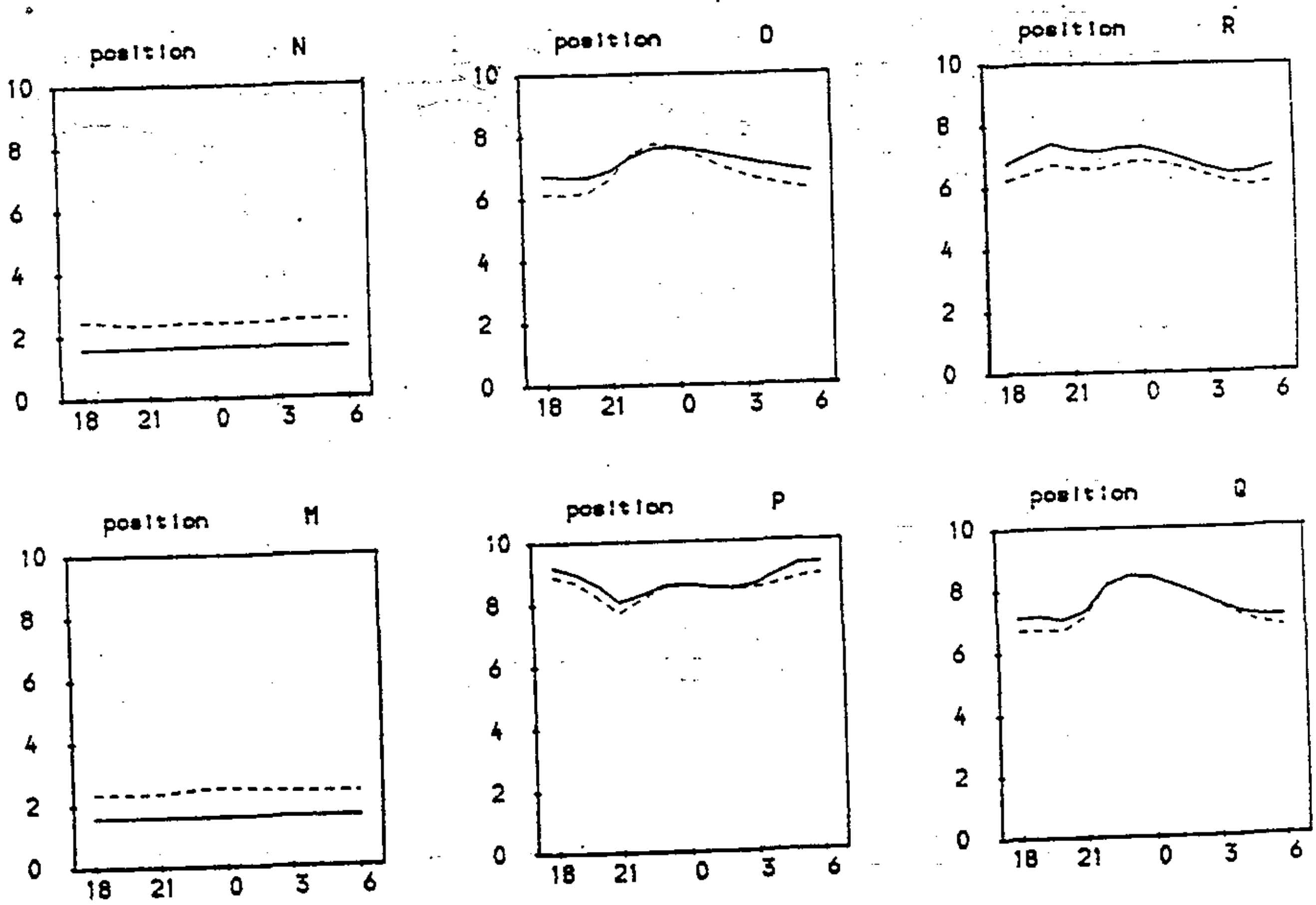


Figure 6j West Kowloon Reclamation

depth-averaged model - neap tide

distribution of E.Coli (no/100ml) against time

note log-scale to base 10 on y-axis

—— 1993 cfg. ----- base case

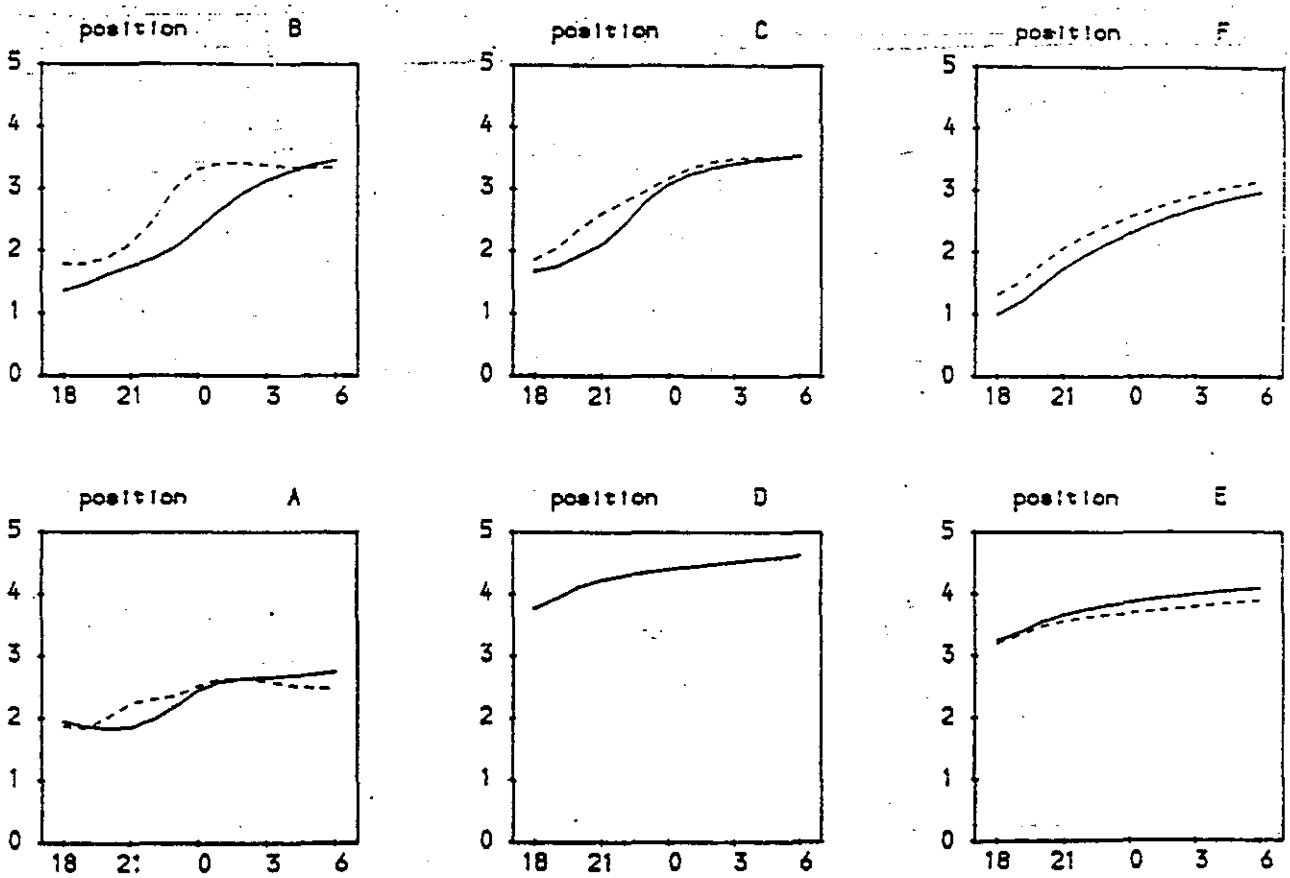


Figure 6k West Kowloon Reclamation

depth-averaged model - neap tide

distribution of E.Coli (no/100ml) against time

note log-scale to base 10 on y-axis

—— 1993 cfg. ----- base case

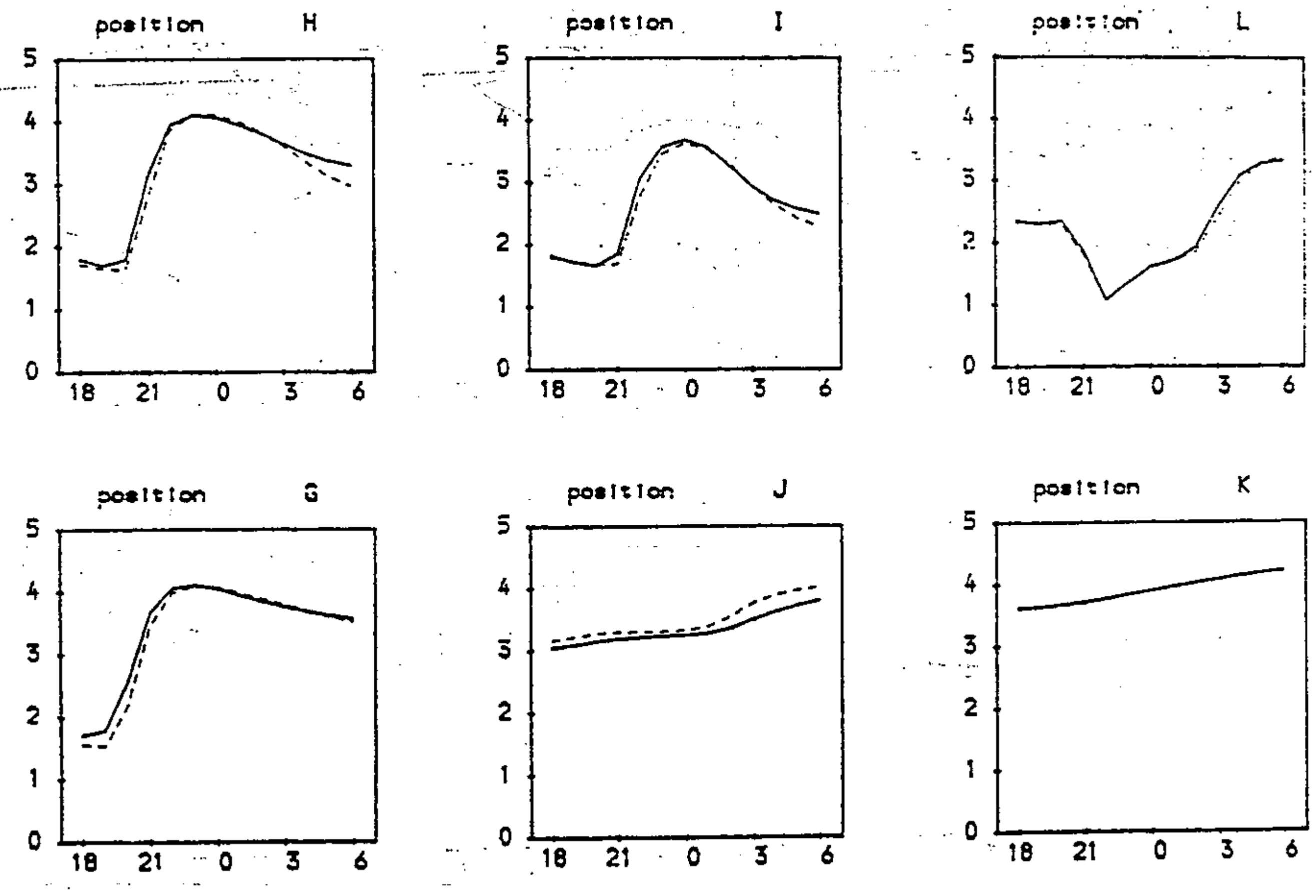


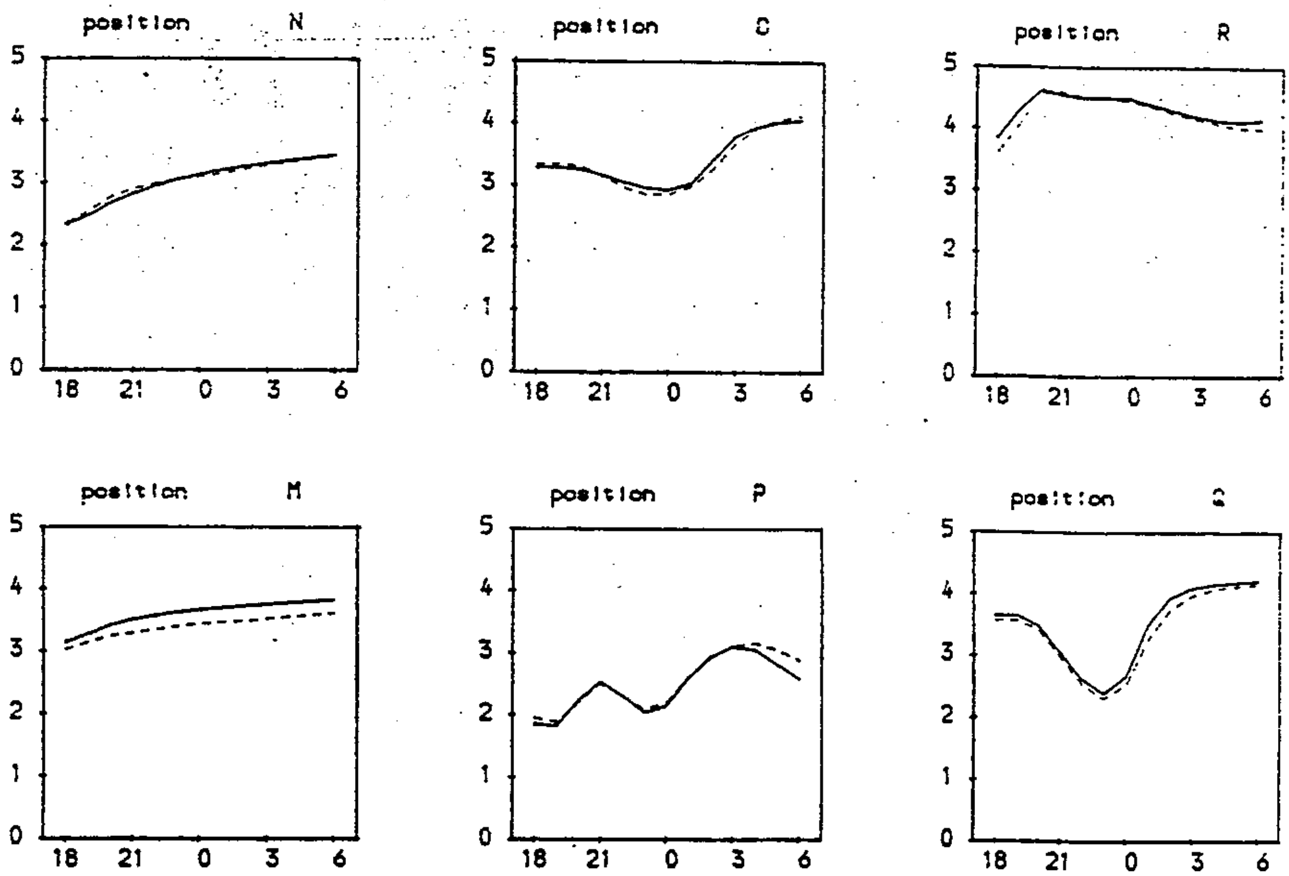
Figure 61 West Kowloon Reclamation

depth-averaged model - neap tide

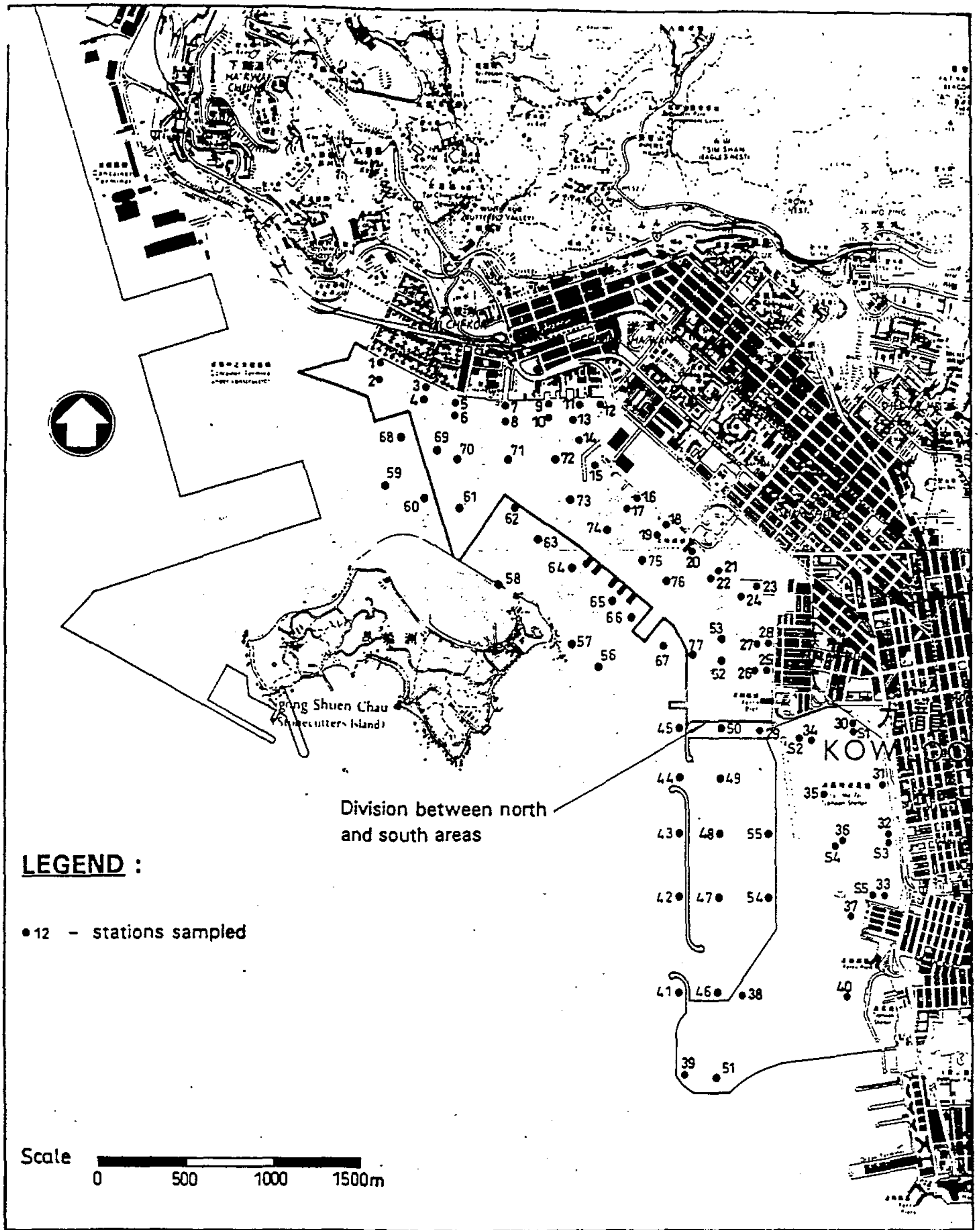
distribution of E.Coli (no./100ml) against time

note log-scale to base 10 on y-axis

—— 1993 cfg. ----- base case



Annex D
Marine Sediment: Survey Results



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URBAN AREA DEVELOPMENT OFFICE

WEST KOWLOON RECLAMATION

FIG. 1 _
MARINE SEDIMENT SURVEY
SAMPLING STATIONS

Consultants
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Scale 1 : 30 000
Sketch No. 285/ E/ SK/ 053
Rev. A

Table 1.(a) Series A Marine Sediment Sample Locations

Sample	Northing	Easting	Type
SI/01	821 760	832 230	CORE
SI/02	821 730	832 210	"
SI/03	821 670	832 470	"
SI/04	821 630	832 460	"
SI/05	821 570	832 690	"
SI/06	821 520	832 680	"
SI/07	821 560	832 960	"
SI/08	821 530	832 960	"
SI/09	821 585	833 270	"
SI/10	821 545	833 275	"
SI/11	821 630	833 370	"
SI/12	821 580	833 430	"
SI/13	821 540	833 320	"
SI/14	821 420	833 380	"
SI/15	821 240	833 470	"
SI/16	821 070	833 710	GRAB
SI/17	821 020	833 685	CORE
SI/18	820 940	833 910	GRAB
SI/19	820 870	833 860	CORE
SI/20	820 780	834 020	"
SI/21	820 640	834 210	"
SI/22	820 600	834 180	"
SI/23	820 630	834 420	"
SI/24	820 560	834 340	"
SI/25	820 450	834 460	"
SI/26	820 450	834 420	"
SI/27	820 270	834 470	"
SI/28	820 270	834 420	"
SI/29	819 870	834 430	"
SI/30	819 850	835 000	CORE
SI/31	819 520	835 150	"
SI/32	819 250	835 140	"
SI/33	818 880	835 130	"
SI/34	819 730	834 730	"
SI/35	819 550	834 830	"
SI/36	819 220	834 890	"
SI/37	818 790	834 970	"
SI/38	818 360	834 370	"
SI/39	817 860	833 960	"
SI/40	818 320	834 850	"

Table 1.(b) Marine Sediment Sample Locations

Sample	Northing	Easting	Type
SI/41	818360	833930	CORE
SI/42	818900	833930	"
SI/43	819240	833930	"
SI/44	819540	833930	"
SI/45	819830	833930	"
SI/46	818360	834230	"
SI/47	818900	834230	"
SI/48	819240	834230	"
SI/49	819540	834230	"
SI/50	817850	834230	"
SI/51	820140	834230	"
SI/52	820270	834230	"
SI/53	818900	834230	"
SI/54	819240	834530	"
SI/55	820150	834530	"
SI/56	820250	833500	"
SI/57	820610	833350	"
SI/58	821160	832920	"
SI/59	821060	832280	"
SI/60	821030	832470	"
SI/61	821030	832720	"
SI/62	820850	832950	"
SI/63	820658	833120	"
SI/64	820490	833360	"
SI/65	820390	833550	"
SI/66	820230	833690	"
SI/67	821430	833850	"
SI/68	821350	832390	"
SI/69	821310	832580	"
SI/70	821310	832720	"
SI/71	821310	832970	"
SI/72	821310	833210	"
SI/73	821080	833320	"
SI/74	820880	833550	"
SI/75	820730	833750	"
SI/76	820600	833890	"
SI/77	820200	834080	"

Table 2 WKR Sediment Sampling Survey - Analytical Methodology

Parameter	Method
1. Particle size distribution of fine grained material.	Ref. BS1377 1975 Tests 7a and 3d
2. Total Organic Matter	Sample drived at 103-105 deg. C., weighed, ignited at 500 de. C and reweighed.
3. Total Kjeldahl Nitrogen	Digestion of the sample with Mercuric sulphate and Sulphuric acid followed by distillation. Evolved Ammonia trapped by Boric Acid and determined by colorimetric method.
4. Total Phosphorus	Acid digestion followed by colorimetric determination using molybdate reagent and Ascorbic Acid
5. Chemical Oxygen Demand	Open Dichromate reflux followed by titrimetric determination.
6. Cadmium Chromium Copper Mercury Lead Zinc Nickel	Sample mixed with dilute Hydrocloric acid and heated over a water bath. Following filtration the metal content is determined by atomic Absorption spectrophotometry For Mercury, the cold vapour generation method is adopted.

Table 3 West Kowloon Sediment Survey Series A Analytical Results

PARAMETER	STN.1	STN.2	STN.3	STN.4	STN.5	STN.6
C.O.D. (mg/Kg)	46,000	56,000	32,000	35,000	33,000	77,000
COPPER (mg/Kg)	330	150	71	300	120	250
ZINC (mg/Kg)	70	220	140	100	70	230
NICKEL (mg/Kg)	22	19	10	19	9	28
LEAD (mg/Kg)	77	100	26	59	24	82
CADMIUM (mg/Kg)	2	3	1	3	2	7
CHROMIUM (mg/Kg)	50	50	20	50	30	50
MERCURY (mg/Kg)	0.74	-	-	-	0.21	0.62
TOTAL KJELDAHL NITROGEN (mg/Kg)	740	710	670	1200	630	1100
TOTAL PHOSPHATE (mg/Kg)	4	3	2	5	3	-
TOTAL ORGANIC MATTER %	3.4	3.2	2.6	2.9	3.9	3.4
TOTAL TOXIC METAL (mg/Kg)	551	542	268	541	255	647

PARAMETER	STN.7	STN.8	STN.9	STN.10	STN.11	STN.12
C.O.D. (mg/Kg)	31,000	66,000	54,000	69,000	43,000	100,000
COPPER (mg/Kg)	260	800	190	600	160	270
ZINC (mg/Kg)	150	170	160	160	250	400
NICKEL (mg/Kg)	19	34	19	68	21	38
LEAD (mg/Kg)	73	100	67	-	92	140
CADMIUM (mg/Kg)	3	4	1	8	1	2
CHROMIUM (mg/Kg)	80	60	60	-	60	130
MERCURY (mg/Kg)	-	0.78	0.50	-	0.14	0.21
TOTAL KJELDAHL NITROGEN (mg/Kg)	1000	2400	1600	1800	1300	2400
TOTAL PHOSPHATE (mg/Kg)	3	13	3	3	4	5
TOTAL ORGANIC MATTER %	3.9	2.8	8.5	4.4	4.5	4.8
TOTAL TOXIC METAL (mg/Kg)	585	1168	497	928	584	980

Table 3 (Con't)

PARAMETER	STN.13	STN.14	STN.15	STN.16	STN.17	STN.18
C.O.D. (mg/Kg)	71,000	42,000	48,000	64,000	47,000	37,000
COPPER (mg/Kg)	160	240	370	240	310	200
ZINC (mg/Kg)	120	70	470	220	280	220
NICKEL (mg/Kg)	22	51	30	19	31	18
LEAD (mg/Kg)	61	160	93	60	83	46
CADMIUM (mg/Kg)	1	2	2	2	2	2
CHROMIUM (mg/Kg)	40	60	80	60	80	50
MERCURY (mg/Kg)	0.40	0.47	0.19	0.20	0.19	0.11
TOTAL KJELDAHL NITROGEN (mg/Kg)	1800	1200	2700	880	1600	1500
TOTAL PHOSPHATE (mg/Kg)	3	-	3	1	-	3
TOTAL ORGANIC MATTER %	4.5	4.0	4.1	4.2	3.8	2.5
TOTAL TOXIC METAL (mg/Kg)	404	583	1045	601	786	536

PARAMETER	STN.19	STN.20	STN.21	STN.22	STN.23	STN.24
C.O.D. (mg/Kg)	52,000	48,000	32,000	79,000	85,000	56,000
COPPER (mg/Kg)	160	160	420	67	100	130
ZINC (mg/Kg)	90	70	100	60	90	300
NICKEL (mg/Kg)	31	38	70	8	18	19
LEAD (mg/Kg)	180	130	130	7	11	120
CADMIUM (mg/Kg)	2	2	3	1	2	1
CHROMIUM (mg/Kg)	50	60	90	20	40	70
MERCURY (mg/Kg)	0.30	0.45	0.62	0.24	0.47	0.14
TOTAL KJELDAHL NITROGEN (mg/Kg)	1500	1500	-	2800	2800	1100
TOTAL PHOSPHATE (mg/Kg)	3	11	8	8	7	3
TOTAL ORGANIC MATTER %	3.5	3.1	4.1	3.4	4.0	3.7
TOTAL TOXIC METAL (mg/Kg)	513	460	813	163	761	690

Table 3 (Con't)

PARAMETER	STN.25	STN.26	STN.27	STN.28	STN.29	STN.30
C.O.D. (mg/Kg)	87,000	24,000	56,000	69,000	32,000	120,000
COPPER (mg/Kg)	400	45	390	560	30	360
ZINC (mg/Kg)	70	92	330	110	70	110
NICKEL (mg/Kg)	47	8	65	66	20	53
LEAD (mg/Kg)	-	50	110	120	150	220
CADMIUM (mg/Kg)	3	3	2	3	<1	3
CHROMIUM (mg/Kg)	-	10	-	10	20	60
MERCURY (mg/Kg)	0.41	0.55	0.29	0.12	0.42	0.27
TOTAL KJELDAHL NITROGEN (mg/Kg)	1900	540	2100	1400	1200	3200
TOTAL PHOSPHATE (mg/Kg)	-	2	4	3	8	3
TOTAL ORGANIC MATTER %	4.8	3.3	5.3	4.0	3.4	4.9
TOTAL TOXIC METAL (mg/Kg)	520	208	887	869	291	806

PARAMETER	STN.31	STN.32	STN.33	STN.34	STN.35	STN.36
C.O.D. (mg/Kg)	66,000	24,000	42,000	69,000	52,000	9,000
COPPER (mg/Kg)	55	14	24	120	130	7
ZINC (mg/Kg)	270	200	58	300	80	41
NICKEL (mg/Kg)	6	4	9	14	34	13
LEAD (mg/Kg)	230	140	31	65	190	18
CADMIUM (mg/Kg)	<1	<1	<1	<1	<1	<1
CHROMIUM (mg/Kg)	10	5	7	30	20	9
MERCURY (mg/Kg)	-	0.37	0.56	0.33	-	0.20
TOTAL KJELDAHL NITROGEN (mg/Kg)	1400	430	750	1600	1400	200
TOTAL PHOSPHATE (mg/Kg)	8	1	2	3	9	3
TOTAL ORGANIC MATTER %	5.8	6.1	7.1	5.3	4.2	2.8
TOTAL TOXIC METAL (mg/Kg)	572	354	130	540	465	89

Table 3 (Con't)

PARAMETER	STN.37	STN.38	STN.39	STN.40		
C.O.D. (mg/Kg)	13,000	17,000	15,000	26,000		
COPPER (mg/Kg)	5	9	10	10		
ZINC (mg/Kg)	50	38	38	43		
NICKEL (mg/Kg)	8	10	11	10		
LEAD (mg/Kg)	23	16	18	18		
CADMIUM (mg/Kg)	6	<1	<1	<1		
CHROMIUM (mg/Kg)	8	8	9	9		
MERCURY (mg/Kg)	0.26	0.25	0.63	0.47		
TOTAL KJELDAHL NITROGEN (mg/Kg)	210	700	900	810		
TOTAL PHOSPHATE (mg/Kg)	-	2	3	7		
TOTAL ORGANIC MATTER %	2.7	2.6	2.9	2.6		
TOTAL TOXIC METAL (mg/Kg)	100	84	87	91		

Table 3(a) Nearshore Stations (Series A)

Mean Value by Catchment (expressed as mg/Kg dry weight)

METAL	LAI CHI KOK	CHEUNG SHA WAN	SHAM SHUI PO	TAI KOK TSUI	YAU MA TEI	TSIM SHA TSUI
COPPER	203.5	327.00	176.00	288.00	89.00	9.67
NICKEL	1783	32.00	28.86	39.2	17.60	11.00
ZINC	138.00	222.00	132.00	134.00	138.00	39.66
CADMIUM	3.00	2.54	1.86	2.17	1.87	<1.00
CHROMIUM	41.66	71.00	54.28	13.33	18.62	8.66
MERCURY	0.523	0.342	0.333	0.358	0.332	0.450
LEAD	61.33	92.7	89.14	107.5	114.62	17.33
T.T.M.	467.33	741.91	483.71	555.00	382.00	87.33

Table 4 West Kowloon Sediment Survey Series B Analytical Results

Testing Items	POS41 14:17	POS42 11:03	POS43 11:43	POS44 11:49	POS45 12:03	POS46 13:12	POS47 11:13	POS48 11:39
Chemical oxygen demand, mg/kg	$21x10^3$	$18x10^3$	$22x10^3$	$20x10^3$	$24x10^3$	$31x10^3$	$20x10^3$	$20x10^3$
Copper content, mg/kg	7.0	40	18	19	38	44	8.4	21
Zinc content, mg/kg	57	47	59	69	990	68	53	100
Nickel content, mg/kg	22	6.2	17	20	17	12	17	14
Lead content, mg/kg	21	19	36	24	47	85	28	58
Cadmium content, mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chromium content, mg/kg	8	6	7	10	18	7	9	14
Mercury content, μg/kg	<10	52	10	98	140	250	10	240
Total Kjeldahl nitrogen content mgN/kg	650	500	550	510	880	770	680	700
Total phosphorus content, mgP/kg	10	120	11	12	31	22	12	72
Total Organic matter content, %	2.3	2.2	3.2	3.1	3.1	4.7	2.5	3.3
Total Toxic metals, mg/kg	116	119	138	124	1111	217.2	116	208

Testing Items	POS49 11:54	POS50 11:57	POS51 10:20	POS52 12:10	POS53 12:13	POS54 11:29	POS55 11:34	POS56 12:26
Chemical oxygen demand, mg/kg	$30x10^3$	$60x10^3$	$20x10^3$	$56x10^3$	$79x10^3$	$19x10^3$	$51x10^3$	$51x10^3$
Copper content, mg/kg	27	150	12	240	220	7.2	180	100
Zinc content, mg/kg	140	560	45	310	370	47	190	200
Nickel content, mg/kg	19	23	8	39	42	22	24	27
Lead content, mg/kg	45	210	36	130	170	43	120	130
Cadmium content, mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chromium content, mg/kg	41	54	13	11	67	6	54	25
Mercury content, μg/kg	170	260	170	300	410	120	270	330
Total Kjeldahl nitrogen content mgN/kg	600	1400	580	1600	1400	490	1600	1200
Total phosphorus content, mgP/kg	68	54	17	28	18	15	9	14
Total Organic matter content, %	3.0	3.6	3.2	4.3	4.1	3.4	2.8	4.0
Total Toxic metals, mg/kg	273	998	115	1031	870	126	569	483

Table 4 (Cont'd)

Testing Items	POS57 12:37	POS58 13:57	POS59 14:52	POS60 14:48	POS61 14:40	POS62 14:33	POS63 13:02	POS64 12:55
Chemical oxygen demand, mg/kg	$9x10^3$	$42x10^3$	$26x10^3$	$25x10^3$	$19x10^3$	$41x10^3$	$43x10^3$	$39x10^3$
Copper content, mg/kg	33	270	64	8.2	22	160	100	140
Zinc content, mg/kg	23	200	880	61	53	290	120	120
Nickel content, mg/kg	3.9	30	21	26	13	22	22	19
Lead content, mg/kg	14	120	76	49	42	160	110	94
Cadmium content, mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chromium content, mg/kg	6	53	24	7	12	47	31	19
Mercury content, µg/kg	<10	390	19	270	250	820	210	200
Total Kjeldahl nitrogen content mgN/kg	380	1300	710	840	560	1200	870	930
Total phosphorus content, mgP/kg	5	69	10	13	11	39	12	12
Total Organic matter content, %	2.4	3.3	2.9	2.5	2.8	3.3	3.4	2.6
Total Toxic metals, mg/kg	81	674	1066	152	143	680	384	412

Testing Items	POS65 12:50	POS66 12:42	POS67 14:42	POS68 15:06	POS69 15:16	POS70 15:21	POS71 14:27	POS72 14:24
Chemical oxygen demand, mg/kg	$25x10^3$	$33x10^3$	$53x10^3$	$36x10^3$	$47x10^3$	$54x10^3$	$52x10^3$	$59x10^3$
Copper content, mg/kg	23	78	200	82	180	260	260	190
Zinc content, mg/kg	52	77	140	89	150	320	160	350
Nickel content, mg/kg	19	232	30	27	24	47	38	37
Lead content, mg/kg	51	56	110	72	96	110	100	180
Cadmium content, mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Chromium content, mg/kg	10	14	46	24	37	55	47	67
Mercury content, µg/kg	75	<10	180	50	230	140	120	340
Total Kjeldahl nitrogen content mgN/kg	760	600	870	1000	1400	1300	1600	1200
Total phosphorus content, mgP/kg	5	16	67	11	80	25	10	12
Total Organic matter content, %	3.1	3.1	3.5	3.3	2.9	3.5	3.3	3.6
Total Toxic metals, mg/kg	156	458	527	295	488	793	606	825

Table 4 (Cont'd)

Testing Items	POS73 14:20	POS74 14:14	POS75 14:11	POS76 14:07	POS77 12:19
Chemical oxygen demand, mg/kg	$53x10^3$	$31x10^3$	$46x10^3$	$57x10^3$	$50x10^3$
Copper content, mg/kg	210	140	190	170	110
Zinc content, mg/kg	150	240	320	1300	200
Nickel content, mg/kg	41	27	31	36	31
Lead content, mg/kg	81	79	110	210	99
Cadmium content, mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
Chromium content, mg/kg	36	34	57	66	33
Mercury content, μg/kg	57	180	170	430	230
Total Kjeldahl nitrogen content mgN/kg	1600	640	1300	1600	770
Total phosphorus content, mgP/kg	22	14	6	14	48
Total Organic matter content, %	3.2	3.2	3.5	3.6	4.0
Total Toxic metals, mg/kg	519	520	708	1782	479

Table 5 Series C Trace Metal Concentration with Depth - Bulk Samples (concns. expressed in mg/kg)

Stn. No>	Depth	Cd	Cr	Cu	Pb	Hg	Ni	Zn
S1	0-1m	1.0	36.0	75.0	209.5	2.0	24.5	285.5
	1-2m	0.9	25.8	6.9	24.7	0.6	20.0	97.0
	2-3m	0.9	22.4	5.7	23.0	0.4	18.8	66.8
S2	0-1m	3.2	98.2	300.2	303.4	2.4	57.0	960.9
	1-2m	2.5	95.2	318.1	359.0	7.2	63.4	910.0
	2-3m	1.7	24.0	6.5	26.0	2.1	22.0	54.0
S3	0-1m	3.1	117.1	385.8	192.5	2.0	66.8	543.9
	1-2m	1.8	113.5	200.0	237.5	5.9	51.5	392.5
	2-3m	1.9	58.4	292.4	136.9	7.6	36.9	203.6
S4	0-1m	1.8	18.0	50.5	168.0	1.7	19.0	210.5
	1-2m	0.6	24.9	7.0	24.9	0.8	22.5	64.1
	2-3m	0.6	30.0	7.9	24.4	0.9	24.4	76.1
S5	0-1m	3.0	35.5	344.5	282.5	17.0	53.3	661.5
	1-2m	3.6	79.2	417.9	300.9	13.5	53.9	690.0
	2-3m	2.2	41.8	116.8	135.5	1.5	34.1	409.3

Table 6 Series C Trace Metal Concentration with Depth - Fine fraction (<63 um)

Stn. No>	Depth	Cd	Cr	Cu	Pb	Hg	Ni	Zn
S1	0-1m	1.6	25.0	59.0	160.5	4.6	25.5	269.0
	1-2m	0.9	25.2	6.0	35.0	1.0	22.4	117.0
	2-3m	0.9	21.2	6.3	23.2	1.1	19.3	76.6
S2	0-1m	1.4	93.0	398.9	268.4	4.2	58.8	993.6
	1-2m	1.4	90.2	401.1	292.0	5.5	63.6	1014.0
	2-3m	0.3	22.2	9.1	25.0	3.0	20.6	38.0
S3	0-1m	1.2	99.8	459.6	144.0	2.2	60.2	536.1
	1-2m	1.7	80.5	332.8	137.5	0.1	50.9	480.9
	2-3m	0.7	50.0	110.5	92.7	1.5	33.4	243.8
S4	0-1m	1.1	16.1	69.0	136.7	4.5	19.7	202.0
	1-2m	0.9	26.1	9.3	27.1	0.7	24.7	85.8
	2-3m	0.9	24.1	6.6	24.4	0.7	19.6	84.6
S5	0-1m	2.3	73.6	283.9	251.5	14.1	69.2	642.2
	1-2m	2.0	71.7	282.6	232.3	11.2	72.5	648.2
	2-3m	0.6	34.8	89.8	95.6	0.8	32.9	238.3

Annex E
Monitoring and Audit Requirements

SECTION 34

WATER POLLUTION CONTROL AND WATER QUALITY MONITORING

34.01 GENERAL REQUIREMENTS

(a) The Contractor shall carry out the Works in such a manner as to minimise adverse impacts on the water quality during execution of the Works. In particular he shall arrange his method of working to minimise the effects on the water quality within the Site, adjacent to the Site, on the transport routes and at the loading, dredging and dumping areas.

(b) Before marine plant is used on the Works, it shall be inspected by the Engineer to ensure that the plant is suitable for the project and can be operated to achieve the Water Quality Objectives (WQO) as detailed in PS clause 34.03. The Contractor shall provide all necessary facilities to the Engineer for inspecting or checking such vessels and shall not use such vessels or plant for the Works without the agreement of the Engineer. The Engineer may require the Contractor to carry out trials of any plant or vessels to prove their suitability.

(c) The Contractor shall design methods of working to minimise water pollution and to meet the WQO, and shall provide experienced personnel with suitable training to ensure that these methods are implemented.

(d) Before the commencement of the Works, the Contractor shall submit to the Engineer the proposed methods of working.

(e) After commencement of the Works if the Plant or work methods are believed by the Engineer, to be causing unacceptable levels of pollution, the Plant or work methods shall be inspected and remedial proposals drawn up, approved and implemented, as detailed in PS clause 34.09(b). Where such remedial measures include the use of additional or alternative plant such plant shall not be used on the Works until agreed by the Engineer. Where remedial measures include maintenance or modification of previously approved plant such plant shall not be used on the Works until such maintenance or modification is completed and the adequacy of the maintenance or modification is demonstrated to the satisfaction of the Engineer.

34.02 DEFINITIONS

For use in this Section of the Particular Specification only, the following definitions are used :-

a) dredged material - all dredged material.

b) marine mud - dredged material to be removed from the reclamation or borrow areas and which will not be reused in the Works.

c) contaminated marine mud - designated dredged material to be removed from the reclamation areas containing sufficient micro-pollutants to require particular handling and disposal procedures.

d) fill material - dredged or land based material to be used in the reclamation, (including foundations to seawall, drainage layers etc.)

e) unsuitable material - material, other than marine mud, taken from the area of the Works, (including borrow areas), which is unsuitable for use as fill material. The material is to be disposed of at designated spoil dumping grounds. The material may include builders debris, spoil and hard material dumped by others, and seabed debris.

34.03 WATER QUALITY OBJECTIVE

The objective is to minimise adverse impacts resulting from the Contractors operations on the water quality within Hong Kong waters . To achieve this objective the Contractor is to design and implement methods of working that:-

(i) minimise disturbance to the seabed while dredging;
(ii) minimise leakage of dredged material during lifting;
(iii) minimise loss of material during transport of fill or dredged material;
(iv) prevent discharge of fill or dredged material except at approved locations;
(v) prevent the unacceptable reduction, due to the Works, of the dissolved; oxygen content of the water adjacent to the Works; and
(vi) prevent excess suspended solids from being present in intake waters.

34.04 WATER QUALITY MONITORING EQUIPMENT

The Contractor shall provide within one week of the commencement of the Contract, the following equipment :-

a) Dissolved oxygen and temperature measuring equipment

The instrument shall be a portable, weatherproof dissolved oxygen measuring instrument complete with cable, sensor, comprehensive operation manuals, and be operable from a DC power source. It shall be capable of measuring:-

i) a dissolved oxygen level in the range of 0-15 mg/l and 0-200% saturation; and

ii) a temperature of 0-45 degree Celsius.

It shall have a membrane electrode with automatic temperature compensation complete with a cable of not less than 25m in length. Sufficient stocks of spare electrodes and cable shall be maintained for replacement where necessary. (YSI model 58 meter, YSI 5739 probe, YSI 5795A submersible stirrer with reel and cable or similar approved)

b) Turbidity Measurement Instrument

Turbidity within the water shall be measured in-situ by the nephelometric method. The instrument shall be a portable, weatherproof turbidity-measuring instrument complete with cable, sensor and comprehensive operation manuals. The equipment shall be operable from a DC power source. It shall have a photoelectric sensor capable of measuring turbidity between 0-100 NTU and be complete with a cable with at least 25 meters long. (Partech Turbidimeter Model 7000 3RP Mark 2 or similar approved).

c) Thermometer

A laboratory standard certified mercury thermometer with an accuracy of at least 0.5 degree Celsius.

d) Water Depth Detector

A portable, battery-operated Echo Sounder shall be used for the determination of water depth at each Designated Monitoring Station. This unit can either be handheld or affixed to the bottom of the work boat if the same vessel is to be used throughout the monitoring programme. (Seafarer 700 or similar approved)

All monitoring instruments shall be checked, calibrated and certified by an approved accredited laboratory before use on the Works and subsequently re-calibrated at 3-month intervals throughout all stages of the water quality monitoring. Responses of sensors and electrodes should be checked with certified standard solutions before each use. The turbidity meter shall be calibrated to establish the relationship between turbidity readings (in NTU) and levels of suspended solids (in mg/L).

34.05 WATER QUALITY MONITORING

The Contractor shall provide approved qualified technicians, capable of operating the monitoring equipment, together with a suitable work boat for carrying out the monitoring. Monitoring shall be commenced by the Contractor under the supervision of the Engineer within 7 days of the commencement of the Works.

Monitoring shall be carried out in-situ and in accordance with the following:-

(a) 'Baseline' conditions for the various water quality parameters are to be established prior to the commencement of the marine works under the Contract. The Contractor shall establish the 'Baseline' conditions by measuring the following water quality parameters, viz. turbidity, dissolved oxygen concentration (DO in mg/L) and dissolved oxygen saturation (DOS in %) at all Designated Monitoring Stations, on 4 sampling days per week, at mid-flood and mid-ebb, for 4 consecutive weeks within six weeks of commencement of the Works. All measurements shall be taken in situ and at 3 water depths, namely, 1m below water surface, mid-water depth, and 1m above sea bed.

(b) During the course of the Works, monitoring shall be undertaken three days a week. Monitoring at each Designated Monitoring Station shall be undertaken on a working day. The interval between each series (mid-ebb and mid-flood) of samplings shall not be less than 36 hours. The values of turbidity, DO and DOS shall be determined in accordance with Clause 34.04 and Clause 34.05(a). Two measurements at each depth of each Station shall be taken. Where the difference in value between the first and second reading of each set is more than 25% of the value of the first reading the readings shall be discarded and further readings shall be taken. For the purpose of evaluating the water quality, all values shall be depth averaged.

(c) Should the monitoring programme record levels of turbidity, or dissolved oxygen levels be, in the opinion of the Engineer, indicative of a deteriorating situation such that, in the opinion of the Engineer, closer monitoring is required, then the Engineer may direct that further monitoring shall be undertaken daily at each Designated Monitoring Station until the recorded depth averaged values of these parameters indicate to the satisfaction of the Engineer an improving and acceptable level of Water Quality.

34.06 POSITIONS OF DESIGNATED MONITORING STATIONS

In the case of the contracts for the southern part of the reclamation :-

STATION NUMBER	EASTING	NORTHING	REMARKS
1	835040	817800	China ferry pier pumphouse
2	833720	819710	Yau Ma Tei entrance
3	834180	819710	Yau Ma Tei entrance
4	834930	819420	Yau Ma Tei

In the case of contracts for the northern part of the reclamation :-

5	833890	820270	Sham Shui Po
6	833000	821000	Lai Chi Kok
7	833100	821600	MTR Intake
8	833500	821290	WSD intake

34.07 REPORTING OF MONITORING DATA

The results of all Water Quality Monitoring shall be provided by the Contractor to the Engineer, in an agreed format, no later than 24 hours after the sampling.

At monthly intervals at times to be agreed with the Engineer, the Contractor shall provide to the Engineer a summary report, in both printed and magnetic media form, to an agreed format, details of all water quality data obtained in that month. This will include a summary report of any repeat monitoring or remedial measures taken to maintain the water quality.

34.08 ACTION ON DETECTION OF A DETERIORATING WATER QUALITY

Where monitoring of the water quality shows, in the opinion of the Engineer, a deteriorating water quality, then the Contractor shall take all necessary steps to ensure that the actions of the Contractors are not contributing to the deterioration. These steps shall include, but not be limited to the following:-

a) checking of all marine plant and equipment;

b) maintenance or replacement of any marine plant or equipment contributing to the deterioration;

c) checking and maintenance of all silt screens; and

d) review of all working methods.

The Engineer shall be kept informed of all steps taken, and written reports and proposals for action shall be passed to the Engineer by the Contractor whenever monitoring shows non-compliance with the WQO.

34.09 GENERAL PROCEDURES FOR THE AVOIDANCE OF POLLUTION DURING DREDGING, TRANSPORTING, AND DUMPING.

(a) All Construction Plant shall be designed and maintained to minimise the risk of silt and other contaminants being released into the water column or deposited in other than designated locations.

(b) Pollution avoidance measures shall include but are not limited to the following:-

i) mechanical grabs shall be designed and maintained to avoid spillage and shall seal tightly while being lifted;

ii) cutterheads of suction dredgers shall be suitable for the material being excavated and shall be designed to minimise overbreak and sedimentation around the cutter;

iii) where trailing suction hopper dredgers for dredging of marine mud, are in use in the Harbour, overflow from the dredger and the operation of lean mixture overboard systems shall not be permitted;

iv) all vessels shall be sized such that adequate clearance is maintained between vessels and the sea bed at all states of the tide to ensure that undue turbidity is not generated by turbulence from vessel movement or propeller wash;

v) all pipe leakages are to be repaired promptly and plant is not to be operated with leaking pipes;

vi) the Works shall cause no visible foam, oil, grease, scum, litter or other objectionable matter to be present on the water within the Site or dumping grounds;

vii) all barges and hopper dredgers shall be fitted with tight fitting seals to their bottom openings to prevent leakage of material;

viii) excess material shall be cleaned from the decks and exposed fittings of barges and hopper dredgers before the vessel is moved; and

ix) loading of barges and hoppers shall be controlled to prevent splashing of dredged material to the surrounding water and barges or hoppers shall not be filled to a level which will cause overflowing of material or polluted water during loading or transportation.

(c) The Engineer may monitor any or all vessels transporting material to ensure that no dumping outside the approved location takes place. The Contractor shall provide all reasonable assistance to the Engineer for this purpose.

(d) The Contractor shall ensure that all marine mud, contaminated marine mud and unsuitable material is disposed of at the approved locations. He will be required to ensure accurate positioning of vessels before discharge and will be required to submit and agree proposals with the Engineer for accurate positional control at disposal sites before commencing dredging.

(e) The Engineer may monitor any or all vessels transporting material to ensure that loss of material does not take place during transportation. The Contractor is to provide all reasonable assistance to the Engineer for this purpose.

34.10 DESIGNATED CONTAMINATED MARINE MUD

Where quantities of the material to be dredged is contaminated with micro-pollutants, the locations and depths of the designated contaminated marine mud will be indicated on the drawings or directed by the Engineer on site. The Contractor is to ensure that the designated contaminated marine mud is dredged, transported and placed in approved special dumping grounds in accordance with the provisions of P.S. clause 34.11 and in such a manner to minimise the loss of material to the water column.

34.11 SPECIAL PROCEDURES FOR THE AVOIDANCE OF POLLUTION DURING DREDGING, TRANSPORTATION AND DISPOSAL OF DESIGNATED CONTAMINATED MARINE MUD.

When dredging, transporting and disposing of designated contaminated marine mud, the Contractor shall implement additional special procedures for the avoidance of pollution which shall include but are not limited to the following:-

(a) dredging of designated contaminated marine mud shall only be undertaken by a suitable grab dredger using a closed grab;

(b) transport of designated contaminated marine mud shall be by split barge of not less than 750 m^3 capacity; well maintained and capable of rapid opening and discharge at the disposal site;

(c) discharge from split barges shall take place within a radius of 100 metres of the centre of the area allocated for the disposal of designated contaminated marine mud; and

(d) discharge shall be undertaken rapidly and the hoppers shall then immediately be closed; any material adhering to the sides of the hopper shall not be washed out of the hopper and the hopper shall remain closed until the barge next returns to the disposal site.

34.12 AUDIT MEASUREMENTS

At the completion of all dredging and filling works, the Contractor shall continue the monitoring of water quality for a period of six consecutive weeks. At the end of this period the Contractor shall provide a summary report to the Engineer in the agreed format.

34.13 PROTECTION OF WATER QUALITY AT WATER INTAKES

When dredging or placing fill the Contractor shall surround the water intakes indicated on the Drawings with suitable silt curtain systems to prevent excess silt contaminating the water drawn into the intakes. The silt curtain system shall be designed to ensure that the indrawn water shall contain less than 140 mg/L of suspended solids.

34.14 SILT CURTAINS

The Contractor will be responsible for designing, agreeing with the Engineer, and installing silt curtains, where required, to achieve the Water Quality Objective and the protection of water quality at water intakes as described in PS Clause 34.13.

Silt curtains shall be formed from tough, abrasion resistant, permeable membranes, suitable for the purpose, supported on floating booms in such a way as to ensure that the ingress of turbid waters to the enclosed waters shall be restricted.

The bottom of the curtain shall be formed and installed in such a way that tidal rise and fall are accommodated, and that the ingress of turbid waters is limited. The removal and reinstallation of such curtains during typhoon conditions shall be as agreed with the Director of Marine.

The Contractor shall regularly inspect the silt curtains and shall ensure that they are adequately moored and marked to avoid danger to marine traffic.

CONSTRUCTION NOISE MONITORING

In order to demonstrate compliance with the Specification clauses limiting the disturbance to the general public caused by construction noise the Contractor shall carry out, to the satisfaction of the Engineer, the following construction noise monitoring procedures:-

a) all measurements shall be carried out by suitably experienced staff, who have been approved by the Engineer.

b) sound level readings shall be recorded on forms provided by the Contractor, and approved by the Engineer.

c) a schedule of proposed sound measurement times and locations shall be produced by the Contractor on a monthly basis and submitted to the Engineer for his approval at least two weeks before the commencement of the scheduled period. The measurement times shall be at least once per week and chosen to fairly represent normal construction activities. The Engineer may direct amendments to the schedule at short notice. If the Contractor obtains a permit for working during restricted hours then additional noise monitoring shall be required.

d) the measurements taken are for the information of the Engineer, Employer and the Contractor and shall not form a basis for prosecution under the Noise Control Ordinance.

e) Construction noise monitoring shall be carried out using approved equipment, which shall be tested at regular intervals in a manner and in a laboratory approved by the Engineer.

f) the sound level meters used shall comply with the International Electrotechnical Commission Publications 651: 1979 (type 1) and 804 : 1985 (type 1), specification, as referred to in the Technical Memorandum to the Noise Control Ordinance.

g) the construction noise level monitoring shall be carried out at 1 meter from the external facade of the following locations, and the Contractor shall be responsible for arranging access. Alternative locations may be agreed or directed by the Engineer if difficulties arise in obtaining access, or if the locations become unsuitable.

- i) Block 66, Mei Foo Sun Chuen at roof level.
- ii) Block 23, Fat Tseung Street THA at second floor level, outside Room 13.
- iii) Cheong Chung House, Nam Cheong Estate at 16th floor roof level.
- iv) Tai Ying House, 48 Wong Tai Street, at 13th floor roof level.
- v) 60-62 Cherry Street , 4th Floor roof level.
- vi) Shun King Building, 317 Ferry Street, at 27th floor roof level.

vii) Man Cheong House, Man Cheong Street at 19th floor roof level.

h) the location and direction of the noise monitoring is to be agreed with the Engineer on site and recorded for use in all subsequent monitoring.

i) Construction noise levels shall be recorded as the average of three consecutive Leq(5 min) measurements, at each of the above locations, to the agreed schedule. Where the Contractor has been granted a permit to work during restricted hours, additional measurements shall be taken during the restricted hours.

j) The Contractor shall prior to the commencement of the construction works carry out baseline monitoring to determine and agree ambient sound levels. The baseline monitoring shall be carried out for a period of at least two weeks, with measurements to be taken every day at each location and to a schedule agreed with the Engineer. From the baseline measurements an agreed ambient noise level, (Leq(5 min)), shall be calculated. Where the Contractor intends to apply for a permit for working during restricted hours he shall carry out further baseline monitoring to determine and agree ambient noise levels during such hours.

k) Checking of ambient noise levels shall be carried out by the Contractor on at least four occasions during the year, at not less than one monthly intervals, for each location. The checking shall be carried out when construction activities are not taking place.

EVALUATION, REPORTING AND ACTION ON CONSTRUCTION NOISE LEVELS

a) The Contractor shall submit to the Engineer, no later than the 10th day of the month following the monthly reporting period, three copies of a report giving the dates and times of each series of measurements. The actual measurements of each recording, together with comments on any discarded measurements shall also be provided. For each location and series of measurements the Contractor shall calculate a construction noise level, and shall compare this level with the agreed comparable ambient noise level. Where the Contractor is required to undertake further action as described in sub-clause b), the monthly report shall include the need for such action, the action carried out and the results of such action.

b) Where the agreed comparable ambient noise level, is less than 70 dB(A), and any of the construction noise levels are more than 75 dB(A) or if the agreed comparable ambient noise level is greater than 70 dB(A) and any of the construction noise levels are more than 5 dB(A) above the agreed comparable ambient noise levels then the Contractor shall:-

i) review all construction noise sources contributing to the recorded construction noise levels, and instigate any changes to scheduling of activities, installation of plant soundproofing, provision of alternative plant, erection of sound barriers around part of the site or the location of construction noise sources, or any other measures as may be required to reduce the noise level to an acceptable level.

ii) as part of the monthly report referred to sub-clause (a), submit a report of the review and action taken, together with further measurement of construction noise levels at the locations concerned.

DUST (TSP) LEVELS ARISING FROM THE WORKS

In order to demonstrate compliance with the Specification clauses limiting the disturbance to the general public caused by construction dust, (measured as total suspended particulates and herein referred to as "dust (TSP)"), the Contractor shall carry out, to the satisfaction of the Engineer, the following construction dust (TSP) monitoring procedures:-

a) all measurements shall be carried out by suitably experienced staff, who have been approved by the Engineer.

b) dust (TSP) level readings shall be recorded on forms provided by the Contractor, and approved by the Engineer.

c) a schedule of proposed dust (TSP) measurement times and locations shall be produced by the Contractor on a monthly basis and submitted to the Engineer for his approval at least two weeks before the commencement of the scheduled period. The measurement times shall be at least once per week and chosen to fairly represent normal construction activities. The Engineer may direct amendments to the schedule at short notice.

d) the measurements taken are for the information of the Engineer, Employer and the Contractor and shall be used to evaluate the Contractors performance in undertaking the requirements for controlling construction dust (TSP) levels.

e) Construction dust (TSP) monitoring shall be carried out using approved equipment, which shall be tested at regular intervals in a manner and in a laboratory approved by the Engineer.

f) the dust (TSP) levels shall be measured by the "High Volume Method for total suspended particulates " as described by the United States Environmental Protection Agency in 40 LFR Part 50.

g) the construction dust (TSP) level monitoring shall be carried out at the following locations, and the Contractor shall be responsible for arranging any access. Alternative locations may be agreed or directed by the Engineer if difficulties arise in obtaining access, or if the locations become unsuitable.

i) Adjacent to the waterfront at Mei Foo Sun Chuen at grid reference - 832400E, 821800N.

ii) Fat Tseung Street THA at grid reference - 833800E, 821300N.

iii) Nam Cheong Estate at grid reference - 834400E, 820700N.

iv) Adjacent to the waterfront at Man Cheong Street at grid reference - 835100E, 818800N

h) Monitoring shall consist of:-

i) the collection of one hour samples during the working day, once a week at each location.

ii) the collection of 24 hour samples, once a month

i) The location and direction of the dust (TSP) monitoring is to be agreed with the Engineer on site and recorded for future compliance. The agreed locations shall not be located at the site of major roads and shall be free from local obstructions or sheltering.

j) The Contractor shall prior to the commencement of the construction works carry out baseline monitoring to determine and agree ambient dust (TSP) levels. The baseline monitoring shall be carried out for a period of at least two weeks, with measurements to be taken every day at each location and to a schedule agreed with the Engineer. From the baseline measurements an agreed ambient dust (TSP) level shall be calculated.

k) Checking of ambient dust (TSP) levels shall be carried out by the Contractor on at least four occasions during the year, at not less than one monthly intervals, at each location. The checking shall be carried out when construction activities are not taking place.

EVALUATION, REPORTING AND ACTION ON CONSTRUCTION DUST (TSP) LEVELS

a) The Contractor shall submit to the Engineer, no later than the 10th day of the month following the monthly reporting period, three copies of a report giving the dates and times of each series of measurements. The actual measurements of each recording, together with comments on any discarded measurements shall also be provided. For each location and series of measurements the Contractor shall compare the construction dust (measured as total particulates and herein referred to as "dust (TSP)") level with the guideline dust (TSP) levels given in PS Clause 1.38 (h)(viii) and PS Clause 1.38(i)(ii) as applicable. Where the Contractor is required to undertake further action as described in sub-clause b), the monthly report shall include the need for such action, the action carried out and the results of such action.

b) Where the recorded dust (TSP) level is greater than the required levels as given in PS Clause 1.38 (h)(viii) and PS Clause 1.38(i)(ii) as applicable the Contractor shall:-

i) review all construction dust (TSP) sources contributing to the recorded construction dust (TSP) levels, and instigate any changes to working procedures or introduce any other measures as may be required to reduce the dust (TSP) level to the required level.

ii) as part of the monthly report referred in sub-clause a), submit a report of the review and action taken, together with further measurement of construction dust (TSP) levels at the locations concerned.

THE FOLLOWING REVISION IS PROPOSED TO BE ISSUED AS A TENDER AMENDMENT BUT HAS NOT YET BEEN APPROVED FOR ISSUE.

Note amendment is underlined.

1.38 AVOIDANCE OF NUISANCE - part

(viii) The Contractor shall follow instructions from the Engineer to implement any measure to further enchance dust suppression measures on the Site. To assist the Engineer in making a decision as to whether further dust suppression measures need to be taken the Contractor shall carry out such measurement as may be directed by the Engineer. As a guide, the Engineer will not order any further dust suppression methods unless the level of environmental dust, (measured as total suspended particulates), judged as originating from the Site exceeds 0.5 milligrams per cubic meter, at standard temperature (25° C) and pressure (1.0 bar) averaged over one hour, and 0.15 milligrams per cubic metre, at standard temperature (25° C) and pressure (1.0 bar) averaged over 24 hours.

(ix) The Contractor shall restrict all motorized vehicles on the Site to a maximum speed of 15 km per hour and confine haulage and delivery vehicles to designated roadways inside the Site. For lengths of roadway longer than 100 m where vehicle movements exceed 100 movements/day, flexible pavement surfacing shall be provided.

(i) If the Engineer approves a concrete batching plant being operated on the Site the following conditions shall be complied with to the satisfaction of the Director of Environmental Protection:

(i) The location, design and operation of any concrete batching plant, access roads, and material storage shall be to the satisfaction of the Engineer. The Contractor shall undertake at all times to prevent dust nuisance as a result of his activities. Any air pollution control system installed shall be operated whenever the plant is in operation.

(ii) The Contractor shall at his own cost and to the satisfaction of the Director of Environmental Protection install effective dust suppression equipment and take such other measures as may be necessary to ensure that at the Site boundary and any nearby sensistive receiver the concentration of environmental dust (measured as total suspended particulates) shall not exceed 0.5 milligrams per cubic meter, at standard temperanire (25° C) and pressure (1.0 bar) averaged over one hour, and 0.26 milligrams per cubic metre, at standard temperature (25° C) and pressure (1.0 bar) averaged over 24 hours.

Annex F
Contract Conditions

The following Mitigation clauses have been designed to ensure the minimisation of noise air and water pollution during the WKR works

CLEANLINESS OF SITE

(a) The Site shall be maintained in a clean and tidy condition. Materials, including materials required for temporary works, shall be stored in an orderly manner. Rubbish and debris shall be disposed of at least once a week.

(b) The Contractor shall be responsible for ensuring that no earth, debris, or rock is deposited on public or private rights of way as a result of the Works, including any deposits arising from the movement of plant and vehicles.

(c) The Contractor shall clean all vehicles and plant before they leave the Site to ensure that no earth, mud, debris and the like is deposited by them on roads, public highways or thoroughfares.

(d) The Contractor is required to comply with the Public Cleansing and Prevention of Nuisances By-Law 1972 and/or the Public Cleansing and Prevention of Nuisance (New Territories) Regulation 1972, as appropriate.

NOISE CONTROL ON WORKS SITE

(a) The Contractor's attention is drawn to the requirements of the Noise Control Ordinance, and the restrictions placed on noise from construction work under that Ordinance. The Contractor is reminded of the requirements to seek Construction Noise Permits when required. Before commencing works requiring such permits the Contractor shall obtain such permits and provide a copy of the application and permit to the Engineer for his information, together with two copies of relevant technical memoranda and literature published by the Environmental Protection Department.

(b) Nothing in this clause shall absolve the Contractor from his responsibility to comply with the provisions of the Noise Control Ordinance or of any Regulations made under that Ordinance.

AVOIDANCE OF NUISANCE

(a) All works and movement of plant shall be carried out in such a manner as to cause as little inconvenience and disturbance as possible to nearby residents and the general public. The Contractor shall not enter or disturb any private land, graveyard, building, structure, urns or agricultural land outside the boundary of the Site whether Crown Land or otherwise, without the prior consent of the Engineer and the land holder.

(b) The Contractor shall at all times ensure that all public and private areas, roads, footpaths and access roads used by him and all existing stream courses and drains within, and adjacent to, the Site are kept safe and free from any debris and excavated materials arising from the Works. The Contractor shall provide a washpit or other approved means at the exits from the Site whence excavated material is hauled and he shall cleanse all vehicles leaving the Site so as to prevent them from fouling the approach roads. The washpit and cleaning methods shall be to the satisfaction of the Engineer. The Contractor shall employ sufficient labour to maintain all such roads, footways, access roads, streams or drains etc. in a clean condition.

(c) The Contractor shall make provision for the discharge or disposal from the Works and Temporary Works of all water and waste products howsoever arising and the methods of disposal shall be to the satisfaction of the Engineer and of any Authority or person having an interest in any land or water over or in which water and waste products may be so discharged.

(d) The Contractor shall construct, maintain, remove and reinstate as necessary temporary drainage works and take all other precautions necessary for the avoidance of damage by flooding and silt washed down from his works. He shall also provide adequate precautions to ensure that no spoil or debris of any kind is allowed to be pushed, washed down, fall or be deposited on land or seabed adjacent to the Site.

(e) In the event of any spoil or debris from the construction works being deposited on adjacent land or seabed or any silt washed down to any area, then all such spoil, debris or material and silt shall be removed and the affected land or seabed and areas restored to their natural state by the Contractor at the earliest opportunity.

(f) The Contractor shall not install any furnace, boiler or other plant or equipment which use any fuel that may produce air pollutants without the prior written consent of the Director of Environmental Protection.

(g) The Contractor shall not light bonfires on Site for the burning of debris or other materials.

(h) The Contractor shall implement dust suppression measures which shall include, but not be limited to the following:

(i) The location of dust producing plant or facilities, either fixed or temporary, shall be subject to the agreement of the Engineer

(ii) Stockpiles of sand and aggregate greater than 20 m^3, the locations of which shall be subject to the approval of the Engineer, shall be enclosed on three sides, with walls extending above the pile and 2 metres beyond the front of the pile. In addition, effective water spray shall be provided and used both to dampen stored materials and during reception of raw materials.

(iii) Areas within the Site where there is a regular movement of vehicles shall be hard surfaced and be kept clear of surface material.

(iv) Conveyor belts shall be fitted with windboards, and conveyor transfer points and hopper discharge areas shall be enclosed to minimize emission of dust. All conveyors carrying dry cement shall be totally enclosed through all stages of the process.

(v) Cement silos shall be fitted with a high level alarm indicator and all air vents on cement silos shall be fitted with a shaken type fabric filter.

(vi) Weigh hoppers shall be vented to a suitable fabric filter or to a cement silo.

(vii) The provision of adequate plant including water bowsers with spray bars.

(viii) Areas of reclamation shall be completed, including final compaction, as quickly as possible to minimise wind blown dust.

(ix) The Contractor shall follow instructions from the Engineer to implement any measure to further enchance dust suppression measures on the Site. To assist the Engineer in making a decision as to whether further dust suppression measures need to be taken the Contractor shall carry out such measurement as may be directed by the Engineer. As a guide, the Engineer will not order any further dust suppression methods unless the level of environmental dust judged as originating from the Site exceeds 0.5 mg/m^3 over one hour or 0.15 mg/m^3 over 24 hours.

(x) The Contractor shall restrict all motorized vehicles on the Site to a maximum speed of 15 km per hour and confine haulage and delivery vehicles to designated roadways inside the Site. For lengths of roadway longer than 100 m where vehicle movements exceed 100 movements/day, flexible pavement surfacing shall be provided.

(i) If the Engineer approves a concrete batching plant being operated on the Site the following conditions shall be complied with to the satisfaction of the Director of Environmental Protection:

(i) The location, design and operation of any concrete batching plant, access roads, and material storage shall be to the satisfaction of the Engineer. The Contractor shall undertake at all times to prevent dust nuisance as a result of his activities. Any air pollution control system installed shall be operated whenever the plant is in operation.

(ii) The Contractor shall at his own cost and to the satisfaction of the Director of Environmental Protection install effective dust suppression equipment and take such other measures as may be necessary to ensure that at the Site boundary and any nearby sensistive receiver the concentration of total suspended particulates shall not exceed 0.5 milligrams per cubic meter, at standard temperature (25° C) and pressure (1.0 bar) averaged over one hour, and 0.26 milligrams per cubic metre, at standard temperature (25° C) and pressure (1.0 bar) averaged over 24 hours.

(iii) In the process of material handling, any material which has the pontential to create dust shall be treated with water or wetting agent sprays.

(iv) Where dusty materials are being discharged to vehicles from a conveying system at a fixed transfer point, a three-sided roofed enclosure with a flexible curtain across the entry shall be provided. Exhaust fans shall be provided for this enclosure and vented to a fabric filter system.

(v) Any vehicle with an open load carrying area used for moving potentially dust producing materials shall have properly fitting side and tail boards. Materials having the potential to create dust shall not be loaded to a level higher than the side and tail boards, and shall be covered by a clean tarpaulin in good condition. The tarpaulin shall be properly secured and shall extend at least 300 mm over the edges of the side and tail boards.

(vi) The Contractor shall frequently clean and water the concrete batching plant site and ancillary areas to minimize any fugitive dust emissions.

(vii) Wheel washing facilities shall be installed near the site entrance and used by all vehicles leaving the site. No earth, mud, debris, dust and the like shall be deposited on public roads. Water in the wheel washing facilities shall be changed at frequent intervals and sediments shall be removed regularly. The allocate shall also provide a hard-surfaced road between the wheel washing facilities and any public or finished road.

(viii) Conveyor belts shall be fitted with windboards, and conveyor transfer points and hopper discharge areas shall be enclosed to minimize dust emission. All conveyors carrying materials which have the potential to create dust shall be totally enclosed and fitted with belt cleaners.

(ix) Cement or pulverised fuel ash delivered in bulk shall be stored in closed silos fitted with a high level alarm indicator. The high level alarm indicators shall be interlocked with the filling line such that in the event of the hopper approaching an overfull condition, an audible alarm will operate, and after 1 minute the pneumatic line to the filling tanker will close.

(x) All air vents on cement silos shall be fitted with fabric filters provided with either shaking or pulse-air cleaning mechanisms. The fabric filter area shall be determined using an air to cloth ratio of 0.01 - 0.03 m/s or the filtering velocity.

(xi) Weigh hoppers shall be vented to a suitable filter.

(xii) The filter bags in the cement silo dust collector must be throughly shaken after cement is blown into the silo to ensure adequate dust collection for subsequent loading.

(xiii) For dry mix batching, the process should be carried out in a totally enclosed area with exhaust to fabric filters.

(xiv) All cement and concrete trucks are to be effectively washed down after loading and prior to leaving the works.

(xv) All the concrete batching batching activities shall be restricted to an area agreed with the Engineer.

(xvi) The Contractor shall provide and operate two high volume air samplers and associated equipment and shelters in accordance with the USA standard Title 40, Code of Federal Regulations, Chapter 1 (Part 50) Appendix B. The samplers, equipments and shelters shall be constructed so as to be transferable between sampling-points. The Contractor shall provide all necessary protective fencing and the like at sampling points. Testing and analysis of sampled materials shall be carried by a laboratory approved by the Director of Environmental Protection.

(j) The West Kowloon road network is already heavily trafficked and the Contractor shall not be permitted to make bulk deliveries of materials, particularly those of a dusty nature, to the Site by road unless expressly approved by the Engineer's Representative.

NORMAL WORKING HOURS

(a) Normal working hours, unless otherwise approved by the Engineer, shall be the period between 7 a.m. and 7 p.m. of the same day except for General Holidays (including Sunday). Such approval by the Engineer will not relieve the Contractor of any of his obligations to seek other approvals.

(b) The Contractor shall inform the Engineer's Representative in advance when he wishes to carry out works outside normal working hours. Approval by the Engineer under such circumstances may be limited to specific operations and/or areas.

(c) Work outside there hours shall not be carried out without the written approval of the Engineer's Representative which approval shall not be unreasonably withheld. Provided that no such approval will be required where the work is unavoidable or absolutely necessary for:

(i) preventing injury to any person or saving the life of any person; or

(ii) preventing damage to property where the immediate carrying out of such work is necessary in order to prevent damage to that property.

in which case the Contractor shall immediately advise the Engineer's Representative.

(d) The Contractor's attention is drawn to the requirements of the Noise Control Ordinance and the restrictions imposed during the 'restricted hours'. It is the Contractor's responsibility to apply for a Construction Noise Permit as required and to comply with any conditions imposed.

MONITORING WATER QUALITY

(a) All marine operations, in particular dredging and filling activities, shall be monitored and regulated in accordance with the requirements of the Contract and, in particular, PS Section 34.

(b) The Contractor shall monitor the effect of his operations on the water quality by the methods outlined in PS Section 34.

REFUSE BOOMS AND FLOATING REFUSE

(a) The Contractor shall comply with the provisions of the Summary Offences Ordinance particularly in respect of marine littering.

(b) The Contractor shall provide and install refuse booms before commencing dumping from barge or direct land dumping of fill material into the sea. The navigation lights on the anchor buoy shall be either fixed red lights or quick flashing yellow lights visible all round the horizon at a distance of at least 2 km approved by the Engineer. The Contractor shall properly maintain and operate the refuse booms to the satisfaction of the Engineer and, as instructed by him throughout the progress of the reclamation work, shall replace the same if necessary when they are under repair. In the event of typhoon conditions or any other circumstances as may in the opinion of the Engineer cause damage to the installed refuse booms, the Engineer may instruct or order the Contractor to temporarily dismantle the refuse booms and re-install the same thereafter. The refuse booms shall, unless otherwise instructed by the Engineer that the booms shall become the property of the Employer, revert to the Contractor upon the completion of all reclamation work or at such earlier date as the Engineer may notify in writing.

(c) The Contractor shall provide sufficient boats and labour for collecting floating refuse and preventing floating refuse within the Site from drifting into adjacent waters. Floating refuse collected shall be removed to tips off Site by the Contractor.

(d) The Contractor shall make due allowance in programming the reclamation work for the provision, installation, operation and maintenance of the refuse booms and the collection of the floating refuse from time to time throughout the progress of the reclamation work.

(e) The Contractor's attention is drawn to Special Condition of Contract clause 33 and the Employer's power to carry out work by persons other than the Contractor if the Contractor shall fail to carry out any work required under this clause.