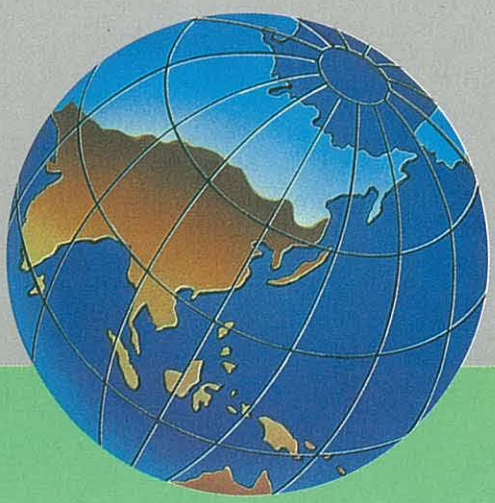
Discovery Bay Development

Master Plan 6.0(A)

Discovery Bay North

Final Environmental Assessment Report

AXIS Environmental



Hong Kong Resort Company Limited

Discovery Bay Development

Master Plan 6.0(A)

Discovery Bay North

Final Environmental Assessment Report

Axis Environmental Consultants Limited

February 1996

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INTRODUCTION

1. Introduction

1.1 Background

1.1.1 The Director of Environmental Protection (EPD) required detailed Environmental Impact Assessment (EIA) studies for the Discovery Bay Master Plan 6.0 proposals (EPD Ref. F(34) in EP2/N9/03). The Terms of Reference for the EIA are presented as Appendix 1.

1.1.2 Following the planning submission of Master Plan 6.0 in December 1994, the development proposals were amended upon the receipt of comments from the project's Study Management Group. The revised development is now known as Master Plan 6.0(A).

1.1.3 The EIA studies for Master Plan 6.0 addressed the Discovery Bay North (residential and related development in Yi Pak and Sam Pak) and Road and Tunnel Link components of the project separately in order to facilitate review of the project by the various Government departments. Initial Assessment Reports (IARs) and Key Issues Reports (KIRs) were produced for both Discovery Bay North and the Road and Tunnel Link (HKR, 1994a; HKR, 1995a; HKR, 1995b; HKR, 1995c). A Final EIA Report for the Road and Tunnel Link (HKR, 1995d) will be submitted to EPD concurrently with this Discovery Bay North Final EIA Report.

1.2 Approach and Objectives

1.2.1 Environmental issues were a key consideration in the development of Master Plan 6.0(A). The requirement for a high quality environment and minimal disruption to the existing community have been primary objectives for the Master Plan. The development proposal has also taken opportunities to contribute positively to sub-regional plans for environmental improvement.

1.2.2 The design progressed through an iterative process whereby potential environmental issues were identified and addressed within the planning and engineering design. Guidelines and standards established in the Hong Kong Planning Standards and Guidelines (HKPSG) were applied throughout the design, and additional requirements for the general environmental quality have been adopted.

1.2.3 This Final EIA Report for the Master Plan 6.0(A) Discovery Bay North proposal is a compilation of the Master Plan 6.0 Discovery Bay North IAR and KIRs which have been endorsed by the project's Study Management Group. The information in these reports has been amended and updated in response to comments from the project's Study Management Group. In addition, the results of the Master Plan 6.0 environmental assessment affected by the changes in the proposed layout have been updated with the results of the supplementary environmental studies for Master Plan 6.0(A).

1.2.4 The objectives of the Final EIA Report are:

- to describe the development proposals including construction and operational requirements which have significant environmental implications:
- to provide a comprehensive assessment of the potential environmental impacts resulting from Master Plan 6.0(A) during construction and operation; and
- to recommend practical and effective mitigation measures for both construction and operational impacts of Discovery Bay North.

1.3 Scope

1.3.1 Key environmental issues associated with the Master Plan 6.0 proposals relate to:

- noise;
- air quality;
- landscape and visual quality;
- ecology;
- water quality;
- sewage;
- waste; and
- Environmental Monitoring and Audit(EM&A).

1.3.2 The study area for the Discovery Bay North assessment covers the area of residential/community/commercial development in Yi Pak and Sam Pak, the reclamation site and the Discovery Bay tunnel portal approach road. The tunnel and Siu Ho Wan section of the link road are considered in the Final EIA Report for the Road and Tunnel Link.

1.4 Report Structure

1.4.1 In addition to this introductory section, the Final EIA Report comprises ten further sections:

Section 2 provides an overview of Master Plan 6.0(A) Discovery Bay North proposal and construction requirements;

Section 3 describes the existing environmental and the planning context of the study area;

Sections 4 to 10 provide the detailed assessments of the noise, air, landscape and visual, ecological, water, sewage and waste issues, respectively; and

Section 11 presents the EM&A requirements for Discovery Bay North.

2.

PROJECT DESCRIPTION

2. Project Description

2.1 Introduction

2.1.1 The present population of the Discovery Bay residential development on Lantau Island is 11,000. The approved Master Plan 5.6 allows for expansion to about 6200 residential units, equating to a total population of 18,000. This assessment addresses the residential and associated developments arising from Master Plan 6.0(A) which provides for an increase in population to 25,000 upon full development of Master Plan 6.0(A).

2.1.2 The residential environment within Discovery Bay is unique in Hong Kong. Private cars are prohibited, background noise levels are low, there are no major permanent sources of air pollution, and the urban landscape and living environment is consistently of high quality. The ongoing construction activity associated with the expansion of the development is the only significant source of noise and air pollution, but is also closely controlled.

2.2 Master Plan 6.0(A)

Overview

2.2.1 Master Plan 6.0(A) involves an extension to the existing Discovery Bay residential development northwards into Yi Pak (Figures 2.1 and 2.2). The total site area is 46.2 ha including 5 ha of reclamation. Yi Pak Hill will be lowered from 75 mPD to 35-40 mPD to provide a series of development platforms and fill material for the reclamation. The general level of the valley floor will be raised from the existing 1-2 mPD to 6.5 mPD.

2.2.2 The Discovery Bay North development will be linked to North Lantau via an access road and tunnel linking to the service road adjacent to the North Lantau Expressway at Siu Ho Wan, with direct access to Tung Chung New Town. Private cars will be prohibited in the existing and new development area. The Road and Tunnel Link will be restricted to residential buses, service vehicles and emergency vehicles in compliance with the approval conditions of the Commissioner for Transport.

Residential Accommodation and Population Growth

2.2.3 Residential accommodation is provided in a total of 2230 units with a gross building area (GBA) of 185,000 m^2. The layout of the Discovery Bay North development is illustrated in Figures 2.3 and 2.4. There will be 12 residential tower blocks (24 storeys), 3 medium rise residential blocks (13 storeys) and 67 low-rise blocks (6 storeys). The number of residential units at Discovery Bay North is detailed in Table 2.1

Table 2.1 Projected Population Growth and Number of Residential Units at Discovery Bay North (1994-2004)

	1994	1997	2000	2004
Units completed under MP 5.7 *	5,515	6,533	-	-
Units completed at Discovery Bay North under MP 6.0(A) *	-	-	1,100	2,230
Total number of units at Discovery Bay *	5,515	6,533	7,633	8,763
Projected total population at Discovery Bay **	15,442 (11,000 ***)	18,292	21,372	24,536

* Master Plan 5.7 was submitted for the Government's approval on 25.4.95. These figures represent accumulative totals with the MP 5.7 development complete by the end of 1997.

** Based on 2.8 persons per unit and 100% occupancy upon completion.

*** Actual current population.

Commercial Facilities

2.2.4 The commercial facilities consist of a 3-storey retail building which wraps around the ferry pier with an open square in between. The commercial building is next to the transport interchange and proposed hotel and has a direct pedestrian link connecting the pier and the public open space with the building platforms above the spur of Yi Pak Hill. The wings of the building extend above the transport interchange to provide access between the pier and the hotel podium.

Transport Facilities

2.2.5 A new ferry pier is proposed at Discovery Bay North to supplement the existing Discovery Bay pier which will continue to operate. The proposed pier will provide two berths initially with the possibility of further extension. During peak periods ferries will operate separately from each pier with a shared service operating during off-peak periods. The ferry terminal will be served by a transport interchange containing a bus terminal. Bus services will serve all blocks within the new development, provide links to the existing ferry terminal, and to Chek Lap Kok Airport and the mainland via the tunnel.

2.2.6 The policy to prohibit private cars will be extended to the Discovery Bay North development. Only buses and service vehicles will be permitted within the development area. Residents will, however, be permitted to use golf carts on designated roads. Open air golf cart parking and a footpath to the transport interchange/commercial centre are provided.

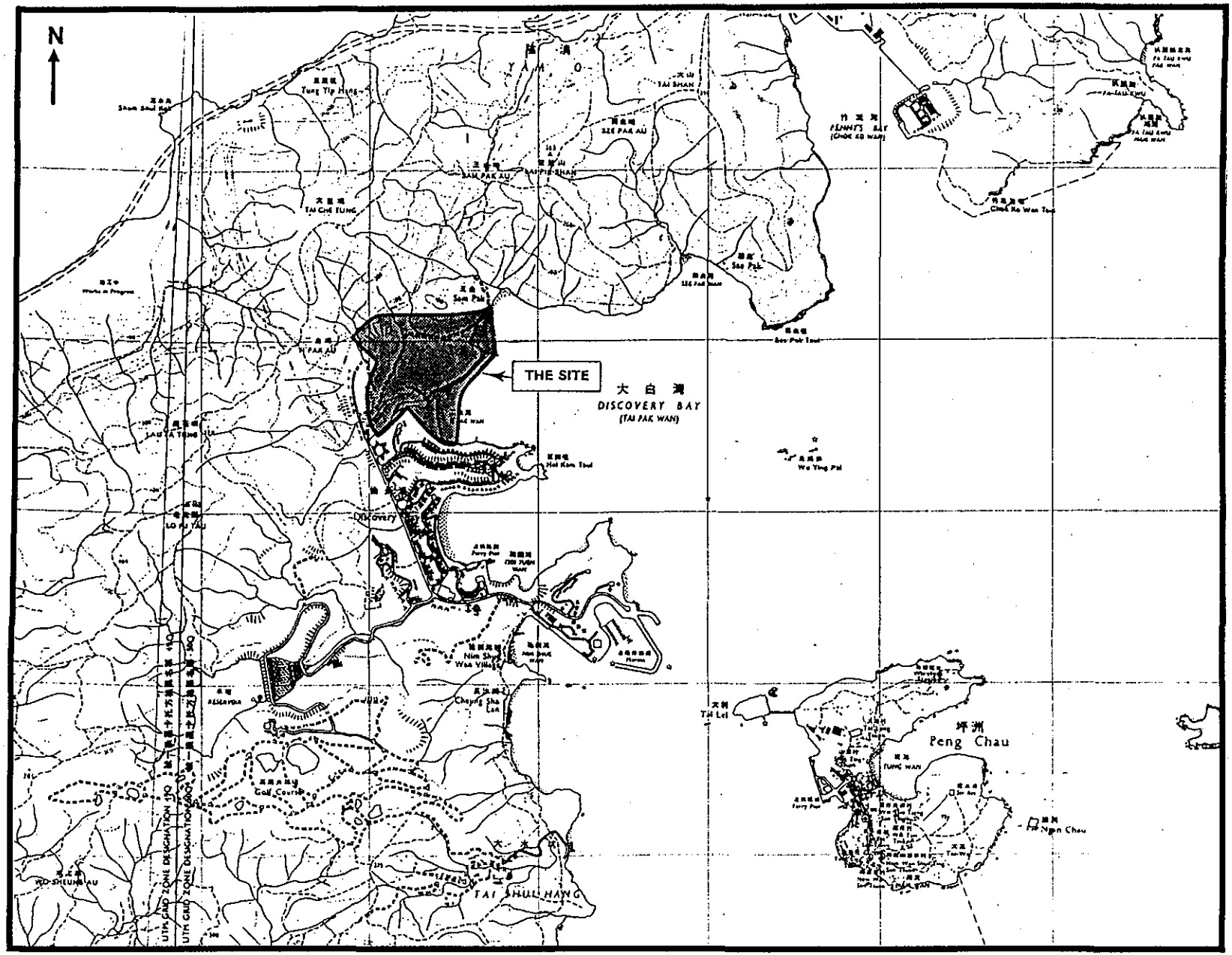


Figure 2.1
Site Location

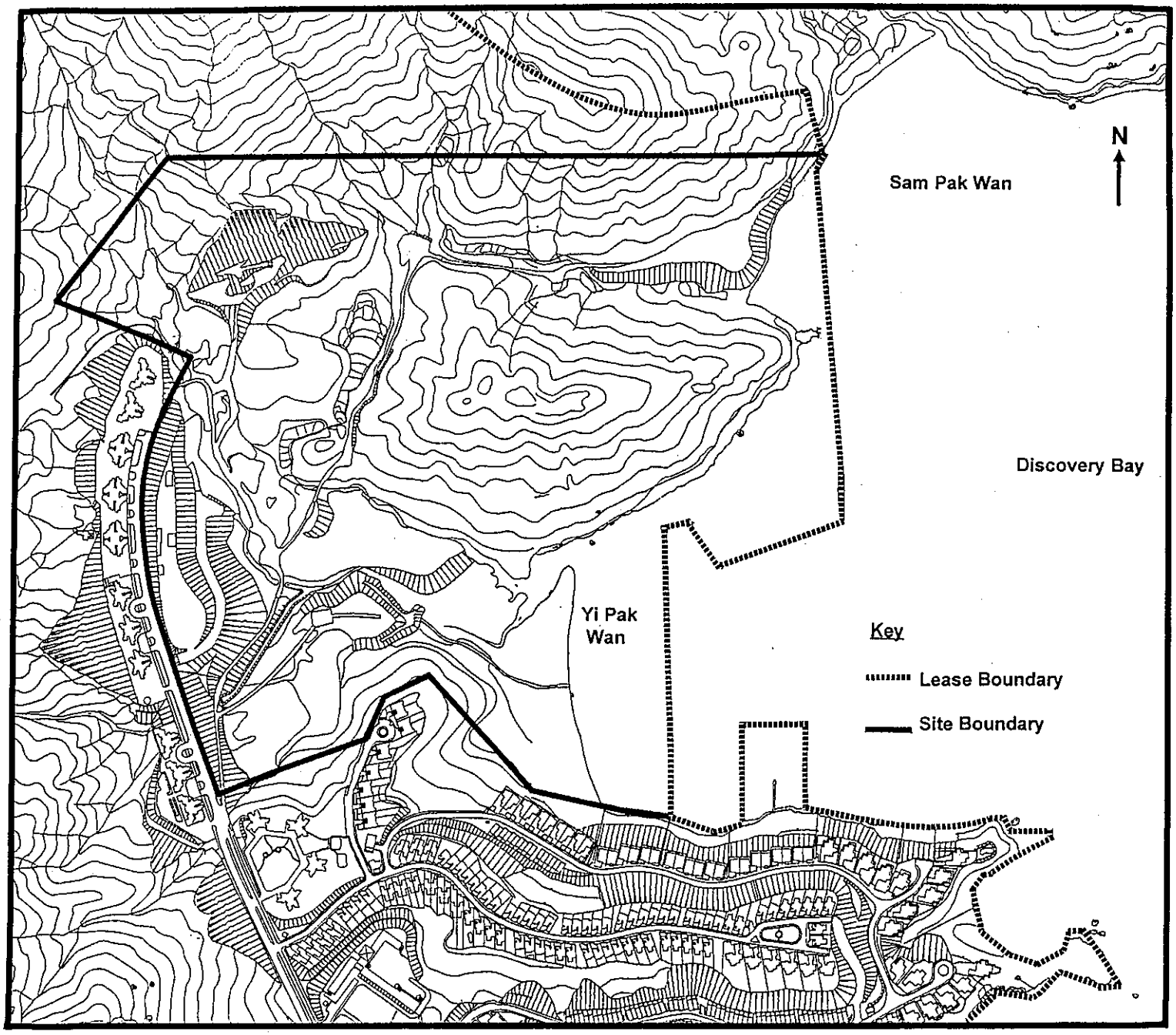


Figure 2.2
Site Location

Figure 2.3
Master Plan 6.0(A) - Discovery Bay North

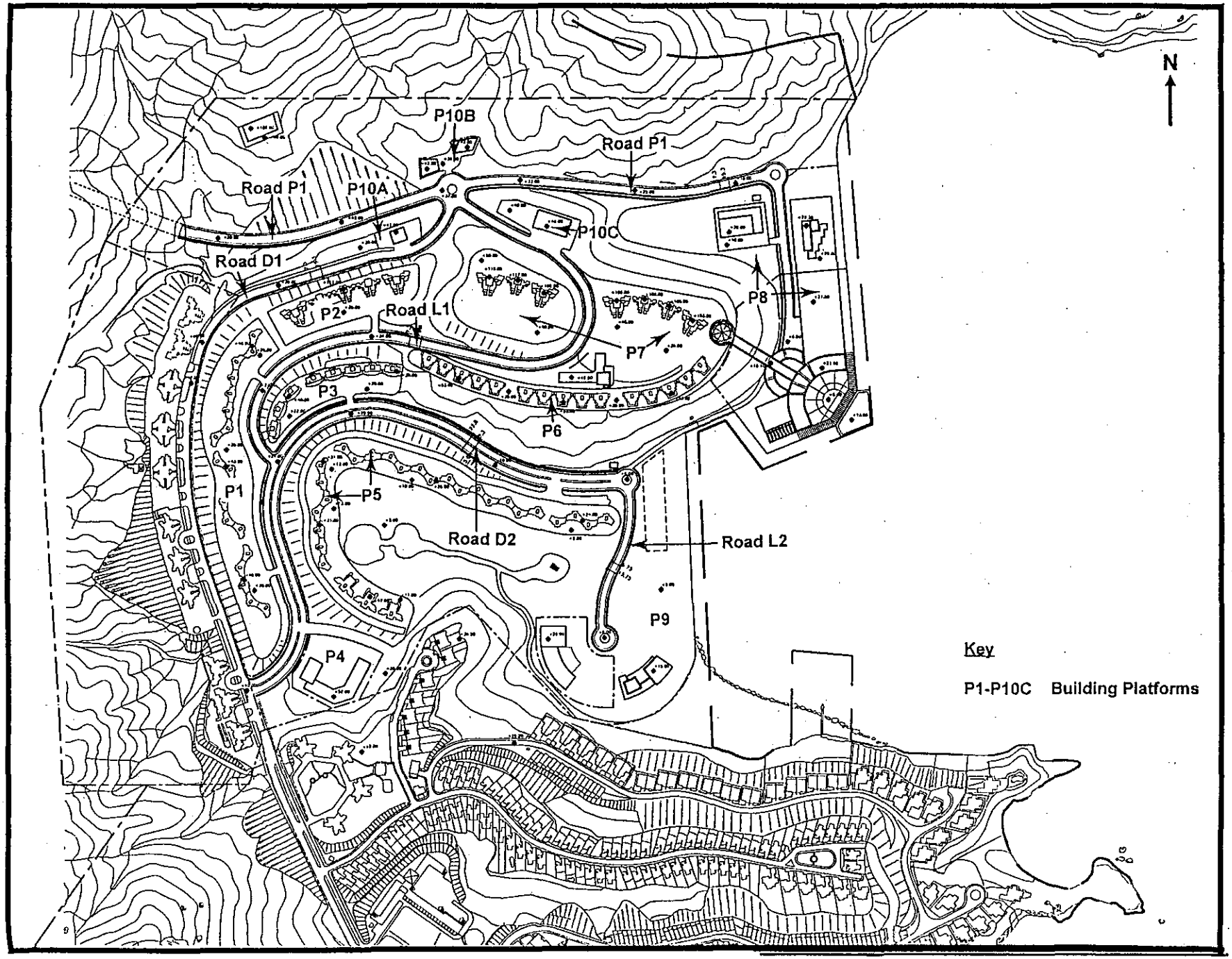


Figure 2.4
Discovery Bay North Road and Platform Layout

2.2.7 The internal road network has been designed to provide for minimum gradients within the relatively steep topography, and to provide for the economic phasing of the development. Bus services have been planned to provide full service to all blocks and to minimise uphill, and therefore more noisy, bus movements. The internal road network is within the lease boundary of the site.

Hotel Development

2.2.8 The proposed hotel has a GBA of 25,000 m^2 and will be a 19-storey building with a 4-storey podium. It is located adjacent to the ferry pier and transport interchange with a proper segregation from the residential areas.

Community Facilities

2.2.9 Master Plan 6.0(A) includes a public primary school and an international school. The proposed Neighbourhood Community Centre is sited in the valley behind the Yi Pak Hill spur, across from the transport interchange and easily accessible for the future residents of Discovery Bay North.

Recreational Facilities

2.2.10 Three Residents' Clubs will be located to service different residential clusters (and phases) of the development. Each club will be approximately 1,000 to 2,000 m^2 in area and will include sports and leisure facilities such as tennis and badminton courts and a swimming pool. A type A Indoor Recreation Centre is also proposed and will share a building footprint with the Neighbourhood Community Centre.

Utilities and Services

2.2.11 The introduction of the tunnel link will create the opportunity for rationalisation of many existing services and utilities on North Lantau, and to a lesser extent, some of the Outlying Islands.

2.2.12 Potable water will be provided from the Siu Ho Wan Water Treatment Works replacing the existing supply derived from the Discovery Bay Reservoir. Flushing water will continue to be sourced from the existing impounded reservoir.

2.2.13 Sewerage connection through the tunnel will permit all sewage loads from Discovery Bay to be treated at the Siu Ho Wan Sewage Treatment Works. This linkage will also permit sewage from Peng Chau to be diverted to Siu Ho Wan. Three local sewage pumping stations with screening facilities will be located within the Master Plan 6.0(A) development area. These will be submersible type pumping stations.

2.2.14 A dangerous goods store (DGS) is located adjacent to the main roundabout near the tunnel access road. LPG will be stored in this facility as installation of gas services in the tunnel is not preferred due to safety reasons. The DGS has been sited as far away from residential areas and the roundabout as possible for safety reasons. However, alternatives to this site may be considered at the detailed development planning stage with regard to residential and traffic safety considerations.

2.2.15 Solid waste will be containerised at a refuse collection point (RCP) adjacent to the main roundabout on the tunnel access road. The waste will then be transported to the planned Refuse Transfer Station at Siu Ho Wan via the tunnel and disposed of as part of the municipal solid waste from Tung Chung. This service will replace the existing marine collection service to Discovery Bay.

2.2.16 Telecommunications services may be diverted from existing micro wave links to landline connections through the tunnel if so desired by Hong Kong Telecom.

Landscaping

2.2.17 The Landscape Master Plan (Figure 2.5) provides for retention of the open valley which is a feature of the current landform and for the development of a range of formal and informal open spaces. From an environmental perspective the main features of the plan include:

- creation of a stream course and fresh water pools and associated riparian vegetation along the southern edge of the development area;
- creation of an extended area of mud flats to the north-east of the site for relocation/planting of mangroves;
- provision of an integrated open space network within the valley floor; and
- extensive woodland creation on slopes within and around the margins of the development area.

Drainage

2.2.18 The streams flowing through Yi Pak will be culverted or diverted to new channels. The major stream will flow through a series of pools and a landscaped channel adjacent to the foot of the ridge separating the new development from the existing residential area. The stream banks will be planted with a range of species currently found on the site. Run-off from buildings, roads and the building platforms will be collected by a separate drainage system, and discharged directly at the sea wall.

Figure 2.5
Discovery Bay North Landscape Master Plan

2.3 Construction Requirements

Construction Works

2.3.1 The major construction works for the development include:

- formation of fourteen building platforms;
- formation of the internal road network;
- filling the Yi Pak valley to +6 mPD;
- construction of the seawall;
- reclamation and earth moving activities; and
- construction of the various residential blocks and other buildings.

Construction Programme

2.3.2 The outline construction programme is shown in Figure 2.6. Construction works for the platforms will commence in January 1996 and is programmed to be completed by the end of 1998. Reclamation will commence by the start of 1997 and will be completed by mid-2001. The preliminary phasing of the development is illustrated in Figure 2.7 and provides for work to begin on the higher platform areas and progress to the reclamation areas. The ferry pier would be constructed during the first and second phases of the development. The construction of the residential and commercial buildings in each phase will take approximately three to four years. The most intense construction works occur during the first year when the majority of borrow activities and earth moving will take place. The details of residential development phasing are included in the 'Responses to Comments and Revised Plans' report for Master Plan 6.0 (HKR, 1995e).

Construction Methods

Platform Formation

2.3.3 Platform formation will require both blasting and excavation. Formation of the main platforms will use fill removed from Yi Pak Hill. The resultant material will be hauled by dump trucks to adjacent fill platforms and spread by bulldozers and shovels before being compacted. The existing formed roads within Discovery Bay North will be used as haul roads. Suitable rock material from the excavation works will be used to form the sea wall.

Reclamation

2.3.4 The reclamation will be to a level of +6.0 mPD. Reclamation activities will be undertaken behind the seawall. Marine mud (150,000 m^3) will be dredged from the site of the seawall but will be left *in situ* in other parts of the reclamation site. The area of the commercial centre may require to be dredged to meet programme objectives. Sampling of the marine muds for physical and chemical analysis has shown that the sediments are

uncontaminated. The dredged marine muds will not be suitable for site formation but can possibly be used for in landscaping works.

2.3.5 Fill material (200,000 m^3) will be imported. The source of the fill material for the reclamation is not defined at present but may be from within Discovery Bay or from alternative land or marine sites. Rock fill for the sea wall (275,000 m^3) will be sourced from within the Master Plan 6.0(A) development site.

Foundation Works

2.3.6 Caissons, large diameter bored piles, small diameter augured piles, H piles and precast concrete piles are all feasible for the foundations of the low rise and high rise buildings and the combination used will be decided at the detailed design stage. Short or auger piles will be used for the foundations of the high and low rise flats in the rock platform areas. Auger or bored piles will be used for the hotel and the commercial centre as well as for the high rise blocks on reclaimed land. The ferry pier is likely to be constructed using H-piles or daido piles.

Plant and Equipment

2.3.7 Assumptions have been made regarding the estimated construction plant required for the development and these are presented in Table 2.2. These assumptions will be revised as the detailed construction programme is refined.

Workforce

2.3.8 Up to 40 workers per shift will be required during platform formation works. Approximately 20 workers per shift will be involved in the reclamation works. 650 workers will be needed on site each year during the construction of the low rise and high rise buildings. Access to the work site is available from the existing Discovery Bay Development and no on-site residential facilities will be required.

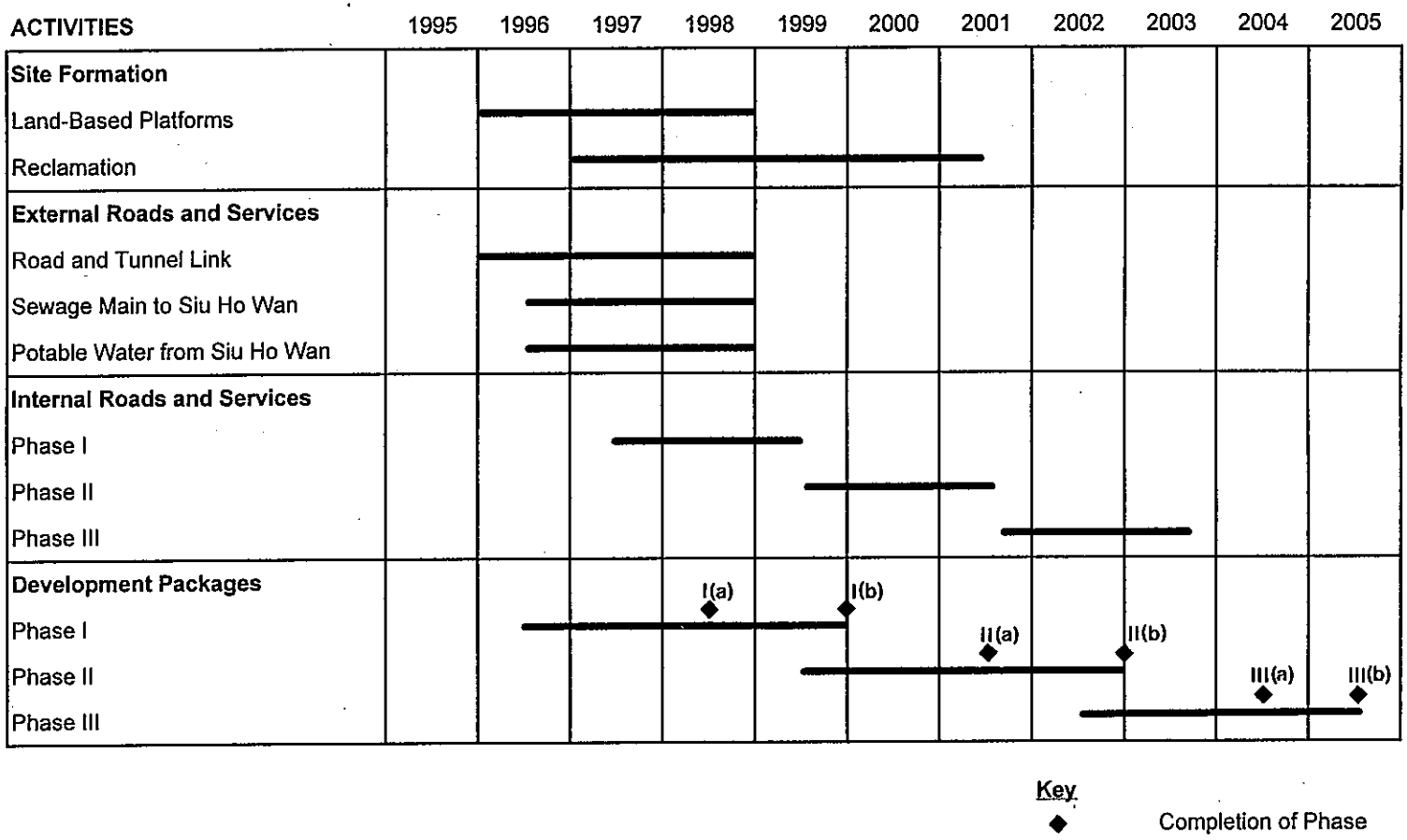


Figure 2.6
Outline Construction Programme

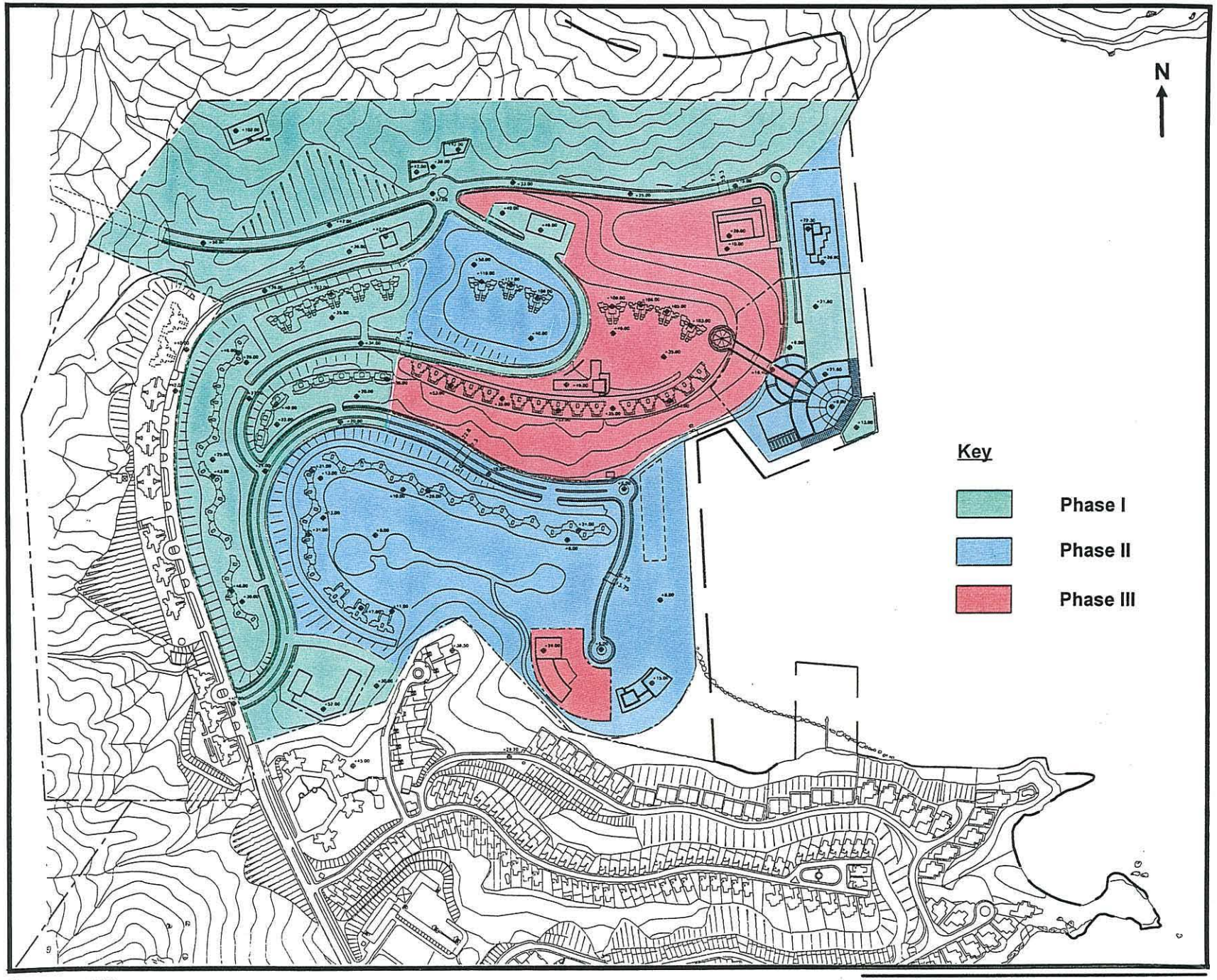


Figure 2.7
Preliminary Development Phasing

Table 2.2 Construction Plant - Discovery Bay North

Plant	Number of Machines	Time of Operation
Platform Formation		
Air compressor	2	08.00 - 18.00
Breaker (excavator mounted)	1	"
Bulldozer	1	"
Crane (mobile)	1	"
Compactor	1	"
Rock drill	4	"
955/755 Loader	2	"
Generator	2	"
Dump truck	5	"
Reclamation		
Dredger (grab/chain bucket)	1	08.00 - 18.00
Derrick barge	1	"
Compactor	1	"
955/755 Loader	1	"
Dump truck	2	"
High Rise and Low Rise Buildings		
Generator	10	08.00 - 18.00
Compressor	10	"
Piling large diameter bored (grab and chisel, reverse circulation drill)	3	"
Piling earth auger	3	"
H-pile/precast concrete (piped piles) drivers	6	"
Water pump	10	"
Winch	20	"
Dump truck	2	"
Electric tower crane	7	"
Mobile crane	2	"

3.

EXISTING ENVIRONMENT

3. Existing Environment

3.1 Introduction

3.1.1 This section outlines the existing environmental conditions in the areas affected by the Discovery Bay North development and includes general descriptions of:

- the study area outlining the existing visual features and environmental conditions;
- existing sensitive receivers (SRs); and
- existing and committed activities or pollution sources which affect the study area.

3.1.2 More detailed descriptions are provided in the relevant technical sections.

3.1.3 The baseline conditions consider the existing environment plus any contribution in terms of pollutant loads (and other implications) from committed projects. The most important of these are the proposed Lantau Port and West Harbour Development (LAPH), and the extensive developments associated with the Chek Lap Kok Airport.

3.1.4 The study area is illustrated in Figure 3.1 and includes Yi Pak Wan, Sam Pak Wan and the coastal lowland and mountains to the west on Lantau Island. The wider study area extends east to Kau Yi Chau, west towards the Brothers and southward to include the existing Discovery Bay development. The core study area includes the coastal foreshore and the small estuarine area that abuts it, the steep foothills that surround Yi Pak Wan and the two dominant coastal promontories that form the natural amphitheatre of the development area.

3.2 General Description

3.2.1 The core study area is characterised by two distinct zones. The first zone covers the foothills to the rear of Yi Pak Wan which has been heavily modified due to the effect of residential development and past construction activity. This area is dominated by a set of tower blocks (Greenvale Village) along Discovery Bay Road. The foothills below the tower blocks have been stabilised with a typical U channel drainage system and grass. Two minor paved access roads cross the area below the slope to access temporary platforms containing a spoil stockpile, horticultural nursery and an abandoned agricultural area.

3.2.2 North of the present development are three large areas of earth works located on the upper slopes of the foothills. These comprise:

- a large terraced platform which lies at the end of the mountain ridge line that runs northwesterly from the floor of the plain;
- a large landscaped area of cut slope just to the north west of this; and

- a large terraced platform of exposed earth directly in front of the present development.

3.2.3 The second distinct zone within the study area is less disturbed. This area has major features that form a natural amphitheatre. The two promontories that enclose Yi Pak Wan, and the prominent knoll that lies to the rear of the bay, combine to form a natural amphitheatre. The floor of the amphitheatre contains the major stream which flows to the Yi Pak Wan Beach.

3.2.4 Works were carried out in March and April 1995 at the fill area to the north of the horticultural nursery area upstream of the estuary at Yi Pak. There was no further encroachment on the estuary and excavator and dump truck activity was confined to dressing the top of the fill.

3.2.5 The southern promontory forms part of the existing Discovery Bay development known as Headland Village and Parkland Drive and consists of low rise residences (2-3 storeys). The existing development area is separated from the proposed development area by the steep and well wooded slopes of the ridge.

3.2.6 The northern promontory is not yet built upon and has an area of established woodland on its lower slopes. The crown and the slopes that face inland are denuded of vegetation due to regular (and recent) wildfire. The knoll that lies opposite, running from north to south, is vegetated with established mature woodland. The knoll faces both ocean and inland directions. The top of the knoll has been developed with low-rise apartments (5-6 storeys) in an area known as Parkridge Village.

3.2.7 The sparsely vegetated steep rounded mountains that surround the potential development site act as a catchment area for 5 natural watercourses which discharge into the sea.

3.2.8 Maximum elevations in the Sam Pak Wan drainage are 264m at Lai Pik Shan and 302m at Tai Che Tung. Gradients from the peaks to the shoreline average 33%. In the Yi Pak Wan drainage, maximum elevations are 302m at Tai Che Tung and 378m at Lau Fa Tung. Gradients to the sea average 29%.

3.2.9 Upland portions of both drainages are composed predominantly of feldsparphyric rhyolite with sand, gravel, cobbles and boulders in a silt matrix in the ravines (Geotechnical Engineering Office, Hong Kong). Streams in the ravines were flowing at the time of the survey (November, 1994) in spite of the relatively long time span since the previous rainfall.

3.2.10 Hill fires burned over much of North Lantau during early November 1994. The proposed development area was not burned, but fires reached the northern edge of the north Sam Pak Wan estuary. The burnt hill slopes remained barren until the onset of the spring 1995 rains. Most low elevation ravines were not burned and therefore remained green through the dry season.

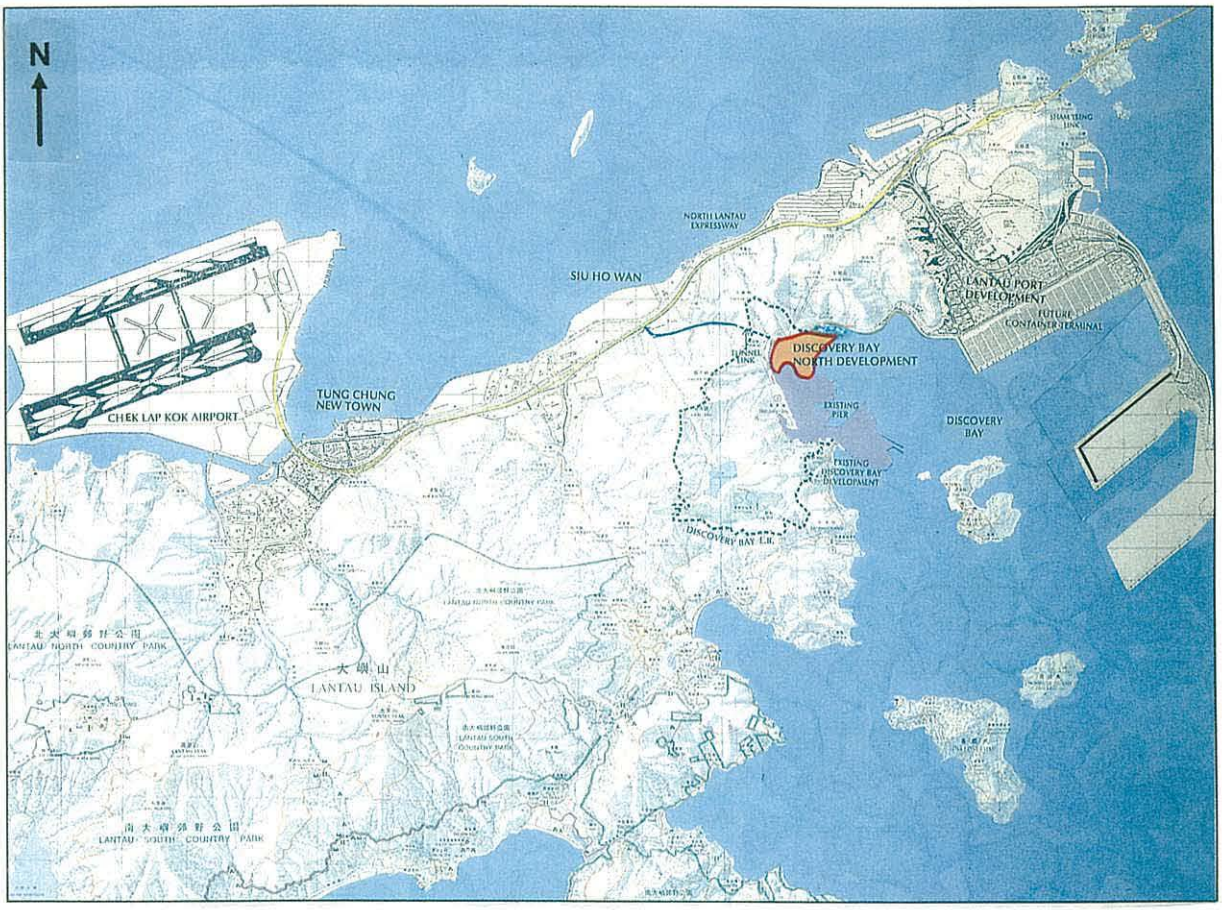


Figure 3.1
Study Area

3.2.11 At the site of the former plant nursery in Sam Pak, the only observed human activity during winter 1994/95 and spring 1995 was infrequent use by hikers. The Sam Pak Wan beach was used by hikers and by shore fishermen. A number of pleasure craft began to use both Yi Pak Wan and Sam Pak Wan during April 1995 for water sports including water skiing, jet skiing and junk trips. Use was confined primarily to weekends and holidays.

3.3 Existing Pollution Sources and Developments

The Port and Airport Development

3.3.1 The general layout of the LAPH Development is presented in Figure 3.1. The first berths of CT10 and CT11 are planned to be operational in mid 1999 and late 1999, respectively. The general programme for later phases is indicated in Table 3.1.

Table 3.1 Lantau Port and Western Harbour Development - Phasing

Construction Phase	Year
I & II	1998/1999 - CT10 1999/2000 - CT11
III	2007 - CT12 *
IV	2011 - CT13 *

* Phases III and IV may be completed earlier than indicated.

3.3.2 The general layout of the Chek Lap Kok Airport and related developments is also shown in Figure 3.1. The approximate completion date for various key works is indicated in Table 3.2. LAPH will have a major effect on Discovery Bay. Later Phases of the port will be clearly visible from Discovery Bay, which will also be potentially affected by minor noise and air pollution effects. The most important effect, however, is likely to be the loss of the sense of isolation and rural setting currently enjoyed by Discovery Bay residents.

Table 3.2 Chek Lap Kok Airport Key Operational Works - Phasing

Description	Year
Airport opening: Phase 1 Southern Runway	1997 (1998)
Phase 2 Western Runway	Post 2010
Siu Ho Wan Sewage Treatment Works	1997
Siu Ho Wan Water Treatment Works	1997

3.4 Noise

3.4.1 The project area is relatively quiet. Noise intrusion is intermittent and is dominated by transport sources which include ferry movements, buses, golf carts and distant aircraft. The background noise level is typical of low density urban conditions and is less than 60 dB(A)L_{90}.

3.4.2 In the future, consideration will need to be given to the noise emanating from the construction and operation of the port. Background noise levels may increase when construction work for the Lantau Port project commences. Noise due to the port project is likely to be noticeable at Discovery Bay and Discovery Bay North once reclamation works extend south-east of the Penny's Bay headland. The future background noise conditions during day and night time are addressed in Section 4.

3.5 Air Quality

3.5.1 The air quality of Discovery Bay compares favourably with urban areas of Hong Kong. The only significant point source near Discovery Bay is the Penny's Bay Power Station, some 3km away. Due to this distance and the comparatively small size of the power station, it will have a minimal impact on Discovery Bay. In addition, the effects of the Chek Lap Kok developments are very well shielded by the central ridge of Lantau Island.

3.5.2 As there is limited vehicle access on Lantau Island and no major air polluting industry, the main impact source of air pollution is the very limited local transport system. However, pollutants are carried by the prevailing winds from major urban areas of Hong Kong and air quality is affected by episodes on the mainland.

3.5.3 The rugged topography of Lantau Island can cause localised air pollution effects. The central ridgeline formed by the mountain range on Lantau forms a barrier to wind, and the steep-sided valleys also influence wind patterns and impede dispersion. Local effects are also caused by land/sea air flows.

3.5.4 Future air quality on Lantau Island may change significantly as a result of airport related developments and the new port facilities and associated industrial developments. Although buffered from these sources of air pollution by distance and the intervening land mass, air quality in Discovery Bay may deteriorate marginally. The most likely effect is a slight deterioration in TSP levels due to the extensive construction works.

3.6 Water Quality

Marine Water Quality

3.6.1 Yi Pak Wan falls within the boundaries of Southern Water Control Zone (SWCZ). Tai Pak beach at Discovery Bay is not gazetted but is regularly used by both residents of Discovery Bay and visitors. A sailing club is based at Tai Pak beach and the beach is used regularly for recreation purposes in particular sailing, windsurfing and swimming. Water quality data is collected as part of the EPD monitoring programme for bathing water quality in Hong Kong. The bathing water quality during 1993 was rated as being 'fair' in the EPD publication *Bacteriological Water Quality of Bathing Beaches in Hong Kong, 1993* (EPD, 1993).

3.6.2 Presently, the marine waters of Discovery Bay come under the influence of wastewater arising from the existing development (population approximately 11,000). Wastewater is discharged via an outfall off the peninsula to the south of Discovery Bay, between Tai Pak and Peng Chau, into the SWCZ.

3.6.3 The wastewaters presently being discharged from the development are screened but are otherwise untreated. With the projected population increase in Discovery Bay, and the impending construction of the Lantau Port and subsequent changes to hydrological conditions resulting from the partial embayment of Discovery Bay, detrimental changes in water quality are anticipated.

3.6.4 The major exchange of water within the Bay will in future be fed from the waters to the south. Work carried out for the LAPH Study predicted that water quality would deteriorate marginally as a result of the port development (APH, 1993). Consequently action has been initiated to improve water quality by improving sewage treatment at Discovery Bay. The first stage of this involves the implementation of a disinfection system and the second stage, export of the sewage to the Siu Ho Wan Sewage Treatment Works (SHWSTW). Following removal of local sewage discharges from Discovery Bay and Peng Chau, water quality in the area will be improved.

Fresh Water Quality

3.6.5 Currently there are five natural watercourses that drain the catchment of the surrounding steep hill slopes.

3.6.6 The study area takes in the lower portions of the streams, which run through a steep hill area before draining to a lowland plain. The streams then drain to Yi Pak Wan through the estuary. One stream is channelled through a medium sized box culvert that runs between the area below the existing settlement to just behind the estuary. The stream flows are generally clean and silt free except in times of exceptional rainfall. The lower sections of the streams are affected by runoff from landscape works that are still at the establishment stage as well as the large spoil stock piles that exist on the valley floor to the rear of the estuary. These inputs create a sediment load that is visible at the mouth of the estuary.

3.6.7 Streams in the ravines leading to both bays had continuous flows through the autumn and winter dry season in 1994. Both Yi Pak and Sam Pak lagoons were open to their bays during the summer season of 1994. However, during late autumn, tidal activity closed both lagoons impounding water behind sandbars at the mouths of the lagoons during periods of low tide. Both lagoons were flooded at high tide.

3.7 Ecology

3.7.1 The area contains ecological resources composed of marine, estuarine and fresh water habitats of importance on a local level. The mangrove communities in the estuarine area at Yi Pak Wan represent the habitat of greatest conservation value in the study area. Some mature upland woodland is also of conservation value.

3.8 Landscape and Visual

3.8.1 The landscape of the study area is characterised by high and low-rise urban development set against the backdrop of the mountains of North Lantau (see Figure 3.1). The development site lies within the influence of the existing Discovery Bay development, in that tower blocks are located immediately to the west of the site. This creates a residential area set against the natural backdrop of bald, steep mountains covered in grassland, characteristic of the landscape of North Lantau. The low-rise areas of the existing development are located on the southern promontory of Yi Pak Wan, and the slope up to this area is covered by established scrub/woodland.

3.8.2 The flat valley landscape is characterised by man-made influences including spoil stock piles, horticultural areas and derelict/abandoned agricultural areas. The area of the valley plain that lies closer to the sea is composed of mangrove and estuarine areas surrounded by scrub/woodland vegetation.

3.8.3 The landscape on Lantau Island is characterised by scenic hills, vegetated valleys and coves harbouring quiet sandy beaches. The mainly undisturbed nature of the area emphasises the effect of development plans on the landscape quality of Lantau Island. Residents of Discovery Bay generally have access, either directly or indirectly, to panoramic views. These views are also enjoyed by recreational users and visitors to the area.

3.8.4 The LAPH and Chek Lap Kok developments will fundamentally alter the character of the island and Discovery Bay.

4.

NOISE

4. Noise

4.1 Introduction

4.1.1 This section assesses noise impacts during the construction and operational phases of the Discovery Bay North development. The noise assessment is based on the planned road layout and landuses defined in Master Plan 6.0(A) and on the outline construction programme described in Section 2.

4.1.2 The potential impact of construction noise during works for Discovery Bay North on noise sensitive receivers (NSRs) in the existing Discovery Bay development is assessed and a construction noise mitigation plan is proposed.

4.1.3 The predicted noise levels in the proposed Discovery Bay North development due to the operation of the Lantau Port Development are also determined and take into account the noise mitigation design of the Discovery Bay North development layout.

4.1.4 The potential impacts of noise from road traffic, the ferry terminal, aircraft/helicopters, the tunnel ventilation system and utility areas are assessed for the operational phase of the project. Noise mitigation measures for protecting residents of the Discovery Bay North development and the existing Discovery Bay development are also presented in this section.

4.2 Existing Noise Environment

4.2.1 The existing Discovery Bay development has a quiet environment. Noise intrusion comes mainly from the passage of golf carts, buses and service vehicles, which are the only means of motorised transport allowed. Based on *in situ* monitoring, the curbside noise levels ($L_{10(1\ hour)}$) range from 53 dB(A) to 64 dB(A) which is some 15 dB(A) below those typically found in Hong Kong's urban areas.

4.2.2 The proposed development is to the north of the existing Discovery Bay development. Ambient noise surveys completed in November 1994 at two locations within the existing development, close to and with unobstructed views of the development area, indicate background noise levels ($L_{90(30\ min)}$) ranged from 43 to 52 dB(A). Figure 4.1 shows the noise monitoring locations at two NSRs. Figures 4.2 and 4.3 give the monitored noise levels over a continuous 24-hour period on typical working days.

4.2.3 The ambient noise levels in the existing Discovery Bay development and the proposed Master Plan 6.0(A) site are expected to increase when construction work for the Lantau Port Peninsula project begins. The effect of the container port noise in particular is discussed in Section 4.6.

4.2.4 Residential buildings on the northern fronts of the existing Discovery Bay development would be the NSRs affected by noise from construction and operation of the Discovery Bay North development. These NSRs would also

be affected by the container port noise. The NSRs include Greenvale Village, Parkridge Village, Parkland Drive, Seabee Lane and Headland Drive.

4.3 Legislation and Guidelines

4.3.1 Statutory control of noise is exercised through the Noise Control Ordinance (NCO) and its subsidiary regulations. Technical Memoranda (TM) are made under the NCO which stipulate the procedures and standards for noise assessment. The NCO control applies to construction noise and industrial noise. The noise planning guidelines are contained in Chapter 4 of the Environmental Guidelines for Planning in Hong Kong. The guidelines provide for planning of road traffic noise, aircraft/helicopter noise, and noise from fixed sources such as electrical substations, water pumping stations and other industrial installations.

Construction Noise

4.3.2 For general construction work involving the use of powered mechanical equipment, the NCO standards are contained in the *Technical Memorandum on Noise from Construction Work other than Percussive Piling.* The noise is controlled in the restricted evening (19.00- 23.00 hours) and night-time (23.00 - 07.00 hours), and on general holidays. The Acceptable Noise Levels (ANLs) at these times depend upon the Area Sensitivity Rating (ASR) of the Noise Sensitive Receiver (NSR). In the areas surrounding the Discovery Bay North Development, the ASR has been assumed to be "A". This ASR applies for low density residential areas unaffected by noise from an industrial area at the time of construction, which is the case assuming the construction of the Discovery Bay North development takes place before the operation of the Container Terminals.

4.3.3 Outside the restricted evening and night-time hours (i.e. between 07.00 and 19.00 hours), general construction work is not subject to the NCO requirements. The HKPSG guideline adopted in this assessment is 60 dB(A). Although this guideline is non-statutory, it has been applied in this assessment as good practice to determine whether the potential noise impact will be greater than 10 dB(A) above the prevailing ambient noise level of 50 dB(A). In practice, the construction noise limit may be increased to 75 dB(A) which is the maximum non-statutory EPD guideline due to the increasing ambient noise level in the study area due in part to noise from construction of CT10 and CT11. Table 4.1 gives the relevant NCO standards and the recommended EPD guideline for noise from general construction work.

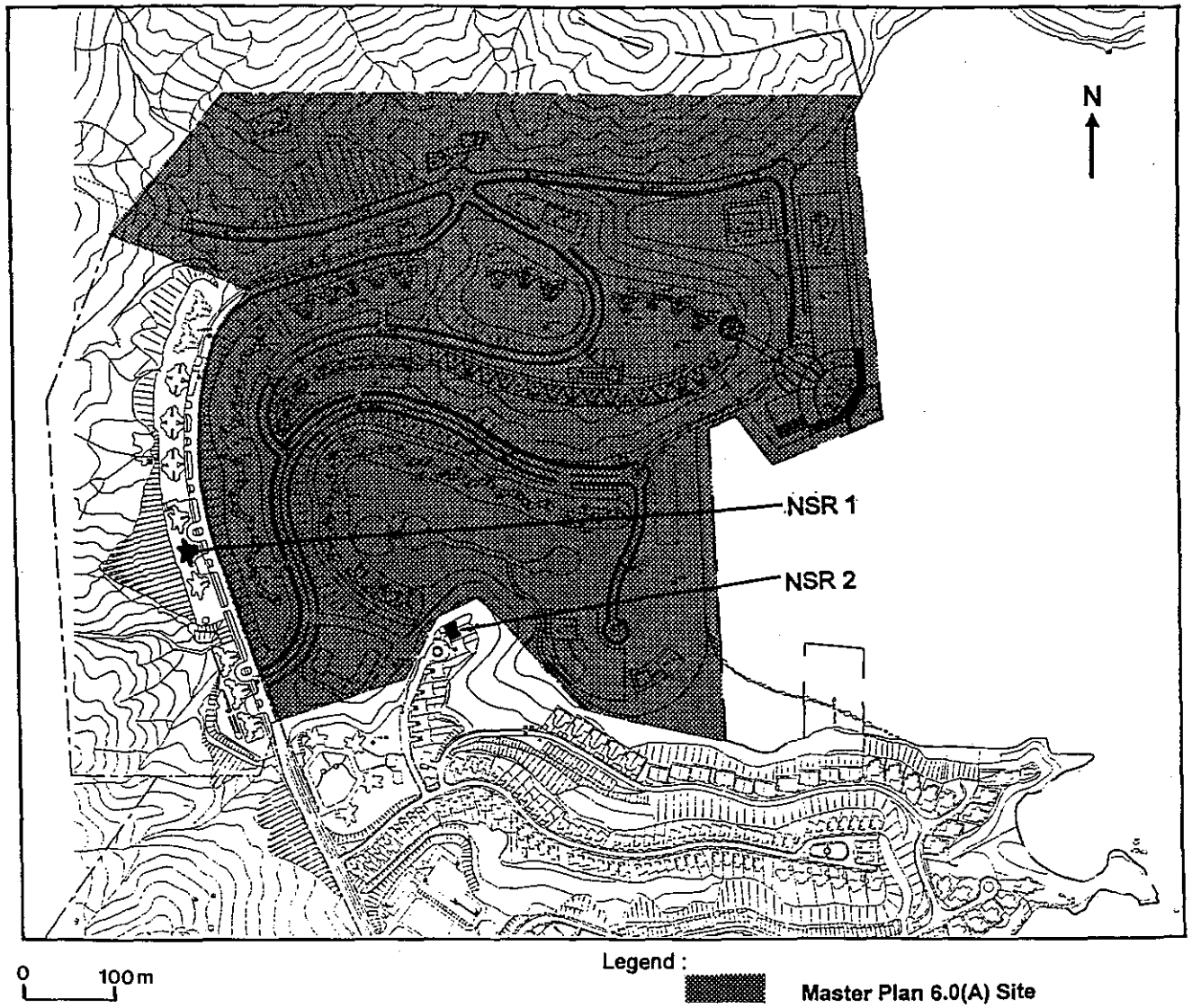


Figure 4.1
Noise Sensitive Receivers

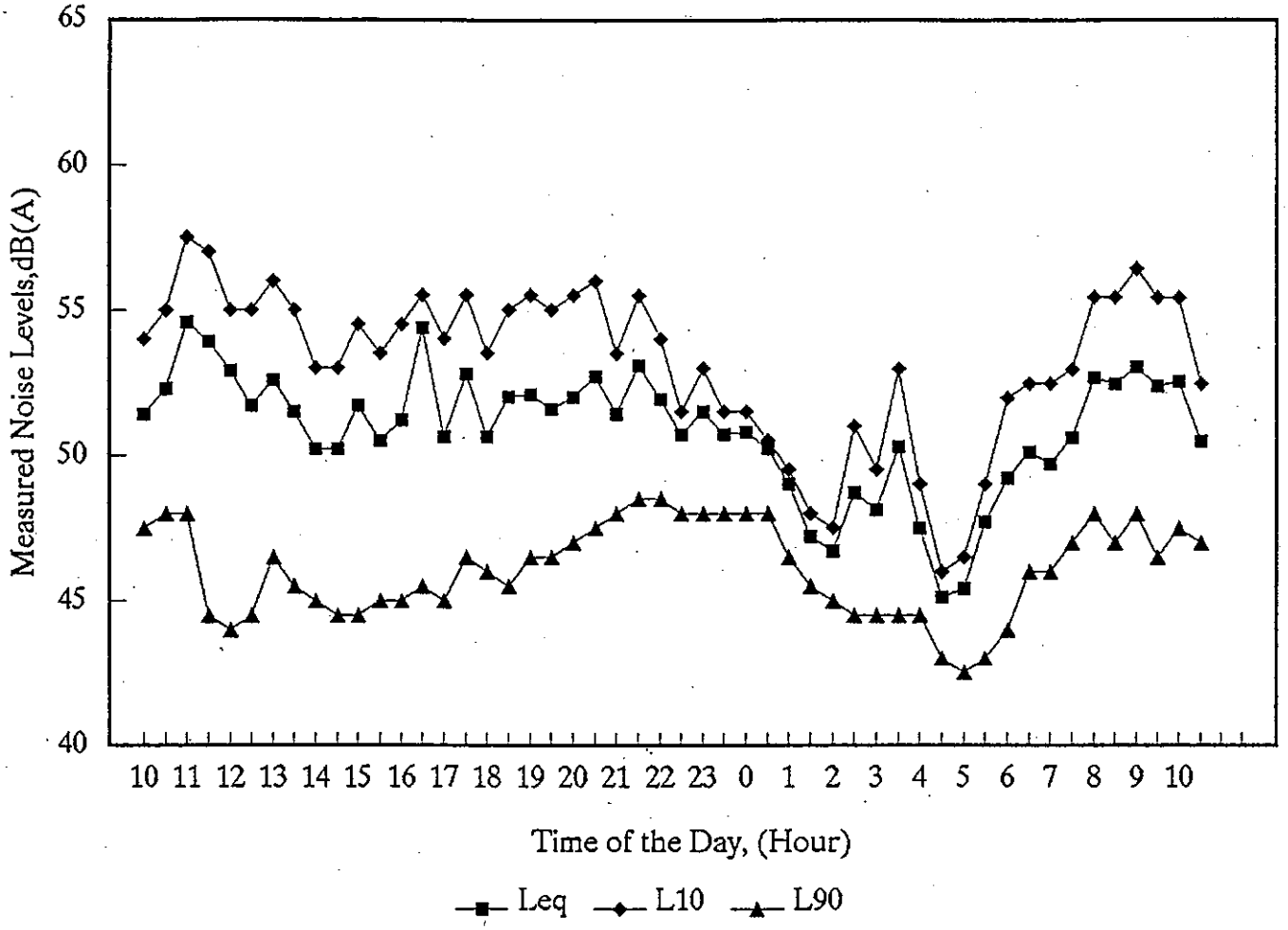


Figure 4.2
Measured Noise Levels on the Roof of Greenland Court (NSR1)

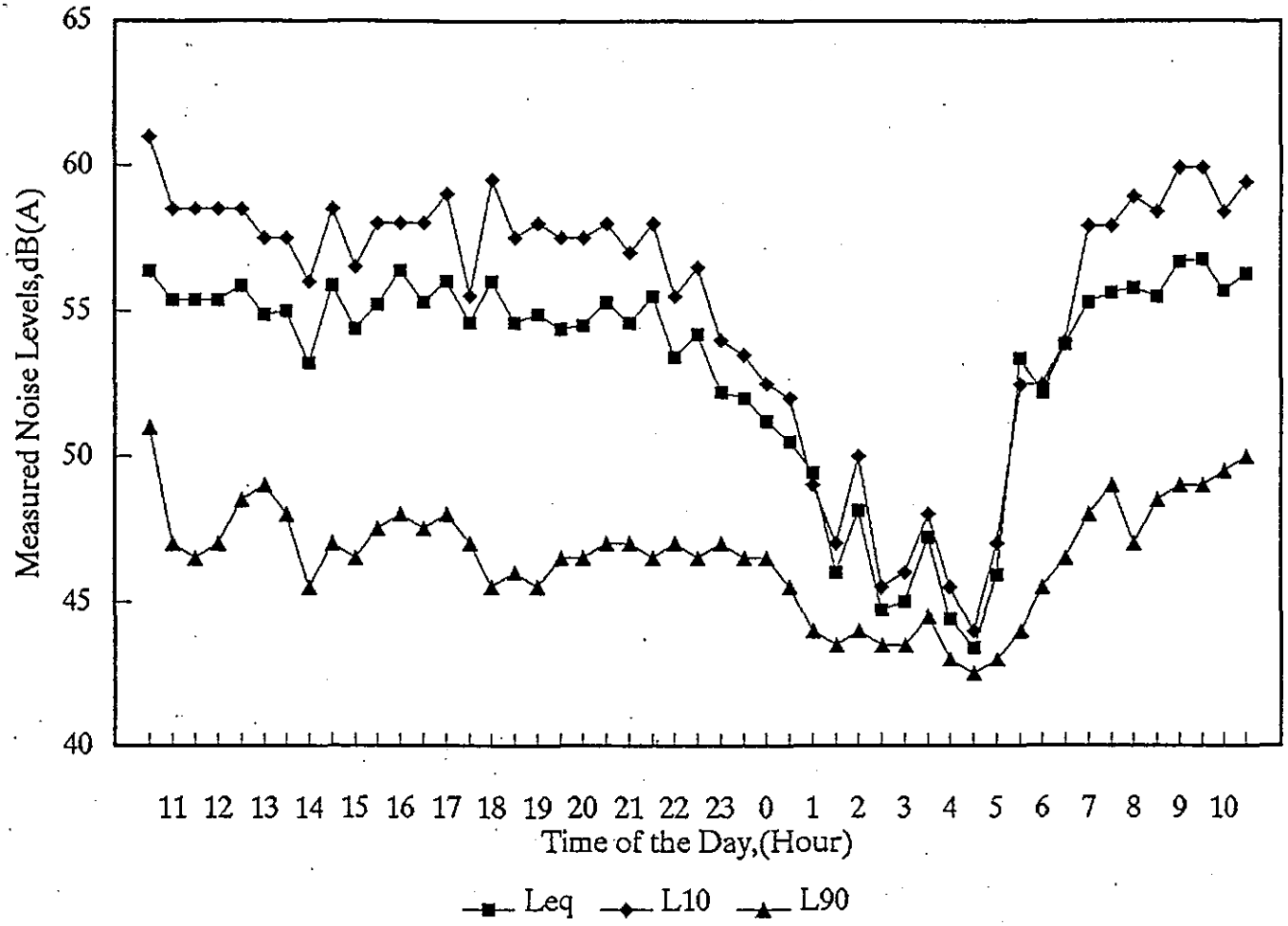


Figure 4.3
Measured Noise Levels on the Roof of 13 Parkland Drive (NSR2)

Table 4.1 Noise Standards for General Construction Work

Time Period	Acceptable Noise Level[3], dB(A) (ASR = "A")
All days during the evening (19.00 to 23.00 hours), and general holidays during the daytime and evening (07.00 to 23.00 hours)[1]	60
All days during the night-time (23.00 to 07.00 hours)[1]	45
Non-holiday daytime (07.00 to 19.00 hours)[2]	60

Notes: 1) NCO standards; 2) HKPSG guideline; 3) ANL in terms of the $Leq_{(5\ min)}$ level.

4.3.4 Under the Technical Memorandum on Noise from Percussive Piling, percussive piling work is prohibited between 19.00 and 07.00 hours and on Sundays and general holidays. Between 07.00 and 19.00 hours on normal working days, piling work is allowed with a Construction Noise Permit (CNP). The permit may restrict the duration of operation to 12 hours, 5 hours or 3 hours depending on the amount by which the predicted piling noise level exceeds the Acceptable Noise Level (ANL) of the worst-affected NSRs. The relevant ANLs are shown in Table 4.2.

Table 4.2 Noise Standards for Percussive Piling

NSR Window Type or Means of Ventilation	Acceptable Noise Level,[1,2] dB(A)
NSR (or part of NSR) with no windows or other openings	100
NSR with central air conditioning system	90
NSR with windows or other openings but without central air conditioning system	85

Notes: 1) 10 dB(A) shall be deducted from the above ANL when the NSR is highly sensitive e.g. clinic, hospital, school etc.
2) ANL in terms of the $Leq_{(5\ min)}$ level.

Container Terminal Noise

4.3.5 Different noise criteria were adopted for the planning and operation of the container terminals. For design planning, the container terminals are governed by the Hong Kong Planning Standard and Guidelines (HKPSG) and the *Technical Memorandum (TM) for the Assessment of Noise from Places other than Domestic Premises, Public Places or Construction Sites*. For operational control, the terminals are under the authority of the TM and the NCO.

4.3.6 During planning, the tranquillity of the surrounding environment in North Lantau, which is rural in nature and classified as having an Area Sensitivity Rating (ASR) of 'A', is preserved by using a night-time criterion of 45 dB(A) at the affected Noise Sensitive Receivers (NSRs). This criterion is 5 dB(A) below the statutory Acceptable Noise Level (ANL) of 50 dB(A) to allow for future developments in the area without threatening the ANL. It applies to the port development which is a fixed noise source and not to the potentially affected NSRs. The NSRs, such as Discovery Bay, are still subject to an ANL of 50 dB(A) only before the terminals are in operation.

4.3.7 After commissioning, the container terminals would increase the ambient noise levels of the surroundings and hence change the ASR from 'A' to 'B'. The ANL at night-time would be revised from 50 dB(A) to 55 dB(A) accordingly. Any measured noise levels from the container terminals would then be assessed against this standard in the future.

4.3.8 The standard for assessment of the container port noise is 55 dB(A) while the 45 dB(A) planning criterion is retained only as a secondary criterion for supplementary evaluation.

Road Traffic Noise, Helicopter/Aircraft Noise

4.3.9 Road traffic noise is under planning control. The noise standard is 70 dB(A) for residential premises, and 65 dB(A) for more sensitive receivers such as schools.

4.3.10 Irrespective of the receiver type, the noise standards for helicopter noise and aircraft noise (for the new Chek Lap Kok Airport) are 85 dB(A) and NEF 25 respectively. The road traffic noise and helicopter/aircraft noise standards are shown in Table 4.3.

Table 4.3 Noise Standards for Road Traffic and Helicopter/Aircraft Flyover

Sensitive Receiver	Noise Standard		
	Road Traffic[1]	Helicopter[2]	Aircraft[3]
Domestic Premises	70 dB(A)	85 dB(A)	NEF 25[4]
Schools	65 dB(A)		

Notes: 1) In terms of the $L_{10(1\text{-}hr)}$ level.
2) In terms of the L_{max} level during the flyover.
3) For the new Chek Lap Kok Airport.
4) NEF = Noise Exposure Forecast.

4.4 Construction Noise

Methodology

4.4.1 The construction noise assessment methods used in the assessment are based on the assessment procedures stipulated in the relevant technical memoranda: the *Technical Memorandum on Noise from Percussive Piling*, and the *Technical Memorandum on Noise from Construction Work other than Percussive Piling*. The methodology is as follows:

- identify the activities to be undertaken at the same construction phase, and define the noise emitting plant involved in each group of activities;
- determine the noise contribution of the plant assuming that they are located at the Notional Source Position (NSP) for general construction work, or at the nearest piling location for percussive piling; the NSP is defined as the mid-way between the approximate geographical centre of the site and the site boundary nearest to the NSR;
- calculate the total noise level at the NSR assuming that all the plant is operated simultaneously in the absence of any noise mitigation measures; and
- by comparison with the noise limit and based on a ranking of the noise contribution from individual plants, propose the preferred form of noise mitigation measures.

4.4.2 The noise calculations have been made using equipment sound power levels (SWLs) taken from the relevant Technical Memorandum. Where no SWL data can be found in the Technical Memorandum, reference is then made to BS 5228 Part I or noise emission levels measured in previous projects in Hong Kong.

Major Activities

4.4.3 During the construction phase, major activities with the potential to cause noise nuisance are:

- platform formation;
- roadworks;
- Discovery Bay tunnel portal construction;
- reclamation; and
- building works.

4.4.4 A typical works programme based on the outline construction plan has been developed and used as the basis for the noise calculation. This works programme will be revised as detailed planning proceeds. Table 4.4 indicates the estimated plant usage. The sound power levels indicated were taken from the relevant Technical Memorandum.

Table 4.4 Assumed Plant Requirements

Activity: Equipment	Sound Power Level dB(A) (without noise control)	No. of Plant	Time In Use
Platform Formation:			
Air compressor	109	2	08.00 - 18.00
Breaker (excavator mounted)	122	1	08.00 - 18.00
Bulldozer	115	1	08.00 - 18.00
Crane mobile	112	1	08.00 - 18.00
Compactor	105	1	08.00 - 18.00
Rock drill	123	4	08.00 - 18.00
Loader	112	2	08.00 - 18.00
Generator	108	2	08.00 - 18.00
Dump truck	117	5	08.00 - 18.00
Roadworks:			
Generator	108	2	08.00 - 18.00
Loader	112	2	08.00 - 18.00
Dump truck	117	2	08.00 - 18.00
Compactor	105	2	08.00 - 18.00
Tunnelling:			
Air compressor	109	2	outside : 24 hrs
Drilling rig	123	1	inside : 24 hrs
Loader	112	1	inside : 24 hrs
Dump truck	117	5	08.00-18.00
Breaker	122	1	inside : 24 hrs
Portal Formation:			
Generator	108	1	08.00 - 18.00
Loader	112	2	08.00 - 18.00
Rock drill	123	2	08.00 - 18.00
Dump truck	117	2	08.00 - 18.00
Crane	112	1	08.00 - 18.00
Compactor	105	1	08.00 - 18.00
Reclamation:			
Dredger (grab/chain bucket)	118	1	08.00 - 18.00
Derrick barge	104	1	08.00 - 18.00
Compactor	105	1	08.00 - 18.00
Loader	112	1	08.00 - 18.00
Dump truck	117	2	08.00 - 18.00
Building Works:			
Generator	108	10	08.00 - 18.00
Air compressor	109	10	08.00 - 18.00
Piling, large diameter grab/chisel	115	1	08.00 - 18.00
Piling, large diameter reverse cir.	100	2	08.00 - 18.00
Piling, earth auger	114	3	08.00 - 18.00
H-pile/concrete, drop hammer	126/116	6	08.00 - 18.00
Water pump	88	10	08.00 - 18.00
Winch	95	20	08.00 - 18.00
Dump truck	117	2	08.00 - 18.00
Crane, electric tower	95	7	08.00 - 18.00
Crane, mobile	112	2	08.00 - 18.00

Platform Formation

4.4.5 About 710,000 m^3 of fill materials will be borrowed from the knoll in the centre of the development. The knoll will be reduced from 76m to 35-40m in height. A proportion of the borrow activities will require blasting. It is estimated that the blasting operations will be carried out 2 to 3 times a day. Prior to blasting, holes will be created in the rock surface using rock drills. Hydraulic rock drills would be used and the assumed sound power level is 123 dB(A). There would be a maximum of four drills operated together at any time. For each platform, the maximum number of rock drills operating is assumed to be two, of which the total sound power level of the drilling activity is 126 dB(A).

4.4.6 The blasting operation will follow current practice in Hong Kong. By choosing the appropriate charge size per delay, the peak particle velocity will be limited to within 25 mm/s in the nearest concrete structure and 11 mm/s in the nearby water mains. After the blasting operations, the materials would be removed using, for each platform: 1 excavator-mounted breaker, 1 bulldozer, 1 crane, 1 loader and 2 dump trucks. The total sound power level calculated for these plants is 125 dB(A).

4.4.7 At platforms where the fill materials are stored temporarily for subsequent deposit in other platforms earth moving would require the following plant: 1 bulldozer, 1 loader and 2 dump trucks, and their total sound power level is calculated to be 122 dB(A).

4.4.8 On platforms that receive fill materials from the knoll, the major plant would be: 2 dump trucks, 2 air compressors and 1 compactor. The total sound power level of the major plants used in the fill receiving platform is 121 dB(A).

Roadworks

4.4.9 The assumed plant requirements for work on each road segment are assumed to be: 1 generator, 1 loader, 1 dump truck and 1 compactor. The calculated total sound power level of these plants is 119 dB(A).

Tunnelling and Portal Formation

4.4.10 The portal formation would involve the operations of hydraulic rock drills and blasting, of which the assumed sound power level is 126 dB(A). Other mechanical equipment used would be: 1 generator, 1 loader, 2 dump trucks, 1 crane and 1 compactor. Their total sound power level is calculated to be 122 dB(A). For the tunnelling operation, drilling rigs and breakers will be operated inside the tunnel; only 1 air compressor and 2 dump trucks would be operated outside the tunnel and the total sound power level is 120 dB(A).

Reclamation

4.4.11 Main activities will be the placement of rock and fill materials. Dredging of marine mud will also be required. The shallow depth of Yi Pak Wan will not necessitate excessive or unusual reclamation methods. The plant used would be: 2 dredgers, 1 compactor, 1 loader and 2 dump trucks. The calculated total sound power level is 124 dB(A).

Building Construction

4.4.12 Standard construction methods for the development will be employed. The equipment used will include generators, air compressors, water pumps, winch, dump trucks and tower cranes etc. Piling will be required for foundation work which may involve the use of non-percussive piling methods including earth auger and large-diameter bored piles using grab/chisel or reverse circulation drill.

Cumulative Noise Levels

4.4.13 The cumulative noise levels of the above activities are given in Table 4.5. The noise levels have been predicted for representative stages of the construction phasing. The predicted noise level are assessed for the nearest NSRs. One is the high-rise block of Greenland Court (NSR1), and the other is at 13 Parkland Drive (NSR2). The cumulative noise calculations included non-percussive piling noise. Noise predictions for percussive piling are presented in the following sub-section.

4.4.14 The cumulative noise levels show that the non-statutory daytime noise limit of 60 dB(A) would be exceeded when construction activities are close to NSRs. The calculation results indicate that the noise exceedance is mainly due to platform formation activity at a distance of 200m or less. It is estimated that the unmitigated noise exceedance is up to 19 dB(A) at NSR1 and 14 dB(A) at NSR2. As the anticipated noise levels exceed even the EPD guideline of 75 dB(A) during the day-time, a noise mitigation plan is required to reduce the noise impact. The construction noise mitigation plan is presented in Section 4.7.

Table 4.5 Cumulative Noise Levels of Construction Activities

Stage	Activity		NSR1		NSR2	
Yr/Qtr	Type	SWL dB(A)	Distance (m)	L_{eq} dB(A)	Distance (m)	L_{eq} dB(A)
1/1	Platform 1	126	500	67	480	67
	Platform 14	121	520	62	630	60
	Platform 6	121	480	62	250	68
	Rd P1 West	119	380	62	650	58
				70		71
1/3	Platform 1	126	500	65	480	67
	Platform 5	121	110	75	400	64
	Platform 8	121	200	70	400	64
	Rd P1 West	119	380	62	650	58
	Tunnel	120	350	64	700	58
	Dredging	122	650	61	220	70
				77		73
2/1	Platform 1	126	500	67	480	67
	Platform 4	121	90	77	480	62
	Platform 11	122	700	60	550	62
	Platform 3	121	200	70	480	62
	Platform 10	121	270	67	460	63
	Rd P1 East	119	720	57	630	58
	Tunnel	120	350	64	700	58
	Sea Wall	122	650	61	220	70
				79		74
2/3	Platform 12	122	600	61	580	62
	Rd P1 East	119	720	57	630	58
	Rd D1	119	250	70	480	60
	Rd L1 Mid	119	200	68	300	64
	Tunnel	120	350	64	700	58
	Sea Wall	122	650	61	220	70
				72		72
3/1	Rd L1 North	119	320	64	550	59
	Rd D2 Mid	119	350	63	450	61
	Tunnel	120	350	64	700	58
	Sea Wall	122	650	61	220	70
				69		71

Percussive Piling Noise

4.4.15 Piling will be required for foundation works which may involve the use of percussive piling methods for H-pile/concrete and drop hammer piles. This section addresses the potential noise impact due to piling operations.

4.4.16 Potential piling noise impacts have been assessed for both NSR1 and NSR2. The assessment method was based on *the Technical Memorandum on Noise from Percussive Piling*. In this assessment, the sound power level for drop hammer driving concrete pile is 116 dB(A) and six pieces of pile are anticipated to be operated at the same time. The horizontal distances between the NSR and the pile location nearest the NSR are approximately 90m and 220m for NSR1 and NSR2, respectively. Therefore, the predicted noise level at NSR1 and NSR2 are 76 dB(A) and 67 dB(A), respectively.

4.4.17 The predicted results indicate that noise from percussive piling will not exceed the ANL of 85 dB(A). Thus, piling work should be permitted according to the conditions in the construction noise permit between 07.00 and 19.00 hours on normal working days.

4.5 Operational Phase

Major Noise Sources

4.5.1 The major noise sources with the potential of causing noise nuisance to residents of Discovery Bay North development are: road traffic, ferry terminal operation, aircraft/helicopter flyover, the tunnel ventilation system, and utilities such as pumping stations and electrical substations.

4.5.2 The potential impact of Container Terminal noise is addressed in detail in Section 4.6.

Road Traffic Noise

Introduction

4.5.3 No private cars will be allowed into the existing or new residential areas. The only vehicles that will be allowed to operate are golf carts, buses and a limited number of service vehicles. The road and building layout of the Discovery Bay North development was planned with due consideration of the road traffic noise. The noise planning options included:

- the use of a predominantly single aspect building layout;
- the alignment of the road network;
- the gradient of the road network; and
- routing of bus movements.

Methodology

4.5.4 The traffic noise model *RoadNoise* has been used to predict operational traffic noise. The *RoadNoise* model was developed in the UK by WS Atkins in strict compliance with the methodology given in the UK Department of Transport's document *Calculation of Road Traffic Noise* (CRTN88) published in 1988. Road traffic noise is calculated in term of the level exceeded for 10% of a 1 hour period, $L_{10(1\ hour)}$, at 1m from a building facade. The noise levels have been predicted for the preliminary estimated peak hour traffic conditions for the years 2005-2011.

4.5.5 The CRTN88 method has been developed for highway noise propagating over relatively open terrain. It takes into account traffic flow characteristics (e.g. traffic volume, mean speed and percentage heavy vehicles), road conditions (e.g. road gradient and type of road surface), noise propagation factors (e.g. slant distance, ground absorption, barrier screening) and receiver conditions (e.g. angle of view and facade effect).

Impact Assessment

4.5.6 Figure 4.4 shows the estimated internal traffic flows through the Master Plan 6.0(A) development upon completion of the project. Road P1 between the tunnel portal and the transport interchange has a road gradient of 7% and will carry the highest traffic flows. The peak hourly traffic volume along road P1 will be 264 vehicles/hr with a mean vehicle speed of 50 km/hr. The traffic on P1 will consist entirely of heavy vehicles (goods vehicles and buses).

4.5.7 Through the use of proper setback distance and single aspect building design, the facade noise level at all flats of the proposed Master Plan 6.0(A) development will be below the planning standard of 70 dB(A). Figure 4.5 shows the calculated road traffic $L_{10(1\ hour)}$ noise level at selected facades of the development. The modelling results indicate that the operational traffic noise levels in the proposed development will range from 58 to 67 dB(A).

4.5.8 The road traffic noise levels at the two proposed schools have also been examined. The modelling results indicate that a maximum noise level of 64 dB(A) is expected at the western facade of the school located in the south-western section of the development. The school in the south-east of the development site will be exposed to a maximum traffic noise level of 58 dB(A). The traffic noise level at both schools will comply with the planning standard of 65 dB(A).

4.5.9 The noise impact on the existing Discovery Bay development has been evaluated. The NSRs that would be most affected by the road traffic noise are the high-rise residential blocks in Greenvale Village which overlook the proposed Yi Pak development site. The peak hour road traffic along the existing road section in front of Greenvale Village is estimated to be 108 vehicles/hr consisting of goods vehicles and buses.

4.5.10 Noise calculations indicate that the predicted facade noise levels at these high-rise blocks will range from 64 to 71 dB(A) (see Figure 4.5). The locations where the 70 dB(A) planning standard will be exceeded are the first and second residential floors of Greenbelt Court, Greenmont Court, Greenwood Court and the two blocks proposed under Master Plan 5.7. It is estimated that less than 1% of the flats in the existing blocks in Greenvale Village will be subject to a minor traffic noise impact of 1 dB(A) or less.

Ferry Terminal Noise

4.5.11 Noise levels produced by the new ferry terminal are expected to be similar to those contributing to the noise climate in the vicinity of the existing ferry terminal. Based on a recent noise survey, the noise levels (L_{eq}) of the ferry arrival/departure movement are typically in the range of 53 to 59 dB(A) when measured at a distance of about 30m. The new ferry terminal will be 180m from the nearest residential building and the noise impact of the new ferry terminal is considered acceptable. Though noticeable, the ferry noise is unlikely to cause noise nuisance because it would be well masked by other noises such as road traffic noise. The only concern is the possibility of test runs of the ferry engines in early morning, but this potential problem can be avoided through administrative control by the ferry operator.

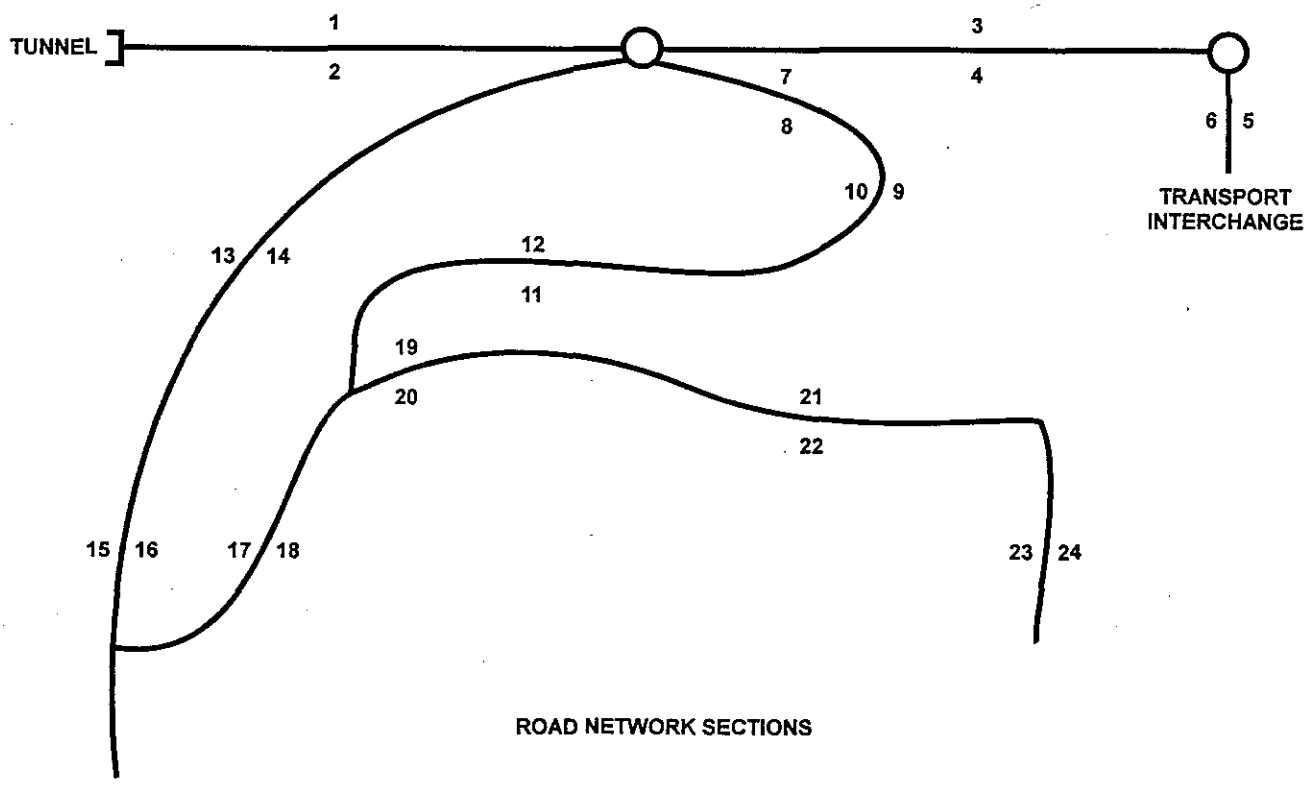
Aircraft/Helicopter Noise

4.5.12 Aircraft and helicopter noise can be heard in the existing development especially within the high-rise blocks to the north. The maximum ambient noise level (L_{max}) will increase typically by about 7 dB(A) for aircraft flyover, and about 9 dB(A) for helicopter flyover. This noise level increase is clearly noticeable. However, the helicopter flyover noise is considered acceptable as the maximum noise levels of 68 to 73 dB(A) are well below the planning criterion of 85 dB(A).

4.5.13 Occupation of Discovery Bay North will coincide with the operation of the new Chek Lap Kok airport. Although some aircraft noise may be audible in Discovery Bay, the proposed development is outside the NEF 25 aircraft noise contour which is the maximum permissible noise level for residential uses in relation to the new airport as prescribed in the HKPSG. The discontinuation of the present aircraft/helicopter flight paths over Discovery Bay will result in an overall improvement for the acoustic environment of the area.

Tunnel Ventilation Noise

4.5.14 Ventilation fans of the proposed tunnel linking Discovery Bay to the North Lantau Expressway will be fitted with sound attenuators on both the air intake and exhaust openings. Noise from these industrial fans will need to comply with the regulatory noise standards ($L_{eq(30\ min)}$) of 60 dB(A) in daytime/evening (07.00-23.00 hrs) and 50 dB(A) at night (23.00-07.00 hrs). The silenced ventilation inlet/outlet will be approximately 80m from the nearest NSR; hence the target noise level 1m from the inlet/outlet will be 103 dB(A) in the daytime/evening and 93 dB(A) at night for compliance with the regulatory noise standards at the nearest NSR. These target levels are high and the ventilation



Road Section	Average Speed (km/hr)	Goods Vehicle	Coach	Light Bus	Bus	Total Vehicles
1	55	58	12	7	24	101
2	45	65	12	6	24	107
3	55	46	0	0	86	132
4	45	46	0	0	86	132
5	40	46	0	0	86	132
6	40	46	0	0	86	132
7	30	10	12	7	28	57
8	30	17	12	6	22	57
9	30	6	6	0	12	24
10	30	10	6	0	6	22
11	30	5	6	0	12	23
12	30	9	6	0	6	21
13	40	17	0	0	40	57
14	40	17	0	0	34	51
15	40	12	0	0	30	42
16	40	12	0	0	24	36
17	40	0	6	0	0	6
18	35	0	6	0	6	12
19	40	1	6	0	6	13
20	35	1	6	0	6	13
21	40	1	6	0	6	13
22	40	1	6	0	6	13
23	20	0	6	0	0	6
24	20	0	6	0	0	6

Figure 4.4
Estimated Internal Traffic Flows
Master Plan 6.0(A)

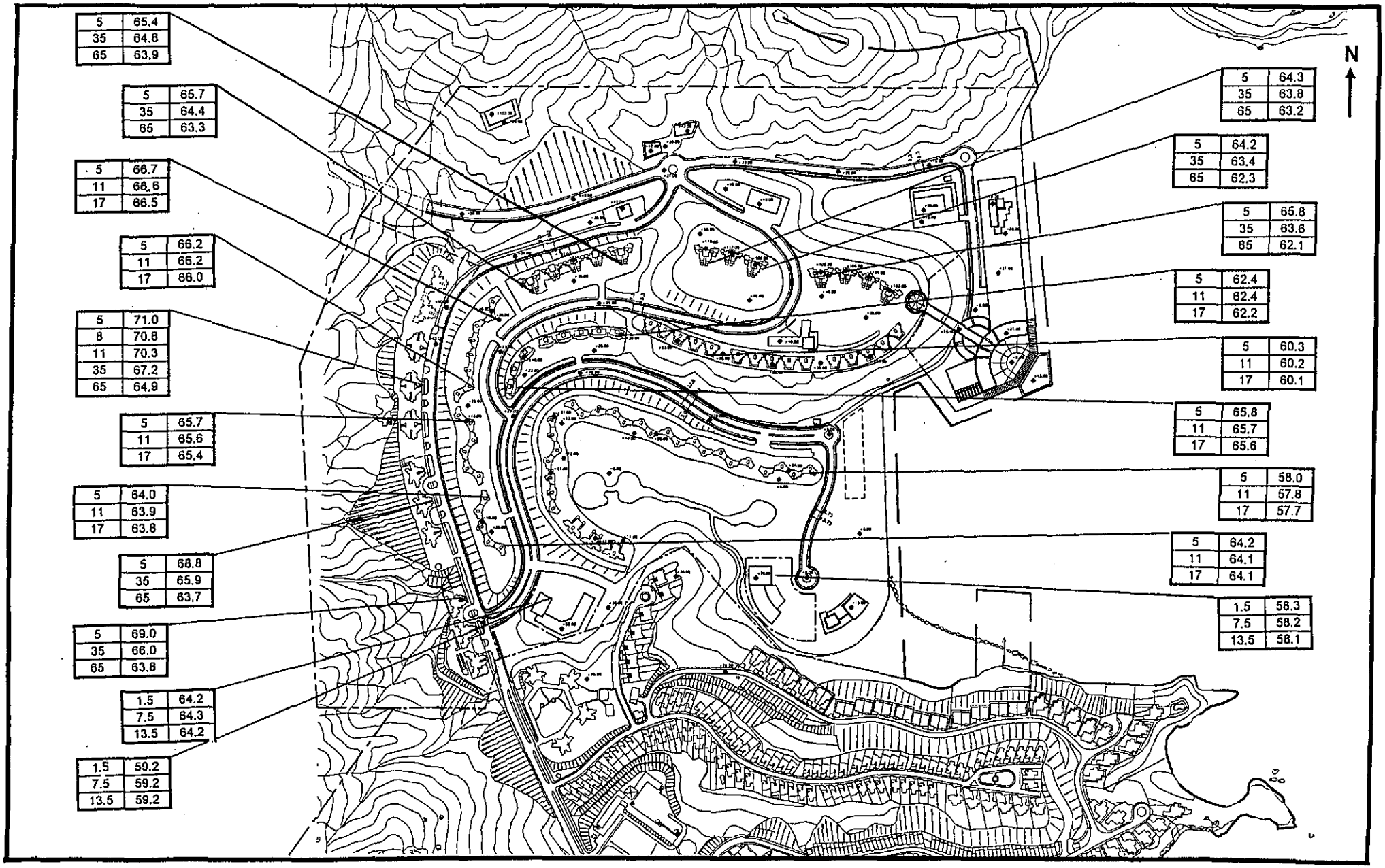


Figure 4.5
Predicted Road Traffic Noise Levels

equipment should easily comply with the NCO requirement. It is therefore anticipated that the ventilation noise impact from the tunnel portal will be insignificant.

Utility Noise

4.5.15 At the development planning stage of Master Plan 6.0(A), noise emitting uses such as the refuse collection point, gas/electrical substations and sewage pumping stations etc. were sited in locations where the ambient noise levels are high. Wherever possible, utilities are placed on the noise insensitive sides of high-rise buildings so that emitted noise will not affect residents in the buildings. In addition, some of the utility areas have been located between roads and NSRs in order to provide screening of the road traffic noise.

4.6 Container Terminal Noise

Background

4.6.1 The container terminals are part of a Government project administered by the Civil Engineering Department. The terminals, together with works in the container back-up area in Penny's Bay, will operate 24 hours a day giving cause for concern over the impacts of noise emissions on the surrounding areas, particularly at night.

4.6.2 Four container terminals are under consideration. The terminals are scheduled in four phases and would be developed over the same period of time as the proposed Discovery Bay North development. One terminal is to be commissioned in each phase. CT10 and CT11 are planned for completion in 2000 and 2001 as Phases 1 and 2, respectively, while target dates for CT12 and CT13 would be determined later as Phases 3 and 4.

4.6.3 The preliminary design of Lantau Port Development Stage 1, Container Terminals 10 and 11, has been completed and the Final Report on Container Terminal EIA (FCTEIA) was accepted in March 1995 (CED, 1995). The report confirmed the previous results. The phased development of CT10, CT11, CT12 and CT13, although being some 2 - 5 km away, were predicted to cause facade noise levels of 36 dB(A) to 50 dB(A) at some locations in the proposed development area at Discovery Bay North.

4.6.4 The latest findings of the Container Terminal EIA have been reviewed and modelling carried out based on the results in the FCTEIA in order to identify any possible constraints for the proposed Discovery Bay North development. Practical design options to reduce the potential noise impact in the Master Plan 6.0(A) layout have been considered and evaluated.

Methodology

4.6.5 Modelling to predict facade noise levels in the Discovery Bay North development was carried out in two stages. Stage 1 predicted the facade noise levels for the scenario that the buildings directly face the port with an unobstructed view. The actual facade noise levels, after taking into account of the orientation of the building and the screening effect of surrounding building structures, were predicted in Stage 2.

4.6.6 At Stage 1, three representative receptors which cover most of the proposed Discovery Bay North residential area were selected from the FCTEIA Report. The receptors are shown in Figure 4.6. Facade noise levels for the 3 selected locations as extracted from FCTEIA are presented in Table 4.6.

Table 4.6 Predicted Facade Noise Level During Different Phases of Port Development

NSR and Elevation	Facade Noise Level dB(A) during			
	Phase 1	Phase 2	Phase 3	Phase 4
YP-1	Night-time			
16 mPD	37.1	47.0	47.4	47.8
YP-2	Night-time			
126 mPD	41.0	48.3	48.7	49.3
117 mPD	40.8	48.1	48.5	49.2
108 mPD	38.8	47.6	48.1	48.8
99 mPD	38.5	47.5	47.9	48.7
DB-13	Night-time			
117 mPD	37.4	44.2	44.9	46.2
108 mPD	37.1	43.5	44.3	45.7
99 mPD	36.7	42.9	43.8	45.3
90 mPD	36.5	42.5	43.4	45.1

Source: Final EIA Report on Preliminary Design of CT10 and CT11 (CED, 1995).

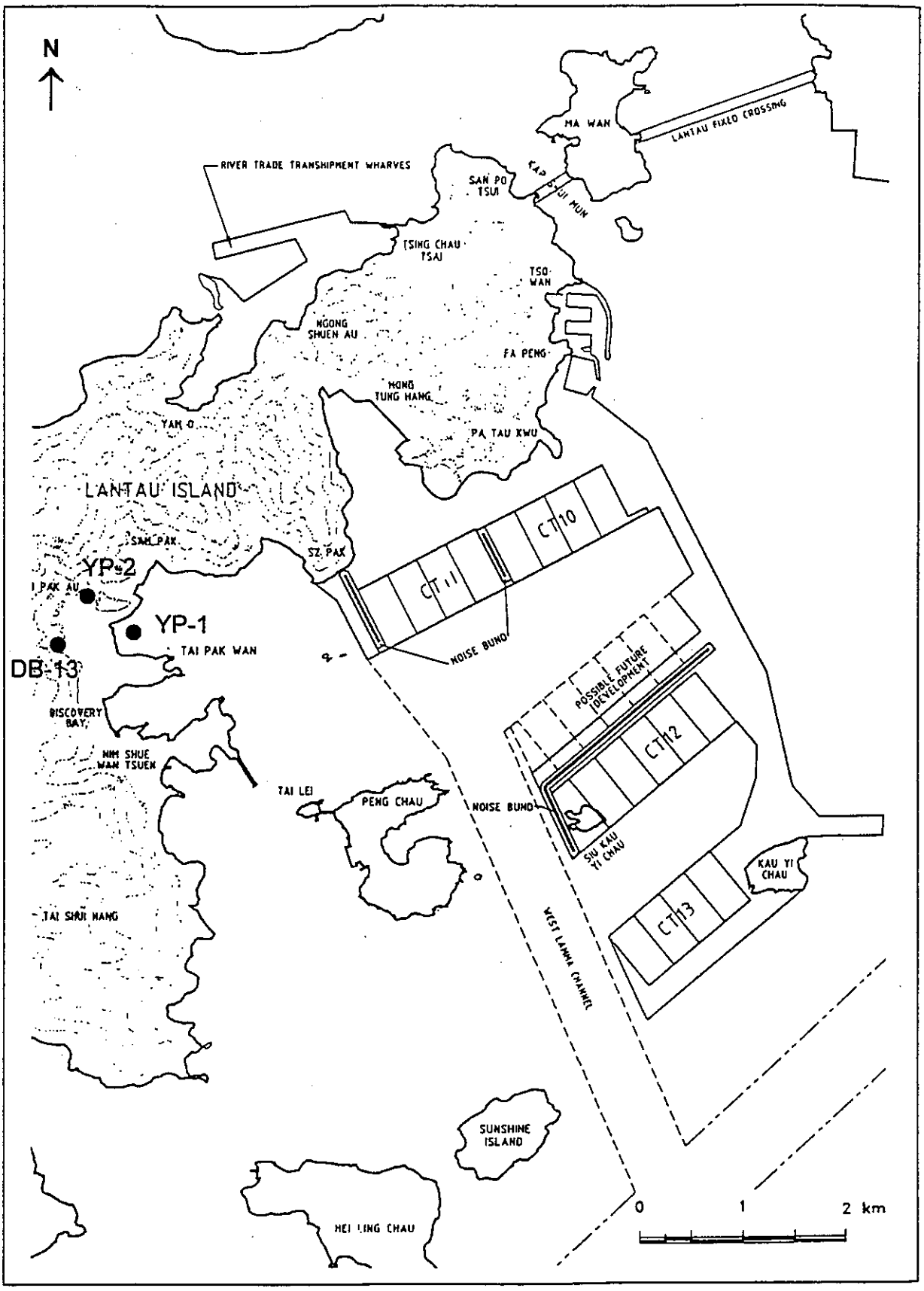


Figure 4.6
Location of Representative Receivers

4.6.7 The contribution from individual container terminals were derived in Table 4.7 following standard acoustical principles. Data under the column CT10 in Table 4.7 were identical with the data under 'Phase I' column in Table 4.6. Data under CT11 was obtained by subtracting data under the 'Phase I' column from 'Phase 2' column. Results for CT12 and CT13 were similarly obtained.

Table 4.7 Predicted Facade Noise Level Due to Each Container Terminal

NSR and Elevation	Facade Noise Level dB(A) due to each Container Terminal			
	CT10	CT11	CT12	CT13
YP-1	Night-time			
16 mPD	37.1	46.5	36.8	37.2
YP-2	Night-time			
126 mPD	41.0	47.4	38.1	40.4
117 mPD	40.8	47.2	37.9	40.9
108 mPD	38.8	47.0	38.5	40.5
99 mPD	38.5	46.9	37.3	41.0
DB-13	Night-time			
117 mPD	37.4	43.2	36.6	40.3
108 mPD	37.1	42.4	36.6	40.1
99 mPD	36.7	41.7	36.5	40.0
90 mPD	36.5	41.2	36.1	40.2

4.6.8 Standard finite difference techniques were then applied to generate a 3-dimensional spatial mesh of noise data for the entire residential area using data in Table 4.7 for each container terminal. This procedure yields the worst-case noise levels if the buildings were directly facing each terminal. Data obtained at this stage had already taken account of the distance attenuation, air absorption factors and the barrier effect of the noise bund at the port. This noise data is called the Predicted Noise Level (PNL).

4.6.9 Stage 2 of the modelling considered the building orientation relative to the container terminals and the additional screening offered by the neighbouring building structures. The prediction is based on an assessment of whether each building facade has a direct line of sight of the container terminals.

4.6.10 According to acoustic principles endorsed in the HKPSG and the TM of the NCO, residential development that does not have a direct line of sight to a noise source, as indicated in a ray tracing diagram, would have attenuations in the range of 5 - 15 dB(A). For a conservative estimate, a 5 dB(A) attenuation is included in the calculations if the entire area cannot be seen from a building facade. If part of the container terminal can be seen due to the orientation of the building itself, the results would be determined by using Table 4.8.

Table 4.8 'Line of Sight' Attenuation to Correct for Partial Exposure to Port Noise

Fraction of area that can be viewed directly by residents	Attenuation due to partial exposure to an area source
0.000	-5 dB(A)/-10 dB(A)*
0.125	-4 dB(A)
0.250	-3 dB(A)
0.375	-2 dB(A)
0.500	-2 dB(A)
0.625	-1 dB(A)
0.750	-1 dB(A)
0.875	0 dB(A)
1.000	0 dB(A)

Note: * -10 dB(A) if the direct line of sight is blocked by a substantial barrier other than the receiver building itself.

4.6.11 If a direct line of sight is blocked by a substantial barrier other than the building itself, a correction of -10 dB(A) has been applied to the noise levels obtained in Stage 1. Facade noise levels after addition of this line of sight attenuation are referred to as Corrected PNL.

4.6.12 Due to the vastly different scale of the Discovery Bay North Master Layout Plan and the map covering the Container Terminals and Discovery Bay, a computer graphics application programme was developed to aid assessment of the direct line of sight criterion at each building locations. A typical view of the graphics application is presented in Figure 4.7.

4.6.13 The facade most exposed to the container port is defined as the most sensitive facade. The Corrected PNL was determined at the most sensitive facade at the highest level of each building where the PNL would be the greatest due to a minimal barrier effect. If the overall Corrected PNL is under the 45 dB(A)

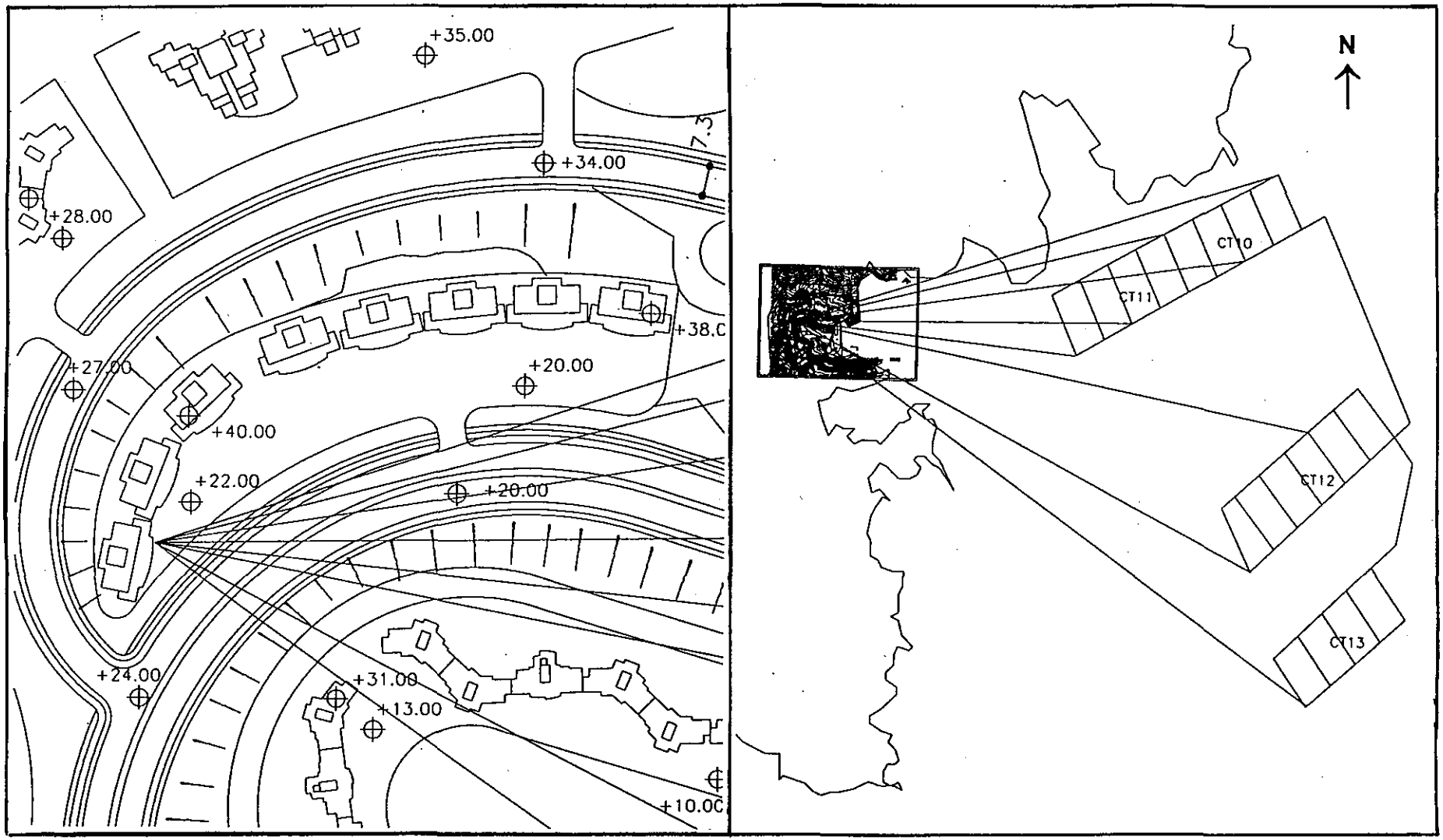


Figure 4.7
Computer Graphic Application Programme for Assessing 'Direct Line of Sight' Attenuation

criterion, every flat in that building is expected to have facade noise levels under 45 dB(A). No further assessment is warranted in such cases.

4.6.14 If the most sensitive facade exceeded 45 dB(A), the lower building levels were assessed vertically along the most sensitive facade until the noise level was under 45 dB(A). For lower floors of the buildings that have the Corrected PNL at the most sensitive facade under 45 dB(A), every flat is expected to pass the criterion. For the upper flats, each facade at different flats were assessed at different heights individually to check in detail the appropriate 'line of sight' attenuation that should apply.

4.6.15 The 'line of sight' attenuation was applied separately to each container terminal. The corrected PNLs for each terminal were then summed to yield an overall PNL due to the entire operation of all 4 phases of the Lantau Port Development.

Modelling Results

4.6.16 Following the modelling methodology described above, the facade noise levels at all residential buildings in the proposed development were obtained, taking into account of the overall effects of distance separation, air absorption, barrier effect, building orientation and building screening in Discovery Bay.

4.6.17 The results are presented in Tables 4.9a-c. The labelling of the buildings is presented in Figure 4.8. The data obtained in Stage I of the modelling are summarised in columns 3 to 7 in each table. The results of the Stage 2 modelling are summarised in Columns 8 to 16.

4.6.18 All building facade noise levels were assessed to be under 55 dB(A) i.e. 100% compliance with the future ANL and 96.6% of the residential flats were under 45 dB(A).

4.6.19 Before building orientation and screening were considered, only 3% of the residential flats would have met the 45 dB(A) planning criterion.

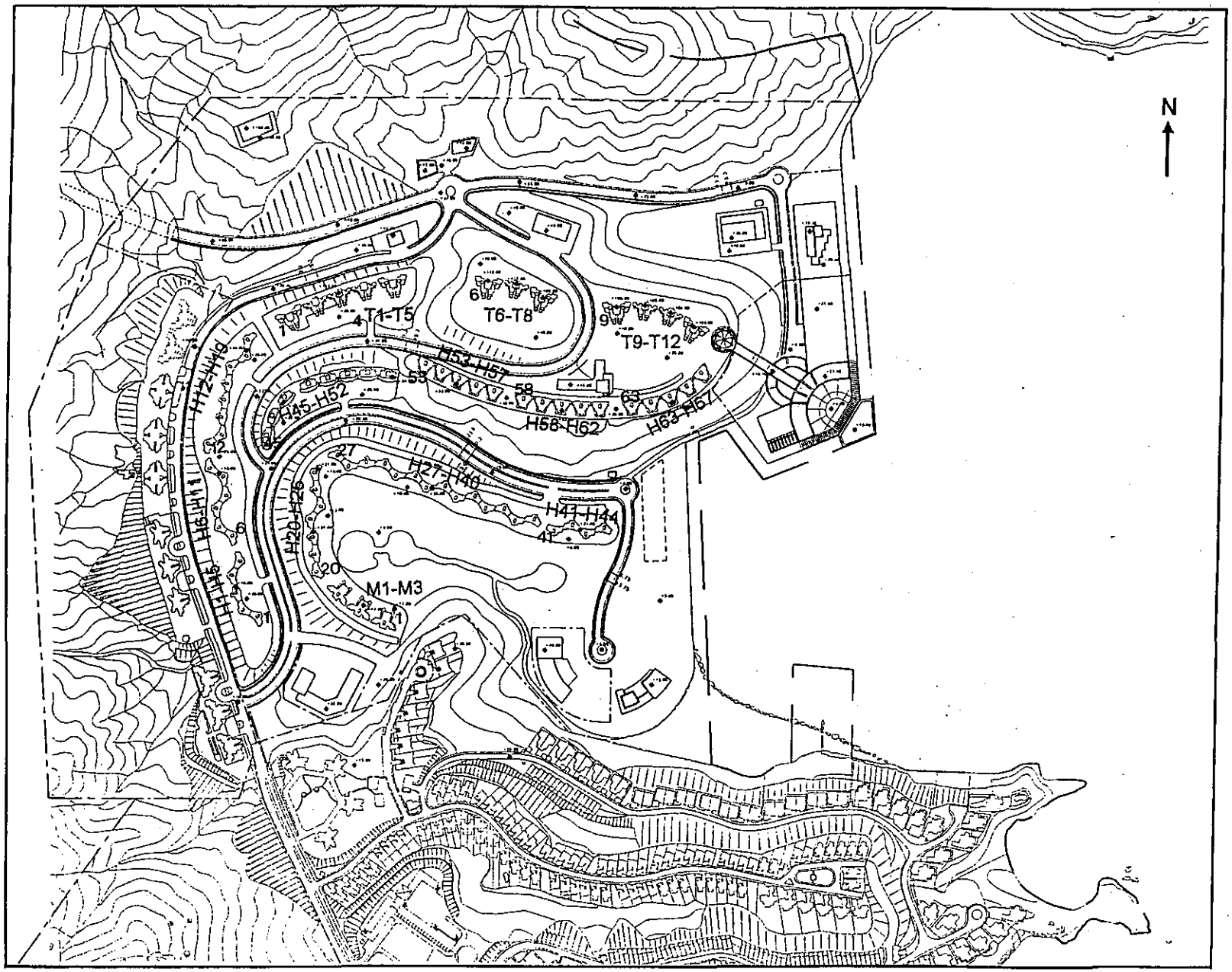


Figure 4.8
Building Locations in Discovery Bay North Master Plan 6.0(A)

Table 4.9a Predicted Facade Noise Levels

Block No.	No. of	PNL due to				Total	"Line of Sight" Attenuation				Corrected PNL due to				Total Corrected	Total Corrected PNL < 55 dB(A)		Total Corrected PNL < 45 dB(A)	
	flats	CT11	CT10	CT12	CT13	PNL	CT11	CT10	CT12	CT13	CT11	CT10	CT12	CT13	PNL	Yes(1)/No(0)	No. of flats	Yes(1)/No(0)	No. of flats
T 1	144	46.1	36.9	37.1	37.7	46.9	-2	-5	0	0	43.5	31.3	36.5	37.1	45.2	1	144	1	144
T 2	96	46.4	37.1	37.1	37.7	47.2	-3	-5	0	0	42.8	31.5	36.5	37.1	44.8	1	96	1	96
T 3	96	46.6	37.3	37.2	37.7	47.3	-3	-5	0	0	43.0	31.7	36.6	37.1	44.9	1	96	1	96
T 4	96	46.9	37.5	37.3	37.8	47.6	-3	-5	0	0	43.3	31.9	36.7	37.2	45.2	1	96	1	96
T 5	144	47.1	37.7	37.4	37.8	47.8	-5	-5	0	0	41.5	32.1	36.8	37.2	44.1	1	144	1	144
T 6	144	47.9	38.2	37.8	38.0	48.4	-5	-5	0	0	42.2	32.5	37.1	37.3	44.6	1	144	1	144
T 7	96	48.0	38.4	37.8	38.0	48.5	-5	-5	0	0	42.3	32.7	37.1	37.3	44.7	1	96	1	96
T 8	144	48.0	38.4	37.8	38.0	48.6	-5	-5	0	0	42.4	32.8	37.2	37.4	44.8	1	144	1	144
T 9	144	48.4	38.6	37.9	38.0	48.9	-5	-5	-1	0	42.8	33.0	36.3	37.4	44.9	1	144	1	144
T 10	96	48.6	38.8	38.0	38.0	49.1	-5	-5	-2	0	43.0	33.2	35.4	37.4	44.9	1	96	1	96
T 11	96	48.8	39.1	38.1	38.1	49.3	-5	-5	-2	0	43.2	33.5	35.5	37.5	45.1	1	96	1	96
T 12 E	48	48.9	39.1	38.1	38.1	49.3	0	0	0	0	48.3	38.5	37.5	37.5	49.3	1	48	0	0
T 12 S	48	48.9	39.1	38.1	38.1	49.3	-5	-5	0	0	43.3	33.5	37.5	37.5	45.4	1	48	1	48
T 12 W	48	48.9	39.1	38.1	38.1	49.3	-5	-5	-5	-5	43.3	33.5	32.5	32.5	44.3	1	48	1	48
M 1	26	44.5	35.5	36.3	37.1	45.9	0	0	-3	-5	44.3	35.3	33.1	31.9	45.3	1	26	1	26
M 2	26	44.4	35.4	36.3	37.1	45.9	0	0	-3	-5	44.2	35.2	33.1	31.9	45.2	1	26	1	26
M 3	26	44.4	35.4	36.3	37.1	45.9	0	0	-4	-5	44.2	35.2	32.1	31.9	45.2	1	26	1	26
H 1	12	43.7	34.8	36.0	37.0	45.3	-5	-5	-5	-5	38.5	29.6	30.8	31.8	40.3	1	12	1	12
H 2	12	43.4	34.5	35.7	36.8	45.2	-5	-5	0	0	38.4	29.5	35.7	36.8	42.1	1	12	1	12
H 3	12	43.5	34.6	35.8	36.8	45.3	-5	-5	0	0	38.5	29.6	35.8	36.8	42.2	1	12	1	12
H 4	12	43.6	34.7	35.8	36.8	45.4	0	0	-4	0	43.6	34.7	31.8	36.8	45.1	1	12	1	12
H 5	12	43.7	34.8	35.8	36.8	45.4	-5	-5	-5	-5	38.7	29.8	30.8	31.8	40.4	1	12	1	12
H 6	12	43.9	35.0	36.0	37.0	45.4	-5	-5	-5	-5	38.7	29.8	30.8	31.8	40.4	1	12	1	12
H 7	12	44.0	35.0	36.1	37.0	45.5	0	-1	0	0	43.8	33.8	35.9	36.8	45.4	1	12	1	12
H 8	12	44.0	35.0	36.1	37.0	45.5	0	-1	0	0	43.8	33.8	35.9	36.8	45.4	1	12	1	12
H 9	12	44.2	35.2	36.2	37.0	45.7	-5	-5	-5	-5	39.0	30.0	31.0	31.8	40.7	1	12	1	12
H 10	12	44.3	35.3	36.2	37.0	45.8	-5	-5	-5	-5	39.1	30.1	31.0	31.8	40.8	1	12	1	12
H 11	12	44.4	35.3	36.3	37.0	45.8	-4	0	0	-3	40.2	35.1	36.1	33.8	43.0	1	12	1	12
H 12	12	44.5	35.4	36.3	37.0	45.9	-4	0	0	-3	40.3	35.2	36.1	33.8	43.1	1	12	1	12
H 13	12	44.6	35.4	36.3	37.0	46.0	-5	-5	-5	-5	39.4	30.2	31.1	31.8	41.0	1	12	1	12

Note: E, S and W means flats on the East, South and West side of the building, respectively.

Table 4.9b Predicted Facade Noise Levels

Block No.	No. of flats	PNL due to				Total PNL	"Line of Sight" Attenuation				Corrected PNL due to				Total Corrected PNL	Total Corrected PNL < 55 dB(A)		Total Corrected PNL < 45 dB(A)	
		CT11	CT10	CT12	CT13		CT11	CT10	CT12	CT13	CT11	CT10	CT12	CT13		Yes/No	No. of flats	Yes/No	No. of flats
H 14	12	44.6	35.5	36.4	37.1	46.0	-4	-5	0	0	40.4	30.3	36.2	36.9	43.2	1	12	1	12
H 15	12	44.7	35.6	36.4	37.1	46.1	-4	-5	0	0	40.5	30.4	36.2	36.9	43.3	1	12	1	12
H 16	12	44.9	35.7	36.4	37.1	46.2	-4	-5	0	0	40.7	30.5	36.2	36.9	43.4	1	12	1	12
H 17	12	45.0	35.8	36.5	37.1	46.3	-5	-5	-2	0	39.8	30.6	34.3	36.9	42.6	1	12	1	12
H 18	12	45.2	36.0	36.5	37.2	46.5	-5	-5	-5	-5	40.0	30.8	31.3	32.0	41.5	1	12	1	12
H 19	12	45.2	36.0	36.5	37.2	46.5	-5	-5	-2	0	40.0	30.8	34.3	37.0	42.8	1	12	1	12
H 20	12	44.3	35.2	36.2	36.9	45.8	-4	-5	0	0	40.2	30.1	36.1	36.8	43.1	1	12	1	12
H 21	12	44.4	35.3	36.2	36.9	45.9	-4	-5	0	0	40.3	30.2	36.1	36.8	43.1	1	12	1	12
H 22	12	44.5	35.4	36.3	36.9	46.0	-4	-5	0	0	40.4	30.3	36.2	36.8	43.2	1	12	1	12
H 23	12	44.6	35.5	36.3	37.0	46.1	-4	-5	0	0	40.5	30.4	36.2	36.9	43.3	1	12	1	12
H 24	12	44.7	35.6	36.3	37.0	46.2	-5	-5	-5	-5	39.6	30.5	31.2	31.9	41.2	1	12	1	12
H 25	12	44.8	35.7	36.4	37.0	46.3	-5	-4	0	0	39.7	31.6	36.3	36.9	43.0	1	12	1	12
H 26	12	44.9	35.8	36.4	37.0	46.3	-5	-4	0	0	39.8	31.7	36.3	36.9	43.1	1	12	1	12
H 27	12	45.1	35.9	36.4	37.1	46.5	-5	-4	0	0	40.0	31.8	36.3	37.0	43.2	1	12	1	12
H 28	12	45.1	35.9	36.4	37.1	46.5	-5	-5	-5	-5	40.0	30.8	31.3	32.0	41.5	1	12	1	12
H 29	12	45.3	36.1	36.5	37.1	46.7	-5	-5	-3	0	40.2	31.0	33.4	37.0	42.8	1	12	1	12
H 30	12	45.3	36.1	36.5	37.1	46.7	-5	-5	-5	-5	40.2	31.0	31.4	32.0	41.7	1	12	1	12
H 31	12	45.3	36.1	36.5	37.1	46.7	-5	-5	-5	-5	40.2	31.0	31.4	32.0	41.7	1	12	1	12
H 32	12	45.4	36.3	36.5	37.1	46.8	-5	-5	-5	-5	40.3	31.2	31.4	32.0	41.8	1	12	1	12
H 33	12	45.4	36.3	36.5	37.1	46.8	-5	-5	-5	-5	40.3	31.2	31.4	32.0	41.8	1	12	1	12
H 34	12	45.6	36.4	36.6	37.2	46.9	-5	-5	-5	-5	40.5	31.3	31.5	32.1	41.9	1	12	1	12
H 35	12	45.6	36.4	36.6	37.2	46.9	-5	-5	-5	-5	40.5	31.3	31.5	32.1	41.9	1	12	1	12
H 36	12	45.8	36.5	36.6	37.2	47.1	-5	-5	-5	-5	40.7	31.4	31.5	32.1	42.1	1	12	1	12
H 37	12	45.8	36.5	36.7	37.2	47.1	-5	-5	-5	-5	40.7	31.4	31.6	32.1	42.1	1	12	1	12
H 38	12	45.8	36.7	36.7	37.2	47.1	-5	-5	-5	-5	40.7	31.6	31.6	32.1	42.1	1	12	1	12
H 39	12	45.8	36.6	36.7	37.2	47.1	-5	-5	-5	-5	40.7	31.5	31.6	32.1	42.1	1	12	1	12
H 40	12	45.9	36.8	36.7	37.2	47.2	-5	-5	-5	-3	40.8	31.7	31.6	34.1	42.4	1	12	1	12
H 41	12	46.1	36.8	36.7	37.2	47.3	-5	-5	-5	-5	41.0	31.7	31.6	32.1	42.3	1	12	1	12
H 42	12	46.4	37.0	36.8	37.2	47.6	-5	-5	-5	-4	41.3	31.9	31.7	33.1	42.7	1	12	1	12
H 43	12	46.4	37.0	36.8	37.3	47.6	-5	-5	-5	-5	41.3	31.9	31.7	32.2	42.6	1	12	1	12
H 44	12	46.5	37.1	36.8	37.3	47.7	-5	-5	0	0	41.4	32.0	36.7	37.2	44.0	1	12	1	12

Note: E, S and W means flats on the East, South and West side of the building, respectively.

Table 4.9c Predicted Facade Noise Levels

Block No.	No. of	PNL due to				Total	"Line of Sight" Attenuation				Corrected PNL due to				Total Corrected	Total Corrected PNL < 55 dB(A)		Total Corrected PNL < 45 dB(A)	
	flats	CT11	CT10	CT12	CT13	PNL	CT11	CT10	CT12	CT13	CT11	CT10	CT12	CT13	PNL	Yes/No	No. of flats	Yes/No	No. of flats
H 45	12	44.8	35.7	36.4	37.2	46.2	-4	-2	0	0	40.6	33.5	36.2	37.0	43.6	1	12	1	12
H 46	12	45.0	35.9	36.4	37.2	46.3	-4	-2	0	0	40.8	33.7	36.2	37.0	43.7	1	12	1	12
H 47	12	45.2	36.0	36.5	37.2	46.5	-4	-3	0	0	41.0	32.8	36.3	37.0	43.8	1	12	1	12
H 48	12	45.5	36.3	36.6	37.3	46.8	-3	-4	0	0	42.3	32.1	36.4	37.1	44.5	1	12	1	12
H 49	12	45.6	36.4	36.6	37.3	46.8	-3	-5	0	0	42.4	31.2	36.4	37.1	44.5	1	12	1	12
H 50	12	45.7	36.5	36.7	37.3	46.9	-2	-5	0	0	43.5	31.3	36.5	37.1	45.2	1	12	1	12
H 51	12	45.8	36.6	36.7	37.3	47.0	-2	-5	0	0	43.6	31.4	36.5	37.1	45.3	1	12	1	12
H 52	12	45.9	36.7	36.8	37.3	47.1	-2	-5	0	0	43.7	31.5	36.6	37.1	45.4	1	12	1	12
H 53	12	46.4	37.1	37.0	37.5	47.4	-5	-5	-5	-1	41.1	31.8	31.7	36.2	43.0	1	12	1	12
H 54	12	46.5	37.1	37.0	37.5	47.5	-5	-5	-5	-1	41.2	31.8	31.7	36.2	43.1	1	12	1	12
H 55	12	46.5	37.3	37.0	37.5	47.5	-5	-5	-5	0	41.2	32.0	31.7	37.2	43.3	1	12	1	12
H 56	12	46.6	37.3	37.0	37.5	47.6	-5	-5	0	0	41.3	32.0	36.7	37.2	44.0	1	12	1	12
H 57	12	46.8	37.4	37.1	37.6	47.8	-5	-5	0	0	41.5	32.1	36.8	37.3	44.1	1	12	1	12
H 58	12	46.9	37.5	37.2	37.6	47.9	-5	-5	0	0	41.6	32.2	36.9	37.3	44.2	1	12	1	12
H 59	12	46.9	37.5	37.2	37.6	47.9	-5	-5	0	0	41.6	32.2	36.9	37.3	44.2	1	12	1	12
H 60	12	47.1	37.7	37.2	37.6	48.0	-4	-5	0	0	42.8	32.4	36.9	37.3	44.9	1	12	1	12
H 61	12	47.3	37.8	37.3	37.6	48.2	-4	-5	0	0	43.0	32.5	37.0	37.3	45.1	1	12	1	12
H 62	12	47.5	37.9	37.4	37.6	48.4	-4	-5	0	0	43.2	32.6	37.1	37.3	45.2	1	12	1	12
H 63 N	6	47.7	38.1	37.4	37.7	48.5	-3	-5	0	0	44.4	32.8	37.1	37.4	46.0	1	6	0	0
H 63 S	6	47.7	38.1	37.4	37.7	48.5	-5	-5	-5	-5	42.4	32.8	32.1	32.4	43.5	1	6	1	6
H 64 N	6	47.8	38.2	37.5	37.7	48.6	0	-3	0	0	47.5	34.9	37.2	37.4	48.5	1	6	0	0
H 64 S	6	47.8	38.2	37.5	37.7	48.6	-5	-5	-5	-5	42.5	32.9	32.2	32.4	43.6	1	6	1	6
H 65 N	6	47.8	38.2	37.5	37.7	48.6	0	-3	0	0	47.5	34.9	37.2	37.4	48.5	1	6	0	0
H 65 S	6	47.8	38.2	37.5	37.7	48.6	-5	-5	-5	-5	42.5	32.9	32.2	32.4	43.6	1	6	1	6
H 66 N	6	48.1	38.4	37.6	37.7	48.9	0	0	0	0	47.8	38.1	37.3	37.4	48.9	1	6	0	0
H 66 S	6	48.1	38.4	37.6	37.7	48.9	-5	-5	-5	-5	42.8	33.1	32.3	32.4	43.9	1	6	1	6
H 67 N	6	48.2	38.6	37.7	37.7	49.0	0	0	0	0	47.9	38.3	37.4	37.4	49.0	1	6	0	0
H 67 S	6	48.2	38.6	37.7	37.7	49.0	-5	-5	-5	-5	42.9	33.3	32.4	32.4	44.0	1	6	1	6
	2316				Max =	49.3								Max	49.3		2316		2238
					Min =	45.2								Min =	40.3		100.0%		96.6%

Note: E, S and W means flats on the East, South and West side of the building, respectively.

Impact Assessment

4.6.20 Based on the findings of the detailed modelling, the noise impact of operation of the Lantau Port Development was assessed against the criteria set out in Section 4.3.8.

4.6.21 With respect to the statutory night-time criteria of 55 dB(A), all facade noise levels were assessed to be under this limit. The noise levels were at least 5 dB(A) below the statutory criterion.

4.6.22 Concerning the night-time planning criterion of 45 dB(A) for Container Terminal design, the results indicated that almost all (96.6%) of the proposed development would achieve the criterion. The reduced facade noise levels were a result of following a general design principle of limiting exposure to port noise by orientating sensitive facades away from the port and the use of adjacent buildings for noise screening.

4.6.23 Other design features incorporated in Master Plan 6.0(A) are:

- location of buildings along the natural landscape to minimise the number of buildings facing east;
- use of south facing units as high rise buildings to minimise the total number of flats facing east;
- set back most of the buildings on the east-facing slope to minimise the overall noise impact; and
- layout of buildings in the same group to protect others from over-exposure to the container port.

Conclusions

4.6.24 The likely noise impact of the Lantau Port Development to the east of the proposed Discovery Bay North development has been assessed by detailed noise modelling. The results indicated that during the operation of the Port, the night-time noise level would not exceed the NCO standard of 55 dB(A) at each residential flat.

4.6.25 The incorporation of practical design measures in Master Plan 6.0(A), such as protective building layouts and orientation, has resulted in 96.6% of the proposed development meeting the secondary night-time criterion of 45 dB(A). As stated in Section 4.3.8, the 45 dB(A) criterion for the Lantau Port Development is retained only as a secondary criterion for the Discovery Bay North development.

4.6.26 All the predicted facade noise levels in the Discovery Bay North development comply with the NCO enforcement criterion of 55 dB(A) and are at least 5 dB(A) below this criterion.

4.7 Construction Noise Mitigation

Approach

4.7.1 To reduce the construction noise impact, it is recommended that noise mitigation measures be incorporated in detailed design stage of the construction work. These measures should include control at the noise sources and along the noise transmission paths. Noise control at receivers would be considered only as a last resort. The typical noise reductions with these mitigation measures are given in the following sections.

4.7.2 The assessment has been based the outline construction plan and assumed equipment schedule given in Section 2, which can give no more than an indicative picture of the potential noise impact. The information available is not sufficient for the design of an accurate noise control programme as details which are essential for the design of the noise controls, such as the works sequence and the phasing and siting of noisy equipment, are unavailable at this stage of the project.

4.7.3 The initial scheme for construction noise is not based on the calculated performance of the mitigation measures, but on the target noise reduction required from these measures i.e. 19 dB(A) for NSR1 and 14 dB(A) for NSR2. Details of how individual measures achieve the target noise reductions will have to be considered further when the necessary data becomes available.

4.7.4 Construction works programming could also be considered as an additional means to achieve noise reductions when the detailed construction plan and equipment schedule are available in the future.

4.7.5 Piling noise is assessed separately from general construction noise and in accordance with the *Technical Memorandum on Noise from Percussive Piling.*

Construction Noise Mitigation Plan

4.7.6 The initial construction noise mitigation plan is based on a combination of noise source and path control measures. Source control methods, such as the use of quietened machinery and machinery noise enclosures, can achieve the predicted noise reductions with relatively little uncertainty. The effectiveness of path control techniques, such as noise hoods/screens/barriers, is determined by the exact location of the noise source, the receiver and the screening structure, as well as the topography of the site. Conservative estimates of the noise reductions possible with these noise control methods are used in this assessment.

4.7.7 With stationary plant, such as air compressors and generators, the use of silenced models would lead to a noise reduction of 8-9 dB(A). For other equipment, such as mobile cranes and winches, it is possible to achieve a noise reduction of 6 dB(A) by enclosing the power unit.

4.7.8 Noise reductions in the order of 5 dB(A) could be achieved for mobile noise sources such as dump trucks, loaders and bulldozers, by fitting more efficient exhaust sound reduction equipment or using the super silenced models.

4.7.9 The excavation and transport of fill material was predicted to be the major source of general construction noise. It is assumed in this assessment that noise from the rock drills could be reduced by 7 dB(A) through the use of suitably designed muffler or sound reduction equipment to reduce noise without impairing machine efficiency.

4.7.10 Table 4.10 gives the estimated equipment sound power levels with and without applying source noise control measures. The expected noise reductions of the control measures have been estimated from relevant literature and past project experience. Their site performance depends on the design and operating conditions of the noisy equipment/process to which the controls are applied.

Table 4.10 Equipment Sound Power Levels With Source Noise Control

Equipment	Equipment Power Level, dB(A)				Control Measures
	CNP Code	Without Noise Control	With Noise Control	Noise Reduction	
Rock drill	CNP182	123	116	-7	noise hood or muffler
Breaker	CNP 027	122	112	-10	sound proof hammer jacket
Air compressor	CNP001	109	100	-9	silenced model
Generator	CNP101	108	100	-8	silenced model
Crane	CNP048	112	106	-6	silenced power unit
Dump truck	CNP067	117	112	-5	muffler/silenced type
Loader	CNP081	112	107	-5	muffler/silenced type
Bulldozer	CNP030	115	110	-5	muffler/silenced type
Compactor	CNP050	105	100	-5	muffler/silenced type
Dredger	CNP062	118	112	-6	grab type
Water pump	CNP281	88	88	0	electric type
Winch	CNP262	95	95	0	electric type
Crane, electric	CNP049	95	95	0	-
Derrick barge	CNP061	104	104	0	-

4.7.11 As shown in Table 4.11, source control measures would reduce construction noise by 5 - 7 dB(A). This corresponds to noise levels of up to 74 dB(A) at Greenland Court (NSR1) and 69 dB(A) at 13 Parkland Drive (NSR2). It is recommended that the noise levels at sensitive receivers be further reduced by the path control technique, using noise barriers at appropriate locations along the site boundary or the platform boundary. The necessity for these barriers would be subject to an assessment of the detailed work programme, once noise mitigation through equipment phasing has been thoroughly considered.

Table 4.11 Activity Sound Power Levels With Source Noise Control

Activity	Equipment		Activity Sound Power Level dB(A)		
	Type	No.	Without Noise Control	With Noise Control	Noise Reduction
Blasting Platform *	rock drill	2	126	119	-7
	breaker bulldozer crane loader dump truck	1 1 1 1 2	125	118	-7
Storage Platform	bulldozer loader dump truck	1 1 2	122	117	-5
Receiving Platform	dump truck compressor compactor	2 2 1	121	115	-6
Roadworks	generator loader dump truck compactor	1 1 1 1	119	114	-5
Tunneling and Portal Formation	generator loader dump truck crane compactor	1 1 2 1 1	122	116	-6
Reclamation	dredger compactor loader dump truck	2 1 1 2	124	118	-6

Note :* Hydraulic rock drills would be used before blasting while the remaining plant would be used after the blasting operation.

4.7.12 The majority of sensitive receivers to the south of the Discovery Bay North development site, e.g. Parkland Village, are low-rise buildings. Noise barriers along the southern site boundary could provide effective screening of the platform activities. Due to the low level of the platforms, it would be practical to design a noise barrier which gives a noise reduction in the order of 10 dB(A) for platforms at close distances of about 200m or less, and 5 dB(A) for platforms further away.

4.7.13 To the west of the Discovery Bay North development site, receivers in the first five storeys of the existing residential blocks forming Greenvale Village could be protected by noise barriers along the site boundary. At higher floor levels, the greater source-receiver distance gives extra noise attenuation. Where necessary, noise from the relevant platforms could be reduced further by erecting barriers along the platform boundary.

4.7.14 As shown in Tables 4.12 and 4.13, path noise mitigation measures would provide further noise reductions of 5-8 dB(A) at Greenland Court (NSR1) and 7-9 dB(A) at 13 Parkland Drive (NSR2).

4.7.15 The mitigated noise levels during the construction stages, Yr/Qtr:1/3 and Yr/Qtr:2/1 would exceed the guideline by 1 dB(A) only at NSR2. However, this very minor exceedance is expected to occur for a short period of time and will be almost unnoticeable. Thus the noise impact will be minimal.

4.7.16 At NSR1, some exceedances of the 60 dB(A) guideline by up to 5 dB(A) would be observed during the construction stages Yr/Qtr:1/3 and Yr/Qtr:2/1. Careful planning for the work programme and phasing during these two critical stages should be considered so as to control construction activities operating simultaneously. The results in Table 4.12 indicate that construction activities at platforms 4 and 5 would result in high noise levels at the NSR1. Thus, the number and type of equipment operating at platforms 4 and 5 should be carefully determined and parallel construction activities should be avoided.

4.7.17 As the construction noise assessment was based on the limited available information, the actual noise impact may be varied by some extent due to changes to the working programme and the location of the noisy equipment. A noise monitoring programme for the affected NSRs has been prepared to monitor the actual noise impact due to the construction work. This noise monitoring programme is detailed in Section 11. The EM&A team will liaise with the Site Manager and recommend effective and practical noise mitigation measures throughout the construction period.

4.7.18 As demonstrated, construction noise levels could be reduced through source and path controls to meet the 60 dB(A) standard during most of the tentative work programme. The extent of application of noise barriers would be reviewed in the light of more detailed information on the construction work programme. Some of the barriers may not be necessary if the work programme is extended or altered at the detailed construction programme scheduling stage resulting in reduced construction noise levels.

Table 4.12 Mitigated Noise Levels at NSR1

Stage	Activity				Further Screening	
Yr/Qtr	Type	SWL dB(A)	Distance (m)	FNL dB(A)	NR dB(A)	CNL dB(A)
1/1	Platform 1	119	500	60	5	55
	Platform 14	115	520	56	5	51
	Platform 6	115	480	56	5	51
	Rd P1 West	114	380	57	5	52
				64		59
1/3	Platform 1	119	500	60	5	55
	Platform 5	115	110	69	10	59
	Platform 8	115	200	64	10	54
	Rd P1 West	114	380	57	5	52
	Tunnel	116	350	60	5	55
	Dredging	118	650	57	5	52
				71		63*
2/1	Platform 1	119	500	60	5	55
	Platform 4	115	90	71	10	61
	Platform 11	117	700	55	5	50
	Platform 3	115	200	64	10	54
	Platform 10	115	270	61	5	56
	Rd P1 East	114	720	52	5	47
	Tunnel	116	350	60	5	55
	Sea Wall	118	650	57	5	52
				73		65*
2/3	Platform 12	117	600	56	5	51
	Rd P1 East	114	720	52	5	47
	Road D1	114	250	61	10	51
	Rd L1 Mid	114	200	63	10	53
	Tunnel	116	350	60	5	55
	Sea Wall	118	650	57	5	52
				67		60
3/1	Rd L1 North	114	320	59	5	54
	Rd D2 Mid	114	350	58	5	53
	Tunnel	116	350	60	5	55
	Sea Wall	118	650	57	5	52
				65		60

Note: * Reduction of this minor exceedance of the 60 dB(A) level has been fully discussed in Section 4.7.
SWL denotes Sound Power Level.
FNL denotes Facade Noise Level.
NR denotes Noise Reduction.
CNL denotes Corrected Noise Level.

Table 4.13 Mitigated Noise Levels at NSR2

Stage	Activity				Further Screening	
Yr/Qtr	Type	SWL dB(A)	Distance (m)	FNL dB(A)	NR dB(A)	CNL dB(A)
1/1	Platform 1	119	480	60	5	55
	Platform 14	115	630	54	5	49
	Platform 6	115	250	62	10	52
	Rd P1 West	114	650	53	5	48
				65		58
1/3	Platform 1	119	480	60	5	55
	Platform 5	115	400	58	5	53
	Platform 8	115	400	58	5	53
	Rd P1 West	114	650	53	5	48
	Tunnel	116	700	54	5	49
	Dredging	118	220	66	10	56
				68		61*
2/1	Platform 1	119	480	60	5	55
	Platform 4	115	480	56	5	51
	Platform 11	117	550	57	5	52
	Platform 3	115	480	56	5	51
	Platform 10	115	460	57	5	52
	Rd P1 East	114	630	53	5	48
	Tunnel	116	700	54	5	49
	Sea Wall	118	220	66	10	56
				69		61*
2/3	Platform 12	117	580	57	5	52
	Rd P1 East	114	630	53	5	48
	Road D1	114	480	55	5	50
	Rd L1 Mid	114	300	59	5	54
	Tunnel	116	700	54	5	49
	Sea Wall	118	220	66	10	56
				68		60
3/1	Rd L1 North	114	550	54	5	49
	Rd D2 Mid	114	450	56	5	51
	Tunnel	116	700	54	5	49
	Sea Wall	118	220	66	10	56
				67		58

Note: * Reduction of this minor exceedance of the 60 dB(A) level has been fully discussed in Section 4.7.
SWL denotes Sound Power Level.
FNL denotes Facade Noise Level.
NR denotes Noise Reduction.
CNL denotes Corrected Noise Level.

Conclusions

4.7.19 It has been demonstrated that the construction noise impact could be mitigated by a suitable combination of source-path control measures. Noise levels can also be reduced through construction programming and good site practice. In addition to the engineering measures outlined above, good community relations should be considered an important element of the site noise management. The affected residents should be notified in advance of planned activities and their progress and, where necessary, a liaison body involving the residents should be established to respond to complaints of excessive noise. Construction noise levels will be closely monitored as part of the EM&A requirements.

4.8 Operational Noise Mitigation

4.8.1 Noise mitigation measures have been incorporated into layout of the roads and buildings to minimise the potential impacts of road traffic and container port noise. These measures include:

- the use of single-aspect building design to provide a noise shield to road P1;
- alignment of road P1 behind single-aspect buildings;
- minimisation of the gradient of roads close to residential blocks;
- orientation of buildings to minimise exposure to port noise; and
- use of noise insensitive buildings to screen NSRs from road traffic noise and port noise.

4.8.2 The above measures have resulted in full compliance with the HKPSG standard for road traffic noise. For container port noise, the benefit of shielding achieved through building orientation has minimised the port noise exposure. Noise modelling results indicate that the night-time noise level would not exceed the NCO standard of 55 dB(A) at any flats in the Discovery Bay North development. The night-time planning criterion of 45 dB(A) would be exceeded at 3.4% of the flats. The operator of the Container Terminals has the duty to adopt effective measures to control the noise at source.

5.

AIR QUALITY

5. Air Quality

5.1 Introduction

5.1.1 This section addresses the potential construction and operation air quality impacts of the Discovery Bay North Master Plan 6.0(A) development. The results of construction dust modelling are presented for different scenarios and dust mitigation measures are recommended.

5.1.2 Emissions of nitrogen dioxide (NO_2) and Respirable Suspended Particulates (RSP) from motor vehicles have been modelled for the operational phase of the project.

5.2 Legislation and Environmental Planning Requirements

5.2.1 The Hong Kong Air Quality Objectives (AQOs) are shown in Table 5.1 for the three relevant air pollutants. The main air pollutant from the construction activities that may affect the proposed development and the existing Discovery Bay development will be Total Suspended Particulates (TSP). Respirable Suspended Particulates (RSP) and Nitrogen Dioxide (NO_2) are modelled and assessed for the operational stage motor vehicle usage.

Table 5.1 Hong Kong Air Quality Objectives

Pollutant	Average Concentration ($\mu g/m^3$)		
	1 hour*	24 hour**	1 year
Sulphur Dioxide	800	350	80
Nitrogen Dioxide	300	150	80
Total Suspended Particulates	500***	260	80
Respirable Suspended Particulates		180	55

* Not to be exceeded more than three time per year.
** Not to be exceeded more once per year.
*** Guidelines used to assess short-term dust nuisance.

5.3 Existing Air Quality

5.3.1 At present there are few sources of air pollution on Lantau Island, the only significant source being the gas turbine power station at Penny's Bay. Vehicle access is restricted and there are no large scale industries. However, pollutants are carried by the prevailing winds from major urban and industrial

areas of Hong Kong and ambient air quality is therefore affected by air emissions from the main urban areas.

5.3.2 Royal Observatory wind data for the period January 1981 to December 1991 is shown as a wind rose in Figure 5.1. Winds blow from the eastern quadrant for more than 60% of the year. During such periods, Discovery Bay is downwind of air pollution sources on Hong Kong Island and Kowloon. Many of the potential pollution sources are several kilometres away from the Yi Pak area, and therefore severe pollution events would not be expected to occur very often.

5.3.3 For 25% of the year, wind blows from the southern and western quadrants. As there no pollution sources to the south and west of Lantau Island, and few on the island itself, Discovery Bay would be expected to experience good air quality during these conditions.

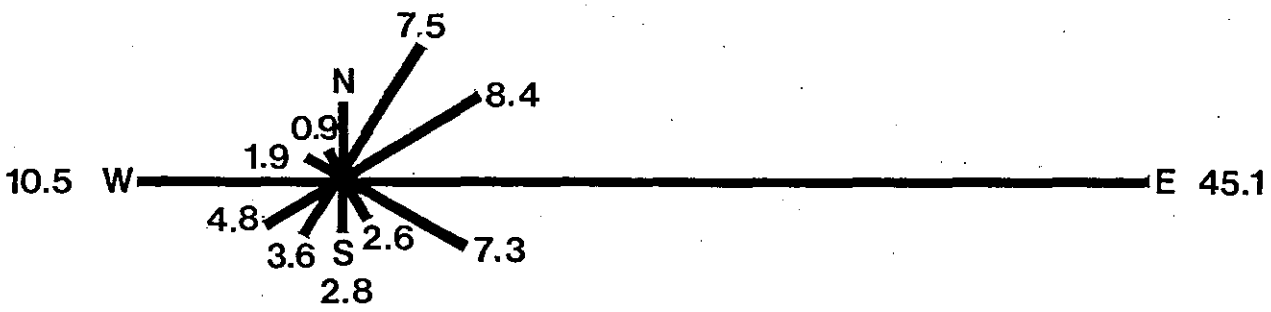
5.3.4 Although data from the Royal Observatory provide a general indication of wind patterns, the topography of Lantau causes localised patterns. The central ridge forms a barrier to wind and the steep-sided valleys also influence wind patterns and can impede dispersion. Local effects are also caused by land/sea air flows.

5.3.5 There is no EPD air quality monitoring station located on Lantau and no historic air quality data is available for the project area. An estimate of the air pollutant concentrations in the North Lantau area was made for the North Lantau Development Study and background monitoring for Discovery Bay has recently been carried out as part of the Lantau Port and Western Harbour Development Study. These results are reproduced in Table 5.2.

Table 5.2 Estimated and Measured Air Pollutant Concentrations in North Lantau and Discovery Bay

	Estimated Concentration ($\mu g/m^3$)		
Pollutant	1 hour	24 hour	1 year
Sulphur dioxide	200 (129)	50 (9)	5
Nitrogen Dioxide	140 (134)	70 (45)	20
TSP		60 (134)	20
RSP		30 (104)	
Ozone	100		40

Note: Unbracketed figures are from the North Lantau Study, for average conditions. Figures in brackets are maximum on-site measurements at Discovery Bay (Lantau Port and Western Harbour Development Studies Environmental Baseline, February 1992).



N.B. Percentage frequency with winds from direction shown (calm 1.0%)

Source: Royal Observatory

Figure 5.1
Hong Kong Wind Rose (1981-1991)

5.3.6 Estimates of ambient concentrations are within the AQOs. The estimates refer to 'average conditions' and in adverse meteorological conditions that limit dispersion, higher concentrations may occur.

5.3.7 The Penny Bay's gas turbine power (GTP) station is located approximately 3km to the north east. The GTP has the highest potential for affecting local air quality over the short term, i.e. 1-hour average conditions. The Environmental Impact Assessment of Penny's Bay Gas Turbine Plant. Key Issue Report No. 1: Air Quality (ERL (Asia) Ltd., November 1990) undertook both numerical modelling and wind tunnel modelling to determine the effect of the power station on Discovery Bay and other localities. The numerical modelling lead to the conclusions 'that beyond 2000m, no significant potential exists for unacceptable air quality impacts, either with or without terrain effects'. The wind tunnel modelling led to the conclusions 'that no unacceptable impacts will be experienced' at Discovery Bay.

Future Developments

5.3.8 Air quality on Lantau Island will change significantly as a result of airport related developments on North Lantau. Although buffered from these sources of air pollution by the intervening peaks, air quality in Discovery Bay is expected to be slightly affected, particularly during construction. However, no significant impact on air quality is expected to be caused by the airport projects during operation.

5.3.9 The port facilities and associated industrial developments will be much closer to Discovery Bay. Air quality in the study area will be influenced by these developments under the prevailing north-easterly winds. In particular, levels of TSP are expected to rise as a result of the port construction activities. These effects could be significant if not adequately controlled.

5.4 Potential Emission Sources

Construction Phase

5.4.1 Dust will be the main air quality concern during the construction phase, particularly the potential nuisance to existing residents during dry dusty working conditions. Locations up to 500m from a ground level dust source may be considered vulnerable to dust nuisance.

5.4.2 Dust will be produced from various earth moving and materials handling operations during reclamation, construction and borrow activities. Dust sources during the reclamation/construction activity will include:

- vehicle travel on unpaved roadways;
- earth movement by shovel, bulldozer or scraper activity;
- possible shot hole drilling and blasting;
- dry material storage piles;

- material handling;
- general construction activity; and
- wind erosion from open areas - especially disturbed areas.

5.4.3 Gaseous emissions from construction plant will have a minor impact on air quality although they may have localised effects if sources (e.g. generators) are badly sited or if mobile sources continue to run their engines whilst loading or unloading in confined spaces. The control of such activities will be a matter for the site management.

Operational Phase

5.4.4 Once construction of the Discovery Bay North development has been completed, there will be few, if any, fixed sources of air pollutants. The only nearby point source with the potential to have any effect on the development is the gas turbine power station at Penny's Bay. However, owing to the distance to the power station (3km) and its relatively small size, the station has minimal impact on Discovery Bay. As discussed in Section 5.3, this has been confirmed by computer and wind tunnel modelling completed as part of the EIA for the station (ERL (Asia) Ltd., November 1990).

5.4.5 There will be emissions associated with transport related sources. Discovery Bay is traffic free except for public transport services and the policy of limited vehicle access will be extended to the Discovery Bay North development. Diesel powered buses will be the principal sources of localised air contaminants.

5.4.6 The tunnel will be ventilated by means of a jet fan system from the Discovery Bay Portal exhausting to Siu Ho Wan. Combined with the prevailing easterly winds, vehicle emissions from the tunnel portal will have no impact on Discovery Bay North.

5.4.7 The only significant traffic flows within Discovery Bay North will be on the tunnel exit road. Owing to the low traffic usage, the layout of roadways and locations of sensitive receivers, no local operational air quality problems due to traffic are expected.

5.4.8 The proposed sewage pumping stations will be a potential source of odour arising both from the sewage and sewage screenings collected in the station. The sewage pumping system design will aim to minimise sewage odour. The existing Discovery Bay Pumping Station No. 2 operates a screening facility without odour nuisance. The screenings are macerated, dehydrated and bagged for disposal. The screenings from the proposed pumping facilities will be treated in a similarly controlled manner and consequently should not cause odour nuisance.

5.5 Construction Dust

Previous Modelling

5.5.1 Modelling of the fugitive dust emissions during the construction phase of the Master Plan 6.0 Discovery Bay North development was undertaken in November and December 1994 and the results presented in the Discovery Bay North Initial Assessment Report (HKR, 1994a) and the Key Issues Report (HKR, 1995b).

5.5.2 The previous studies modelled the predicted dust concentrations for two separate construction periods. The first period included the removal of the top of Yi Pak Hill. In the worst case scenario, this was assumed to be undertaken by blasting and blasting was shown to be the most significant source of dust. The second construction period was assumed to have no blasting. The main source of dust in the second period was the loading/unloading associated with the cut and fill operation within the site. The first construction period was then remodelled assuming that no blasting was required and in this scenario, the main source of dust was the transport of spoil material from the Yi Pak hilltop to fill areas within the site.

5.5.3 Since these modelling studies, the original layout plan has changed and is now known as Master Plan 6.0(A). The main changes are a reduction in the size of the reclamation and an extension to the building platform on the eastern end of Yi Pak Hill. The spur on the north-eastern side of the site will be cut back further with approximately 10,000 m^3 of extra spoil material to be removed and used as fill within the site. The following sections update the previous modelling studies with some refinement of the emission calculations.

Dust Modelling Methodology

5.5.4 It was agreed with EPD that the Fugitive Dust Model (FDM) would be used to assess the impact of the dust emissions from the construction processes. FDM is a computerised air quality model specifically designed for computing concentration and deposition impacts from fugitive dust sources. The model is based on the Gaussian plume formulation for computing concentrations, but the model has been specifically adapted to incorporate an improved gradient transfer deposition algorithm.

5.5.5 The model is limited by the inability to simulate the effects of complex terrain. The model also assumes constant meteorology over the area. Due to the hills to the north and west of the site, the wind data will not accurately represent the local situation. As with all commonly used air pollution models, the results are not totally accurate and should only be used as a guide and with care.

5.5.6 Emission rates were estimated over the development area and the adjoining areas to determine the maximum 1 hour, the maximum 24 hour and the annual average concentrations of TSP for the worst case scenario with no dust mitigation.

Sensitive Receivers

5.5.7 The sensitive receivers are the existing tower blocks to the west of the site (Greenvale Village) and the housing on the southern side of the site (Parkland Drive and the western end of Headland Village). A receptor grid (21 by 17) with a grid spacing of 50m was placed over the site.

5.5.8 As discussed below, it is considered that blasting would have the greatest impact on the existing housing. As the existing housing is at approximately the same height as the area to be blasted, all sources and receptors were placed at the same height.

Meteorology

5.5.9 Meteorological data from Cheung Chau was used for the modelling study as agreed with EPD. The data were edited to a form suitable for the FDM model. Days where there were 3 or more hours of consecutive missing data were discarded. Where two or less hours were missing, the missing data were replaced with interpolated values. In all, data for 8736 hours (364 days) were available. A wind rose for the meteorological data is shown in Figure 5.2. The meteorological station is at a height of approximately +92 mPD.

Emission Estimation

5.5.10 The estimation of dust emissions which are used as input to the model are based on emission factors from US EPA AP-42, 'Compilation of Air Pollutant Emission Factors' Fourth Edition 1985. There is a proposed fifth edition of the document and sections have been publicly released. Relevant to this project is the section '13.2 Fugitive Dust Sources' which is equivalent to the section '11.2 Fugitive Dust Sources' in the fourth edition. There are some minor changes in the new section and these have been adopted where applicable.

5.5.11 The main sources of dust are considered to be:

- removal of the top of the hill in the centre of the development (Yi Pak Hill) from a maximum height of +75 mPD to a height of approximately +35 to 40 mPD;
- dumping of material taken from Yi Pak Hill and building platforms to the fill areas in the valley and the reclamation site;
- loading and unloading associated with the cutting and filling of the platforms for housing; and
- dust from trucks on unpaved roads transporting material from one site (particularly Yi Pak Hill) to another.

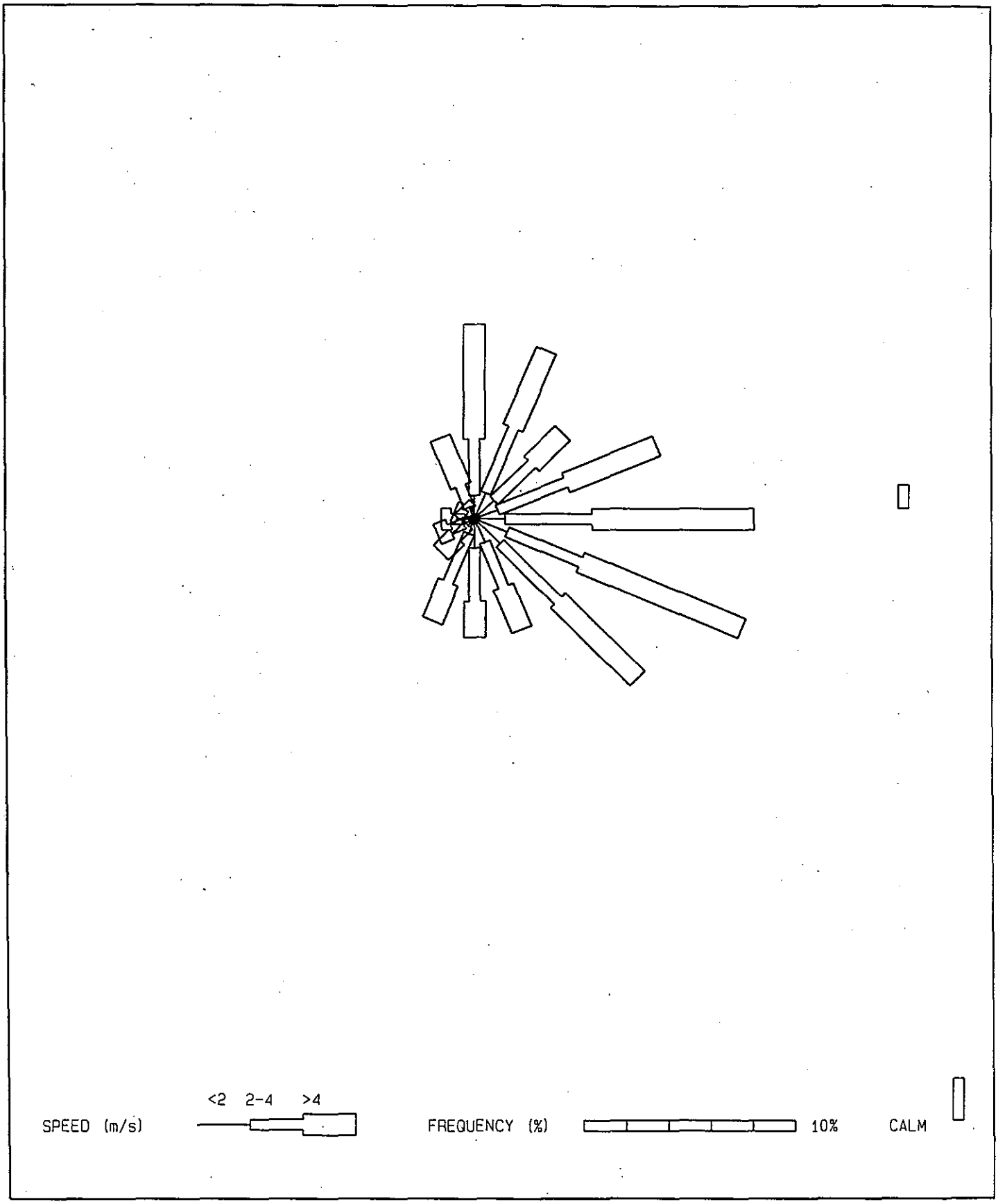


Figure 5.2
Cheung Chau Wind Rose (1991)

5.5.12 Other dust sources that would contribute to the dust levels to a lesser degree include:

- dry storage areas;
- wind erosion from open disturbed areas; and
- general construction activity.

5.5.13 It is assumed that the fill for the main reclamation area will be marine sands which will be transported to the site by sea. These marine sands should have a very high moisture content and should create very little dust when dumped.

5.5.14 It is estimated that there will be a total of 1,010,000 m^3 of material excavated. Of this amount 750,000 m^3 will be from Yi Pak Hill in the centre of the development. The remaining amount will be from the other platforms. Of the material excavated, 700,000 m^3 will be used as fill for various platforms and in the valley. The remaining 310,000 m^3 would be used in the sea wall and reclamation.

5.5.15 Many of the details required to calculate the dust emission factors are not known. For example, tests to determine the type of material in the platforms and the top of Yi Pak Hill are not complete and the best estimations have been used. Past experience has been that the housing platforms are formed by use of front end loader or equivalent. This would produce dust by the picking and dropping of material.

5.5.16 It is assumed that the only blasting required on site (apart from tunnel formation works) is that needed to remove the top of the hill in the centre of the development. Site investigation work may reveal that this blasting can be severely reduced, or perhaps eliminated completely.

5.5.17 Due to the fact that many of the input parameters have needed to be estimated and due to the fact that this type of air pollution modelling is not totally accurate, care must be taken in interpreting the output.

5.5.18 The tentative construction programme indicates two main periods of earthworks. The first period of approximately 10 months would include the removal of Yi Pak Hill and could involve blasting.

5.5.19 The TSP concentrations have been calculated for the two main periods of earthworks. The first period of approximately 10 months was modelled twice as follows:

- once assuming that blasting is used to remove all of the top and spur of Yi Pak Hill; and
- once assuming that the top of Yi Pak Hill could be removed without blasting (dust emissions were calculated for spoil loading/unloading activities).

5.5.20 The second modelling period assumed no blasting works and that the main contributor to fugitive dust emissions would be the cut and fill operations. The method of calculating dust emissions for the FDM model is shown in Appendix 2.

Tunnel Construction

5.5.21 The tunnel will be constructed by the drill and blast method working from both the Discovery Bay and Siu Ho Wan portals. During portal construction, some blasting dust will be emitted to the environment in the form of puffs of dust. The dust per blast is calculated in Appendix 2. The blasting for portal development would be spasmodic. The dust for one blast at the Discovery Bay portal over a 1 hour period was modelled using FDM over the whole year of meteorological data. The results of dust emission modelling at the Siu Ho Wan portal are presented in the Road and Tunnel Link Final EIA Report (HKR, 1995d).

5.5.22 When the main excavation of the tunnel starts, dust will be generated by blasting within the tunnel but will be confined to the tunnel. The main source of dust during tunneling will be the transport of spoil from the tunnel to the dumping site by trucks. The dust generated by the transport of spoil is calculated in Appendix 2. This source of dust was then incorporated into each modelling scenario described in Sections 5.5.19 and 5.5.20.

Impact Assessment

5.5.23 The results of the construction dust modelling for the worst case scenario with no dust mitigation are shown in Figures 5.3 to 5.11. TSP concentrations will be higher near the eastern end of Yi Pak Hill than in Master Plan 6.0 but TSP levels near sensitive receivers have not increased in Master Plan 6.0(A).

5.5.24 During the first construction period (months 1-10) under the 'no blasting' scenario, unmitigated TSP levels would slightly exceed the EPD 1 hour guideline and the 24 hour AQO at 13 Parkland Drive only. The annual TSP level would comply with the annual AQO TSP standard.

5.5.25 During the first construction period (months 1-10) under the 'blasting' scenario for Yi Pak Hill, unmitigated TSP levels would exceed the EPD 1 hour guideline at 13 Parkland Drive and the 5 northern blocks of Greenvale Village with TSP levels approaching 750 ug/m^3 at the 2 blocks proposed under Master Plan 5.7. 24 hour unmitigated TSP levels would exceed the AQO standard at 7, 9, 11 and 13 Parkland Drive and the 8 northern blocks of Greenvale Village; the highest predicted 24 hour TSP level is at 13 Parkland Drive and is 350 ug/m^3. Without mitigation, annual TSP levels would slightly exceed the AQO at 13 Parkland Drive, Greenbelt Court and the two blocks proposed under Master Plan 5.7 with TSP levels approaching 95 ug/m^3.

5.5.26 During the second construction period (months 11-end), unmitigated TSP levels would comply with the EPD guideline and the AQO during the second period of works in the Discovery Bay North site.

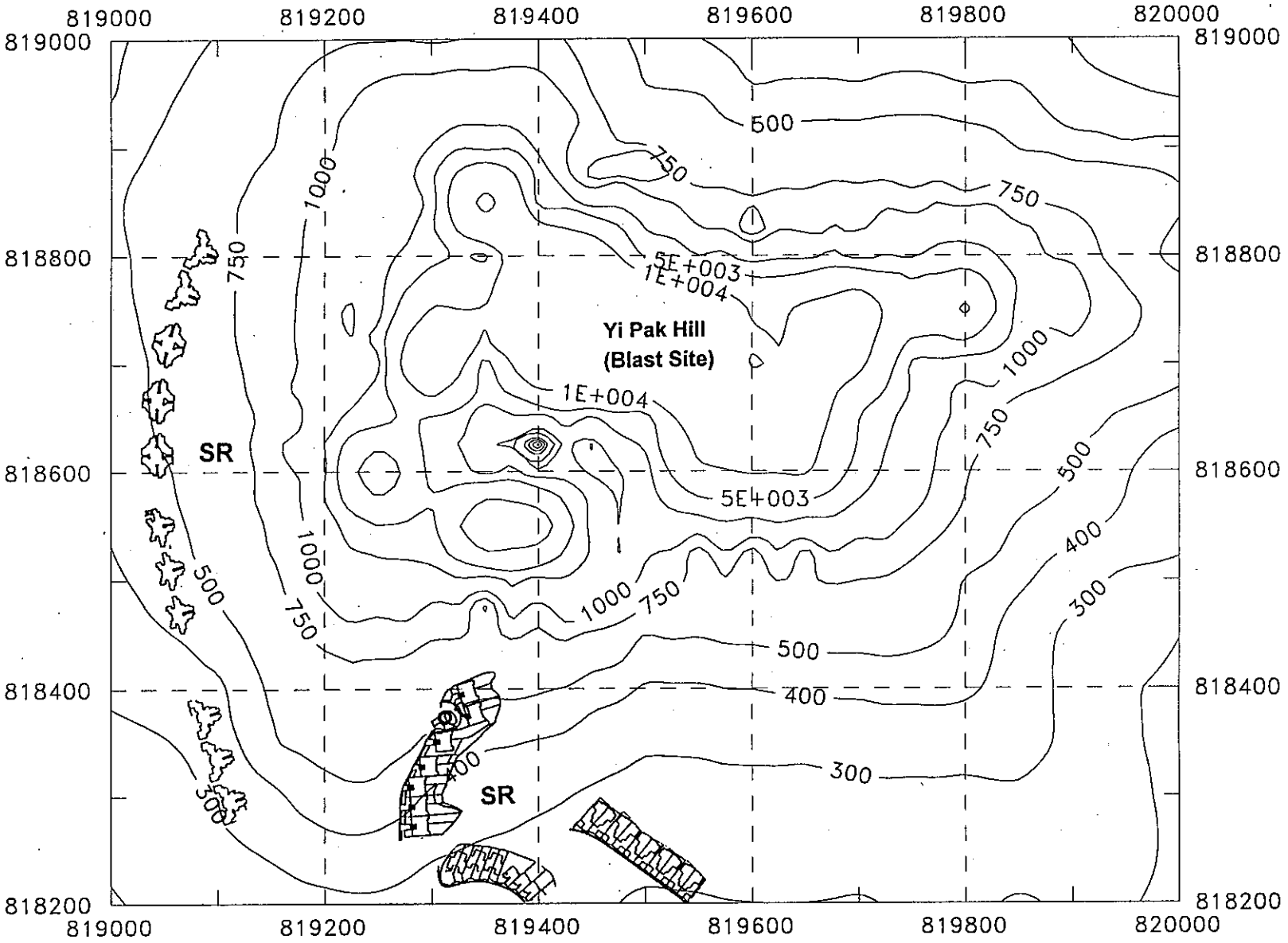
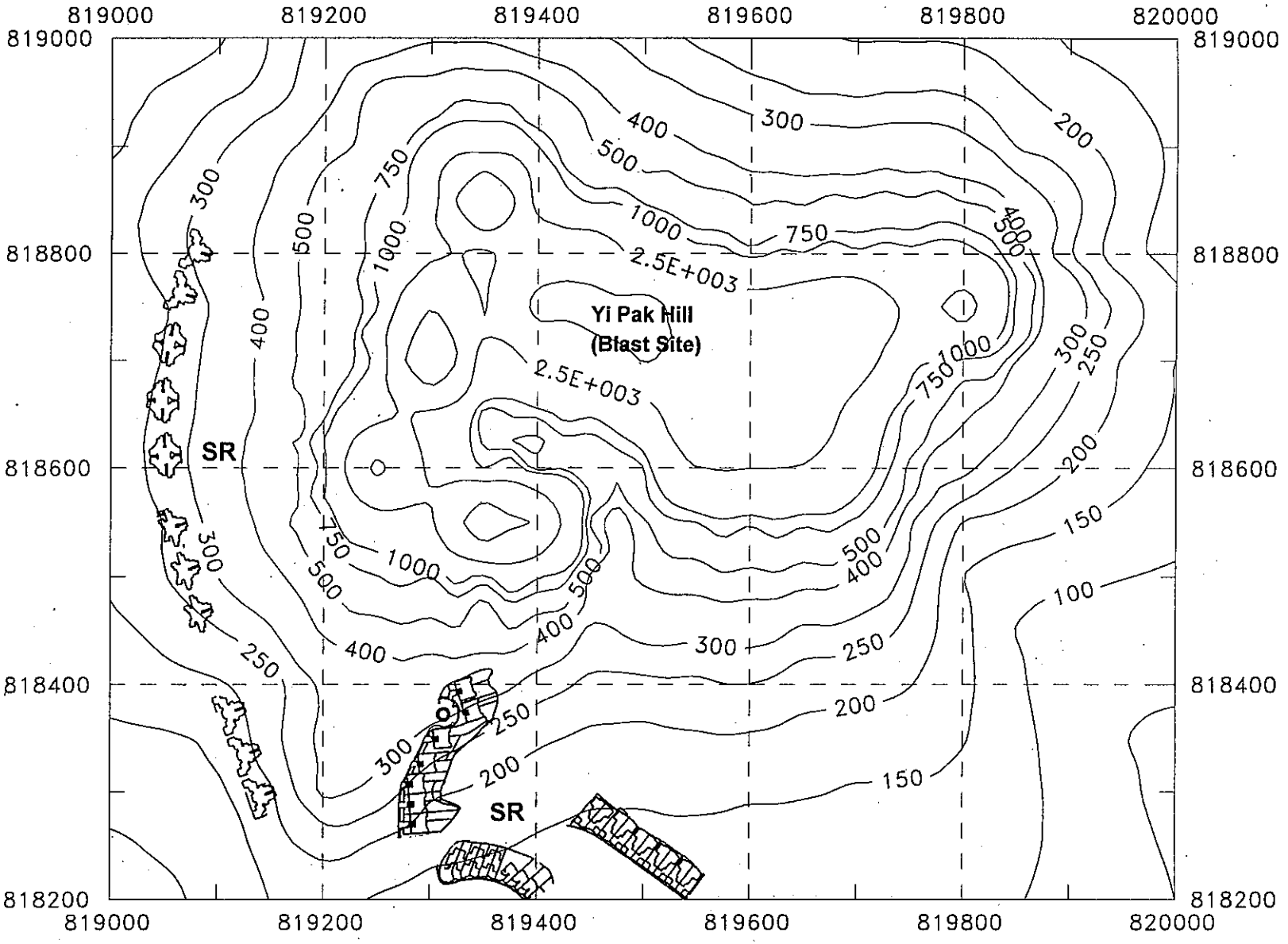


Figure 5.3
Maximum TSP (1 Hour Average) First Period With Blasting



SR = Sensitive Receiver

Figure 5.4
Maximum TSP (24 Hour Average) First Period With Blasting

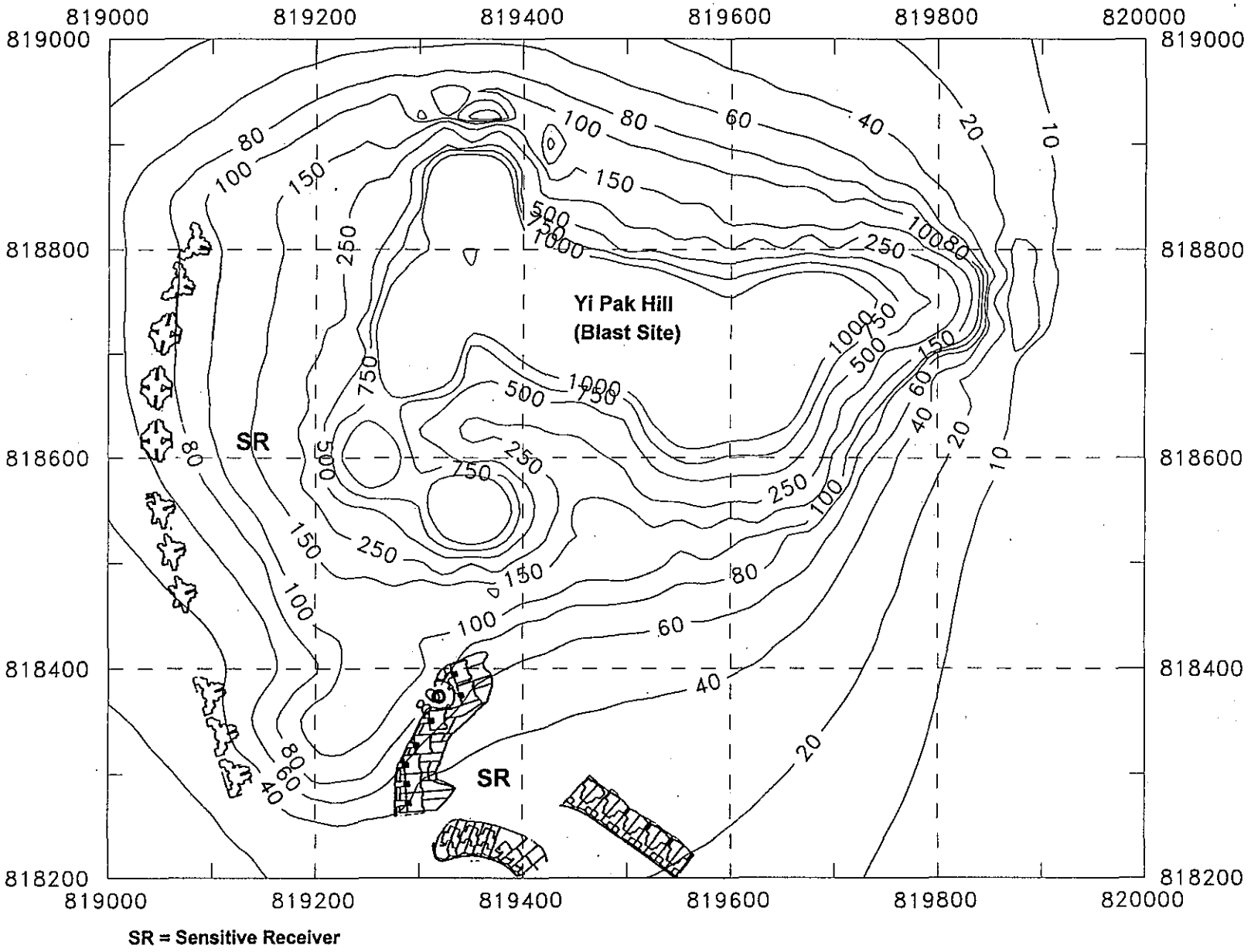


Figure 5.5
TSP (Annual Average) First Period With Blasting

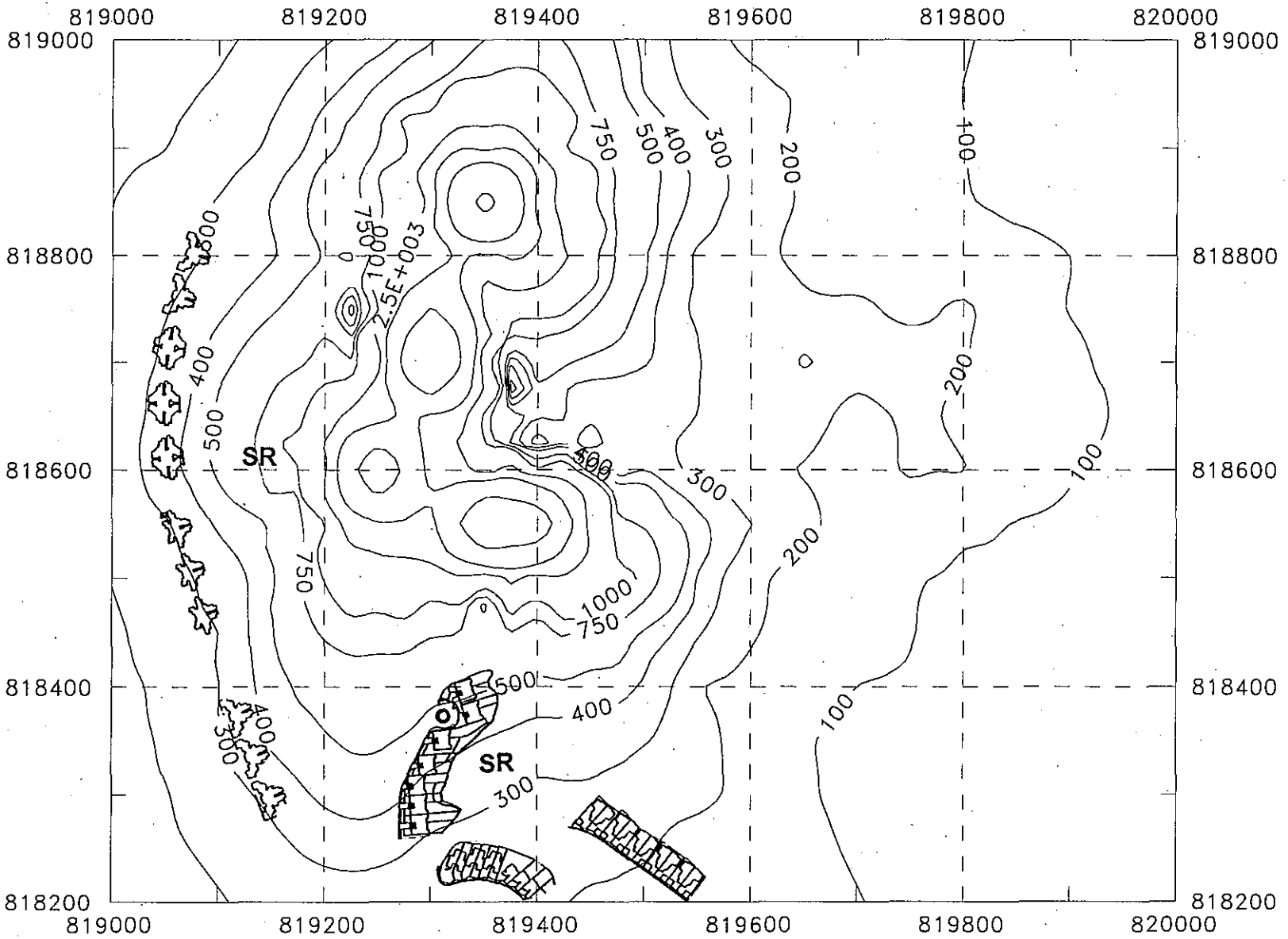


Figure 5.6
Maximum TSP (1 Hour Average) First Period With No Blasting

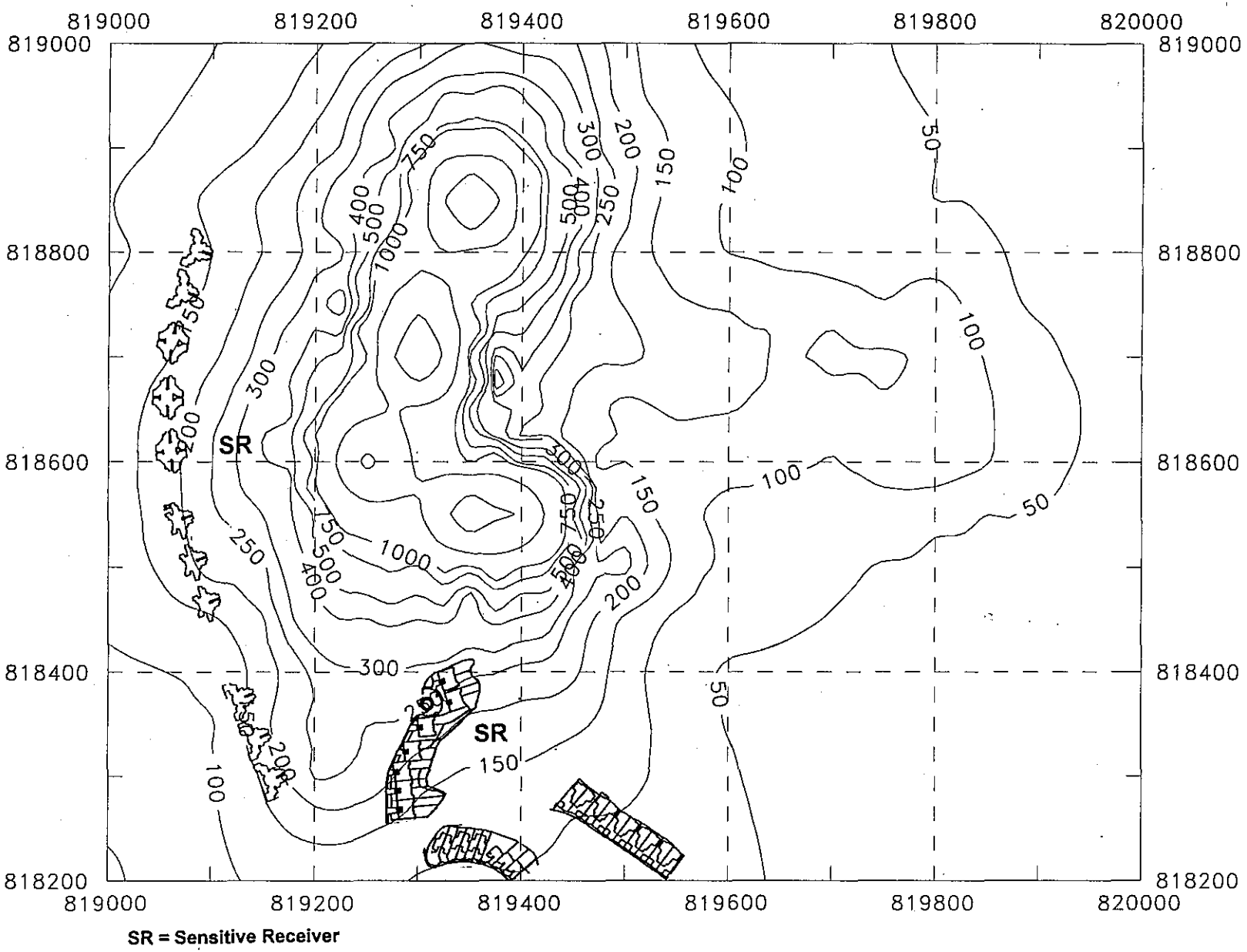
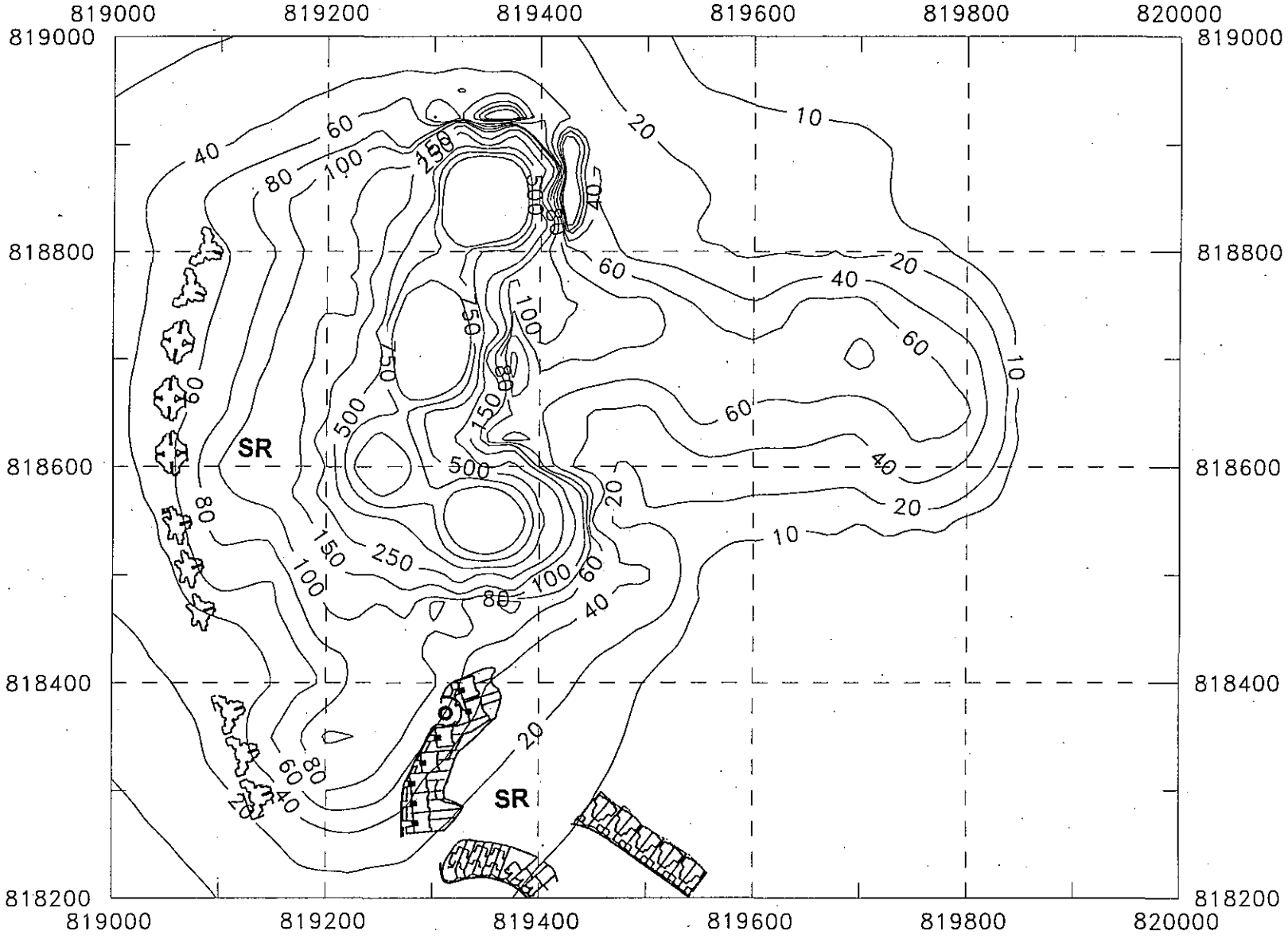


Figure 5.7
Maximum TSP (24 Hour Average) First Period With No Blasting



SR = Sensitive Receiver

Figure 5.8
TSP (Annual Average) First Period With No Blasting

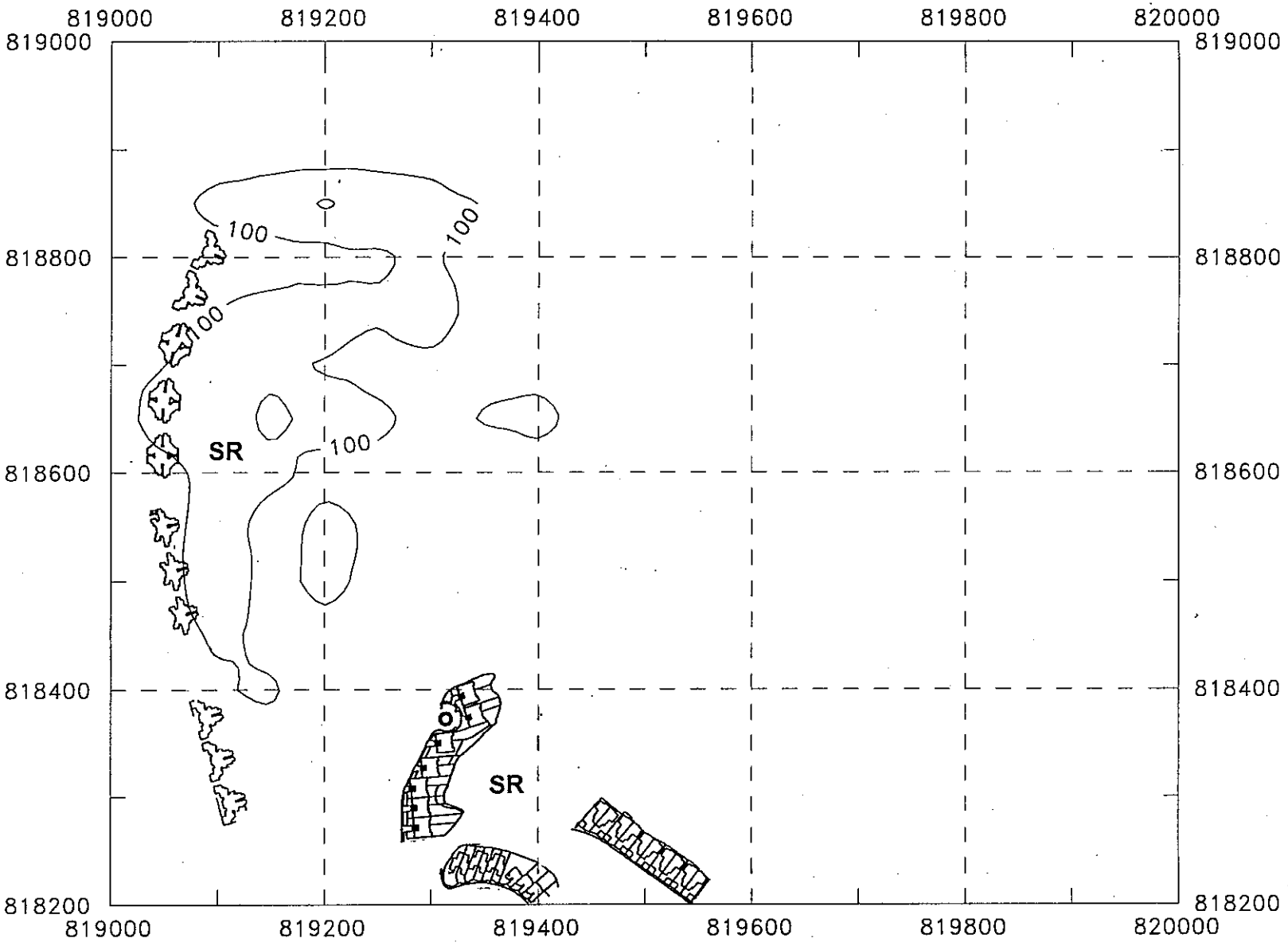


Figure 5.9
Maximum TSP (1 Hour Average) Second Period With No Blasting

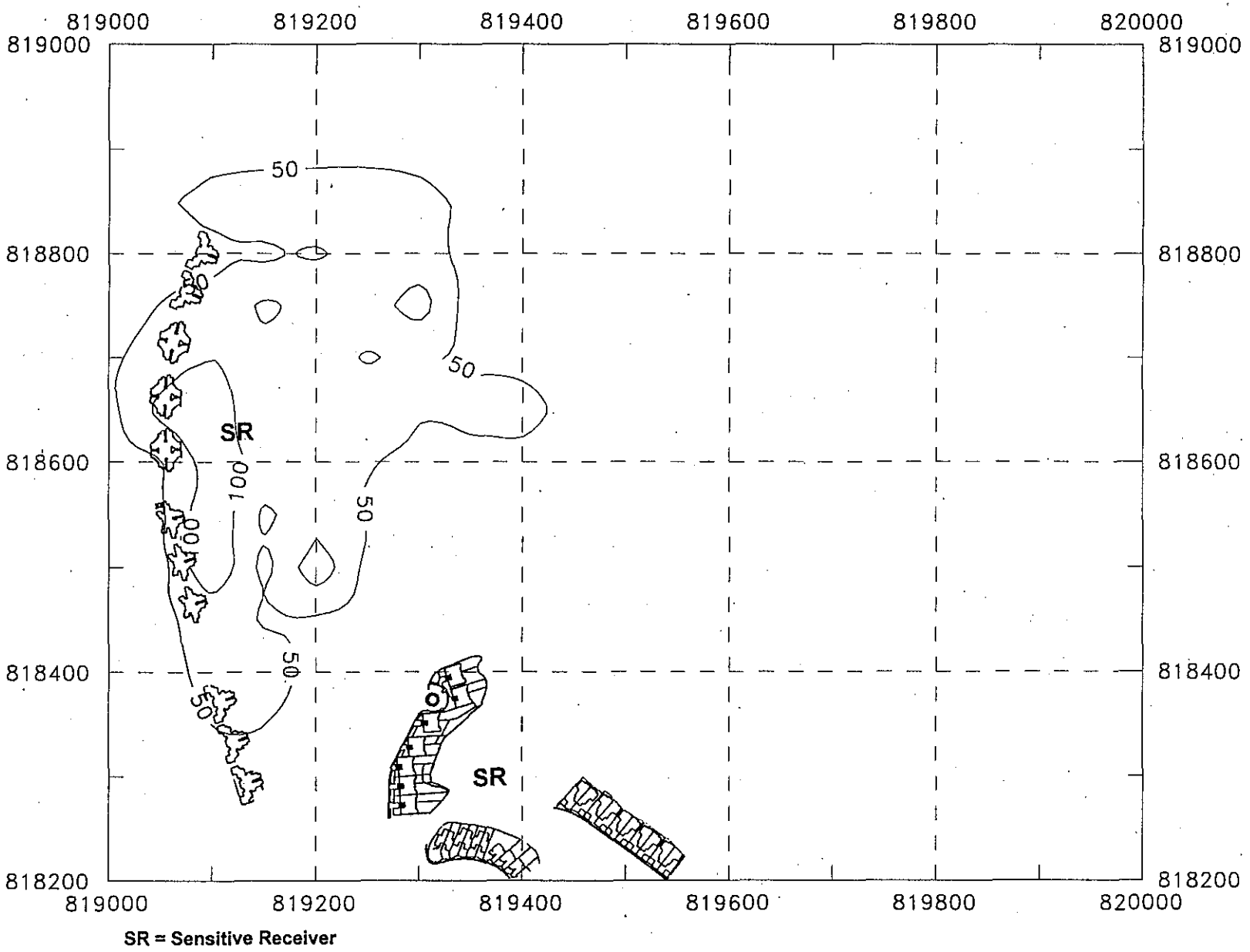
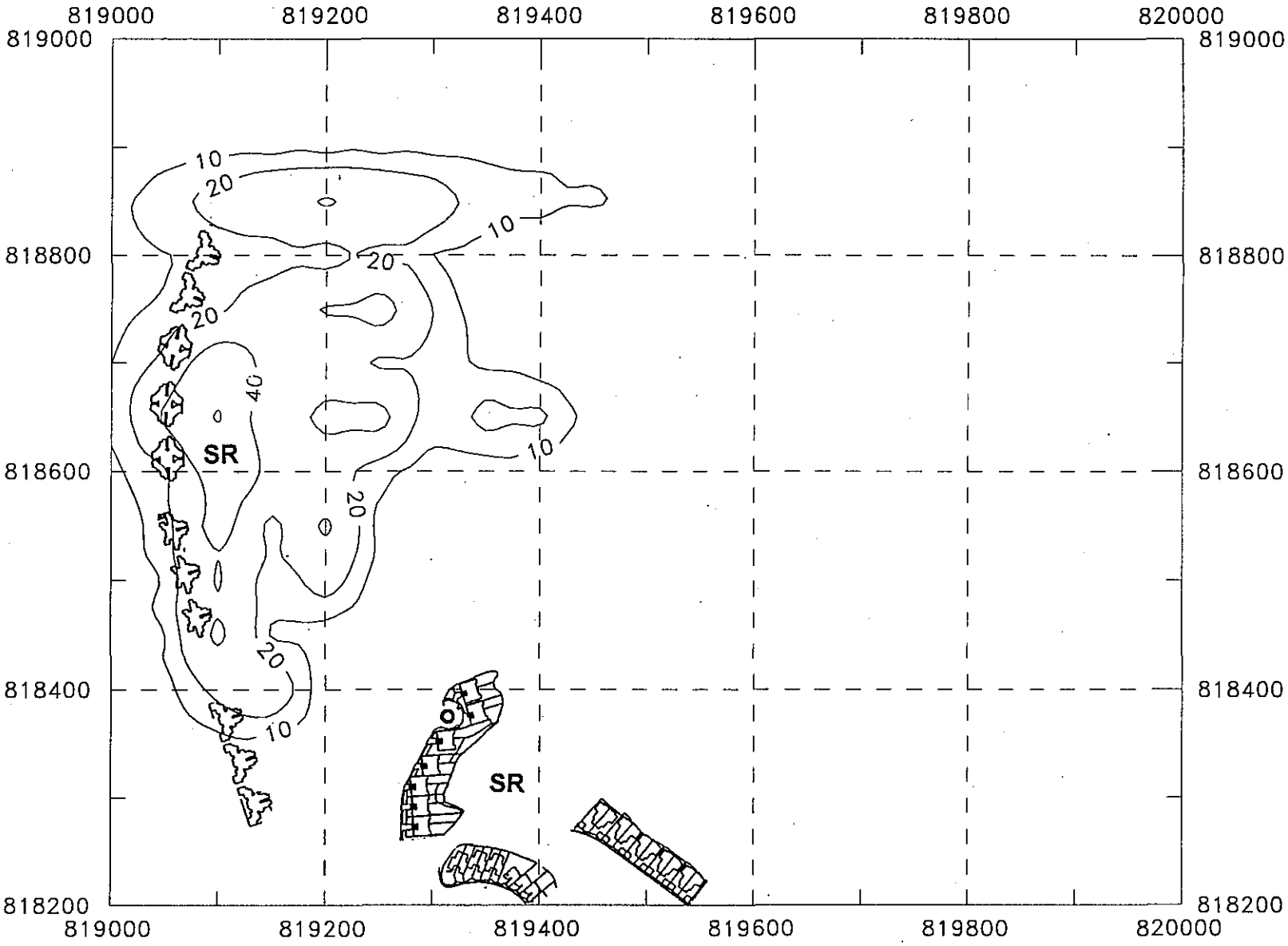


Figure 5.10
Maximum TSP (24 Hour Average) Second Period With No Blasting



SR = Sensitive Receiver

Figure 5.11
TSP (Annual Average) Second Period With No Blasting

5.5.27 The modelling results indicate that dust from blasting and the transport of spoil material from the top of Yi Pak Hill to the fill sites will be the major contributor to TSP levels at the sensitive receivers.

5.5.28 The results of dust emission modelling during blasting at the Discovery Bay portal are shown in Figure 5.12. Blasting at the Discovery Bay tunnel portal is predicted to give rise to TSP emissions which exceed the EPD 1 hour guideline at the 8 northern blocks of Greenvale Village, with unmitigated TSP levels of 10,000 ug/m^3 at the two blocks proposed under Master Plan 5.7. The TSP levels can be reduced through careful control of the blasting process and with the implementation of dust mitigation measures. Additional TSP modelling studies may be required once details of the extent of blasting, ground conditions and construction programme are available.

5.5.29 The modelling results must be interpreted with the following considerations:

- No dust mitigation measures have been included in the modelling.
- The FDM dispersion model cannot simulate complex terrain features. The high ridges to the north and west would drastically alter the wind flow around the area and have a resulting effect on the modelled dust concentrations.
- The extent of blasting activity and material transport is not known at this stage. The top of Yi Pak Hill may not require blasting to remove the top 36m as the rock would be expected to be weathered to some depth. Weathering may be expected to have occurred to some 15m from the top of the hill, and 10m from the sides.

5.5.30 In conclusion, the modelling results indicate that dust levels from general construction works could be high at the sensitive receivers to the immediate west and south-west of the development site. In practice, however, blasting will occur in localised areas and dust arising from fill and spoil transport will be reduced through the implementation of mitigation measures. Dust from blasting works at the Discovery Bay tunnel portal can be reduced with the application of suitable controls and mitigation measures. In general, therefore, TSP emissions from construction works will not be a major problem and with the effective implementation of the dust control measures outlined in Section 5.7, TSP levels should be within the AQOs at sensitive receivers.

5.5.31 Following discussion with EPD, additional TSP modelling studies may be required for blasting works once further details of site conditions, construction programme, methodology and equipment are available.

5.6 Operational Phase Vehicle Emissions

Modelling Methodology

5.6.1 Maximum one-hour concentrations of NO_2 and RSP have been predicted using CALINE4, as agreed with EPD. CALINE4 is a line source air quality model developed by the California Department of Transport. It is based on the Gaussian diffusion equation and employs a mixing zone concept to characterise pollutant dispersion over the roadway.

5.6.2 As motor cars are banned from the development, the vehicles using the tunnel access road will be the main contributors to the emissions of NO_x and RSP.

5.6.3 The following input parameters to CALINE4 were used to represent the worst case:

- Wind speed 1.0 m/s
- Wind Direction Worst case
- Wind Direction Variation 12 degrees
- Stability Class D
- Mixing Height 1000m
- Temperature 25 °C

5.6.4 The assessment has been based on future fleet average emission factors for NOx and RSP. These were provided by EPD and originated from the US EPA MOBILE IV programme and adopt the US FTP 75 driving cycle.

5.6.5 Traffic flows forecast for the AM peak hour for Master Plan 6.0 upon full development were used as input for the modelling (Table 5.3). It was assumed that there are no private cars or taxis. Only the tunnel access road was used for modelling, as this represents the worst case for the development.

Table 5.3 Traffic Flow Forecast - Master Plan 6.0

Road Section	Goods Vehicles	Coach	Light Bus	Bus Vehicles	Total
Tunnel exit to roundabout	130	24	13	48	215
Roundabout to coast	94	12	4	132	242

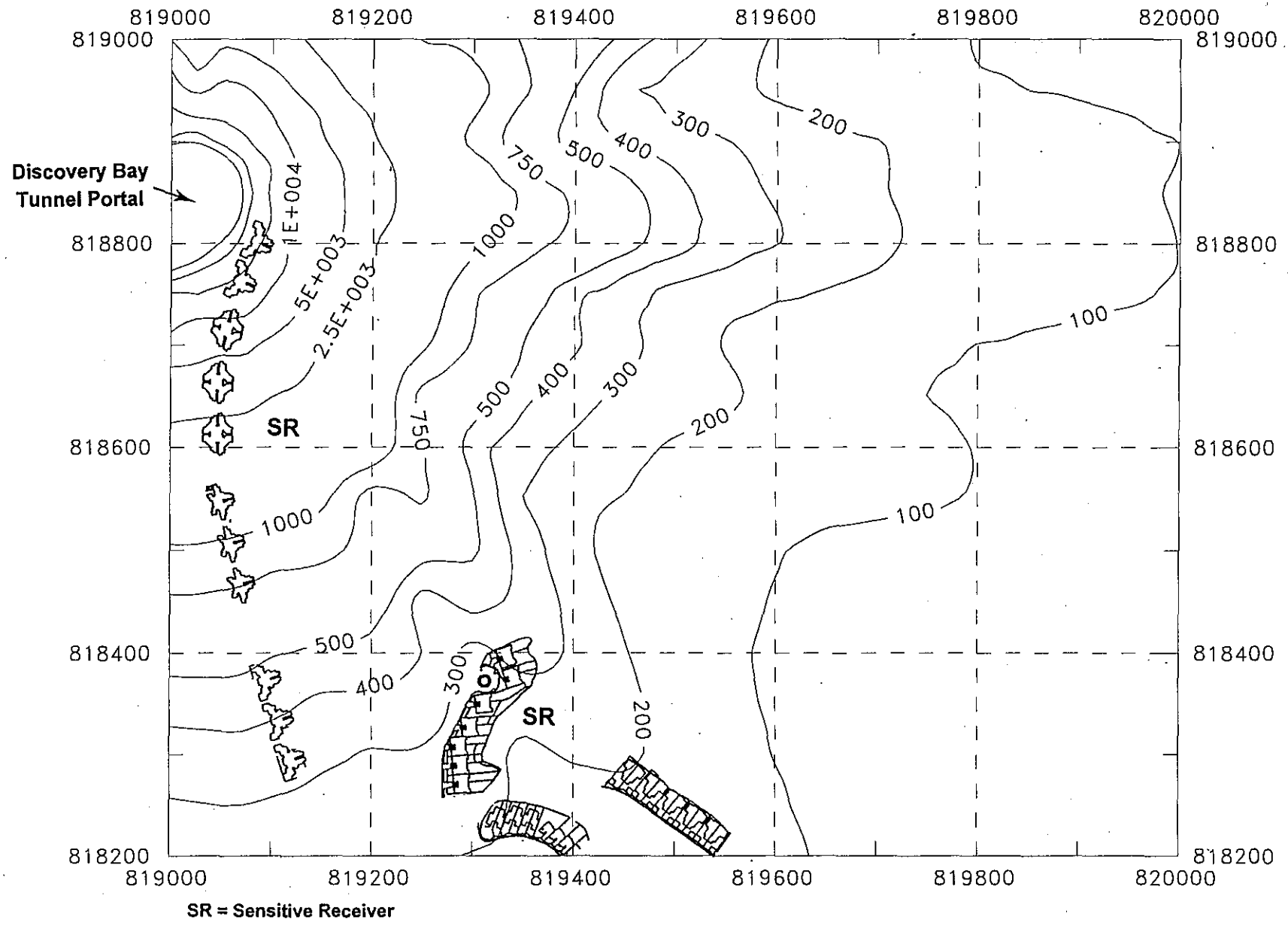


Figure 5.12
Maximum TSP (1 Hour Average) from Blasting at the Discovery Bay North Tunnel Portal

5.6.6 It was assumed that of the Goods Vehicles:

- 6% were heavy goods vehicles (over 16 tonne GVW);
- 9% were medium goods vehicles (up to 16 tonne GVW);
- 72% were diesel fueled light goods vehicles (up to 5.5 tonne GVW); and
- 13% were petrol fueled light goods vehicles (up to 5.5 tonne GVW).

5.6.7 Due to the very low traffic flows on all other roads, the concentrations of NO_x and RSP were only calculated at the buildings closest to the road. The predicted concentrations of NO_x and RSP were only calculated for the buildings on platforms 1 and 2.

Impact Assessment

5.6.8 In Master Plan 6.0, the maximum hourly concentrations of RSP were very low, as shown in Figure 5.13. All predicted concentrations were less than 10 $\mu g/m^3$, which is well below the AQOs for both the 24-hour and the annual figures. In addition, the predicted NO_2 concentrations (1 hour) were below 7 $\mu g/m^3$ at all locations, compared with the AQO of 300 $\mu g/m^3$.

5.6.9 These results were reviewed using the revised traffic flow forecast for Master Plan 6.0(A) upon full development. The revised traffic flow forecast for the tunnel access road is shown in Table 5.4.

Table 5.4 Revised Traffic Flow Forecast - Master Plan 6.0(A)

Road Section	Goods Vehicles	Coach	Light Bus	Buses	Total
Tunnel exit to roundabout	123 (-5%)	24	13	48	208 (-3%)
Roundabout to coast	92 (-2%	0 (-100%)	0 (-100%)	172 (+30%)	264 (+9%)

Note: Figures in brackets refer to the % change in vehicle flows compared with Master Plan 6.0.

5.6.10 The adjustments to the traffic forecasts are minor and the implications of these changes on the modelling results are considered to be insignificant. Thus, both the RSP and NO_2 concentrations from vehicles in Discovery Bay North will continue to be well within the AQOs with Master Plan 6.0(A).

5.6.11 The tunnel will be ventilated by means of a jet fan system from an inlet at Discovery Bay exhausting to the Siu Ho Wan side. Combined with the prevailing easterly winds, vehicle emissions will have no impact on Discovery Bay. Tunnel emissions to Siu Ho Wan are addressed separately in the Road and Tunnel Link Final EIA Report (HKR, 1995d). Given the low vehicle usage,

design of the fan system and lack of sensitive receivers, no problems either within the tunnel or at the portals are expected.

5.6.12 The layout of roadways and sensitive receivers and the lack of any significant sources indicate that no local air pollution problems are expected.

5.7 Mitigation Proposals

5.7.1 The dust mitigation measures described below will be required during the construction phase. In general, the amount of blasting required should be kept to a minimum.

Use of Water

5.7.2 Dust suppression by water sprays is an effective temporary control for fugitive dust emissions from unpaved roads, stockpiles, spoil heaps and general construction activities. The control efficiency depends on the local climate conditions, the nature of the dust source, the frequency of water application and the degree of coverage. A twice daily watering with complete coverage can reduce dust emissions by up to 50% depending on the ambient temperature and the level of site activity. Water may be applied over a large site area by water bowsers or mobile sprinklers. Hand held sprinklers may be more appropriate for water application over a small site area.

Construction Traffic

5.7.3 Dust control measures for construction traffic will include:

- the use of water sprays or chemical crusting agents on all haul routes and site roads;
- vehicle speed restrictions - 25 km/hr on unpaved roads and open areas within the site, 40 km/hr on paved road within the site; and
- the use of tarpaulins or closed vehicles for the transport of fill and spoil material within the site.

Material Handling

5.7.4 Control measures for material handling will include:

- the application of water or other wetting agents during material handling;
- wetting the surface of material stockpiles;
- storage of stonefines and other fine materials in totally enclosed storage bins or storage silos;
- the use of wind breaks and covers for stockpiles of all potentially dusty construction, spoil and fill materials; and
- minimisation of the drop height during material handling (reducing the drop height by half can reduce dust emission by approximately 50%).

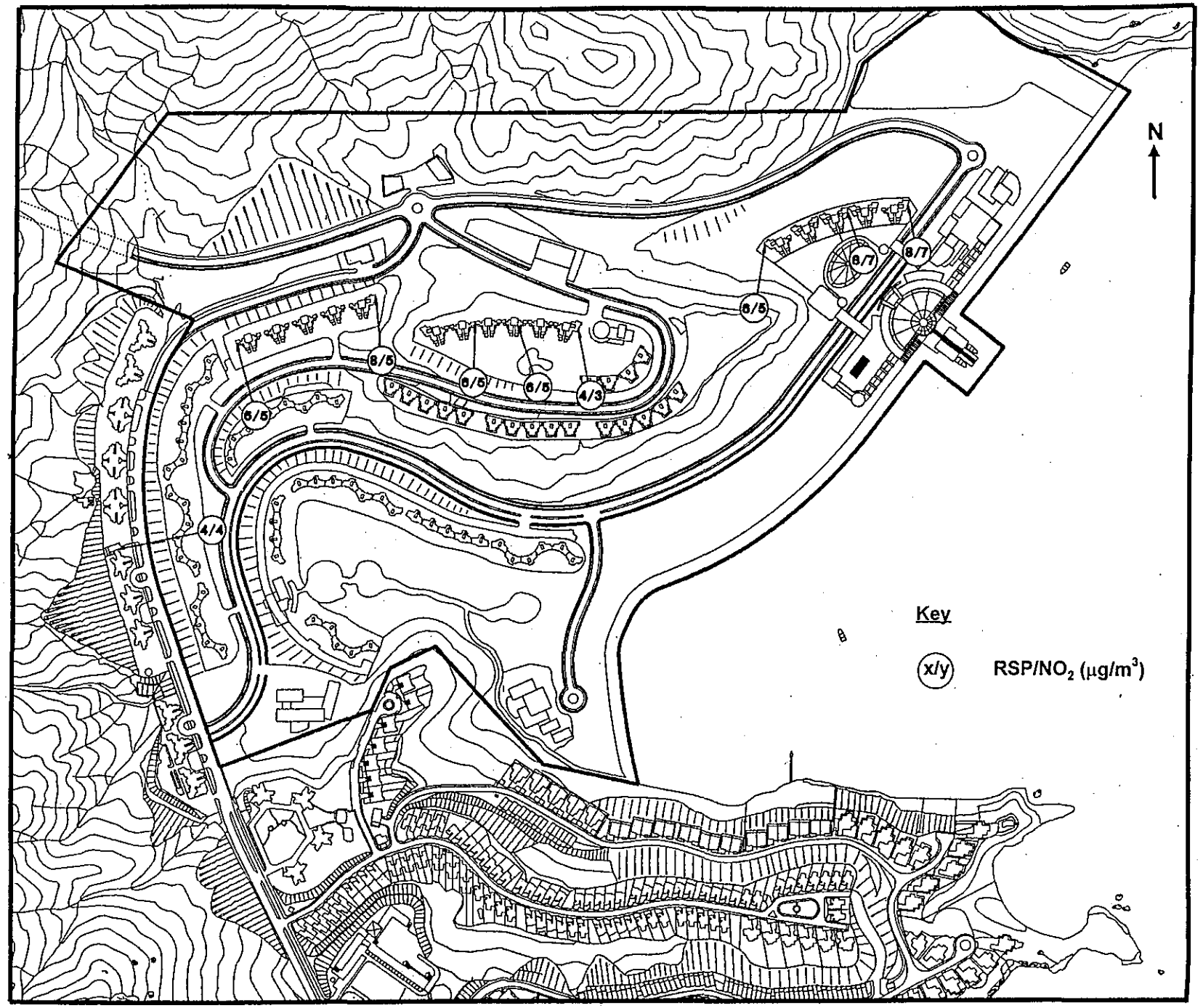


Figure 5.13
Predicted Worst Case Concentration of Respirable Suspended Particulates/ Nitrogen Dioxide (µg/m^3) - Master Plan 6.0

Housekeeping

5.7.5 A high standard of housekeeping will be maintained throughout the site. Any spills of material should be cleaned promptly and the dumping of materials in open areas should be prohibited.

Blasting

5.7.6 The following controls can be used to reduce TSP emissions during blasting works:

- use of blasting mats (typically 5mm mesh) which retain rocks and particles;
- use of angular gravel as a stemming material around the blast hole to improve dust containment;
- reductions in area of blast and controls on the depth and size of charge;
- surface watering; and
- restrictions on timing of blasting to avoid blasting when wind speed and direction are unfavourable. Blasting should be carried out under light, offshore wind conditions.

5.8 Stone Crushing

5.8.1 It is anticipated that a stone crushing and screening plant will be required before the rock material can be reused, particularly for the sea wall. If the capacity of the plant exceeds 5000 tonnes per annum, a licence for its operation as a specified process will be required under the Air Pollution Control Ordinance. As part of the licence application, an Air Pollution Control Plan must be completed. At this stage of the development, details of the stone crushing plant are not available. However, EPD's *Notes on Best Practicable Means for Mineral Works (Stone Crushing Plants)* would be observed to control pollutant emissions.

5.8.2 In order to control fugitive dust emissions, the crushers and screens should be totally enclosed. Water suppression sprays should be fitted to transfer points, including to the throats of crushers. However, if this proves inadequate, outlet emissions should be vented through a fabric filter of suitable design and capacity. The feed opening of the primary crusher should be enclosed on three sides and as far as practicable at the top. The height of this enclosure should be at least 3m above the truck unloading point.

5.8.3 Belt conveyors should be enclosed and provided with wind boards at the bottom to prevent entrainment of dust from the stone crushed products. Water suppression sprays should be used at belt transfer points and to wash off any dust deposited on the bottom wind boards at transfer points. Scrapers should be fitted at the discharge end of the belt to remove dust on the belt surface. Water sprays should be used to prevent entrainment of dust from the crushed stone product areas.

5.9 Concrete Batching

5.9.1 It is not clear whether a concrete batching plant will be required. If the tunnel is completed before concrete is required for the development, it is anticipated that concrete may be sourced from existing concrete batching plants located on North Lantau. If the tunnel is not completed, alternative arrangements would be considered including use of a batching plant on site.

5.9.2 The capacity of the plant, if required, will depend on programming. Should the plant silo capacity exceed 50 tonnes per annum, it will require a licence under the Air Pollution Control Ordinance, and an Air Pollution Control Plan would be prepared. Controls would be in accordance with EPD's *Best Practicable Means Requirements for Cement Works (Concrete Batching Plants).*

5.9.3 During the operation of such plant, dust will be subject to control at several stages in the process:

- during handling of sand and aggregate;
- during handling of cement; and
- during loading of the concrete mix.

5.9.4 Control of fugitive dust can be accomplished by enclosing the handling areas, conveyors and elevators, and by using fabric filters to control dust from the cement silos and batching point. An assessment to determine an acceptable location for any concrete batching plant should be undertaken and this condition should be incorporated into the contract conditions.

5.10 Conclusions

5.10.1 The following conclusion can be drawn from the air quality assessment:

- During construction, the main source of dust will be from the blasting operations, followed by the trucks laden with material moving from one site to another. The loading and unloading operations are much less important.
- If the whole of the Yi Pak Hill top needs to be blasted to reduce to the planned height, blasting may give rise to dust levels at the existing housing to the west and south-west that are near the AQOs.
- To reduce the dust impact on existing housing, the amount of blasting needs to be minimised where possible, and suitable control measures should be adopted during the construction phase.
- Methods to minimise the dust emissions should be adopted throughout the construction process.
- The air pollution impact during the operational stage on the development or the existing development will be minimal, particularly since there are no significant sources of air pollution and the policy of limited vehicular access will be maintained.

5.10.2 At the request of EPD, additional TSP modelling studies may be necessary once details of the blasting requirements and ground conditions for the Discovery Bay North site (including the Discovery Bay North tunnel portal) are available.

6.

LANDSCAPE AND VISUAL QUALITY

6. Landscape and Visual Impact Assessment

6.1 Introduction

6.1.1 Discovery Bay is exceptional in Hong Kong in both its landscape setting and the quality of the internal landscape. Most of the residential units enjoy views over the sea or rural countryside. The relative isolation of Discovery Bay will be severely affected by the Lantau Port Development. The general layout plan has attempted to maintain views over the sea and green areas, and to minimise the impact of the port by orientating views away from the works as far as possible.

6.1.2 Internally, particular attention has been given to maintaining the 'open' feel of the valley, and to providing effective buffers between the existing and new development areas.

6.1.3 Specific landscape measures have been included to compensate for loss of existing habitat and a major programme of slope planting is proposed both within and around the development area.

6.1.4 The standard of internal landscape will be equal to that in the existing Discovery Bay residential development.

6.2 Legislation and Planning Guidelines

6.2.1 There is no legislation in Hong Kong which specifically relates to the landscape and visual impact of development. A degree of control is achieved through the requirement to address visual issues as part of the environmental assessment process. The EPD Advice Note (2/90), relating to the *Application of the Environmental Impact Assessment Process to Major Private Sector Projects*, identifies visual impacts as being an issue to be addressed. In addition, the Landscape and Conservation Chapter of the HKPSG outlines design criteria to be considered when planning within the rural environment.

6.3 The Existing Landscape

Landscape Context

6.3.1 The development site is located on the east coast of North Lantau Island, due west of Hong Kong Harbour's Western Approaches. Discovery Bay (Tai Pak Wan) comprises a sequence of 4 smaller bays:- Sz Pak Wan, Sam Pak Wan, Yi Pak Wan and Tsoi Yuen Wan, enclosed by the headlands of Sz Pak Tsui to the north and Tai Pak Tsui to the south. The site of the proposed Discovery Bay North development is located on hinterland to the rear of the two central beaches of Sam Pak Wan and Yi Pak Wan (See Figure 2.1)

6.3.2 The landscape of North Lantau is characterised by its mountainous, barren terrain with peaks of up to 465m in elevation. A series of peaks and ridges fall steeply to an indented coastline, with a sequence of rocky headlands and sandy bays. Slopes are typical of Hong Kong with gradients of 30° and vegetation cover reduced to rough grass and low scrub by wildfire. Areas of more diverse, and well established scrub woodland are limited to areas adjoining housing, moist gullies and the coastal fringe. The Discovery Bay North development will be located in a natural, east facing, 'amphitheatre' within which the northern half comprises an elongated hill (Yi Pak Hill) and the southern half a 'U' shaped coastal valley (Yi Pak Valley). Within this valley, a number of construction platforms have been, or are currently, under construction. Several concrete and dirt access roads link these platforms, building materials storage yards and a small plant nursery with the Discovery Bay Road to the west.

6.3.3 The development site's landscape context is dominated by the mountainous backdrop of central Lantau to the north and west, and the open expanse of Discovery Bay to the east and south. The site's immediate 'urban/rural fringe' character is, in part, determined by its location on the northern periphery of the Discovery Bay settlement and also by the disturbed nature of the valley floor and the presence of construction yards. Thus, the site is located at the interface of rural and suburban Lantau, being overlooked to the south by the low rise properties of Headland Village and Parkland Drive and by the high rise blocks of Parkridge Village and Greenvale Village to the west. In considering the potential landscape and visual impacts of the development, the future development of the Lantau Port on reclaimed land to the south of Penny's Bay must also be considered.

Land Use, Settlement and Vegetation

6.3.4 The Discovery Bay North development site has been the subject of extensive site surveys and analysis from which a number of discrete LCAs have been defined. Each LCA displays a broadly homogenous character and is described in detail as part of the assessment of potential impacts in Section 6.5.

6.3.5 In general terms, however, the development site may be subdivided into 3 main areas:

- Yi Pak Hill;
- Yi Pak Valley; and
- coastal waters.

6.3.6 **Yi Pak Hill** is a free-standing elongated feature rising to height of +76.5 mPD. Orientated along an east-west axis, the eastern spur forms a small headland which separates Sam Pak Wan from Yi Pak Wan. Sam Pak Valley South (to the north of Yi Pak Hill) contains a small construction yard, a vehicular access track and an elongated platform at the toe of the south facing hillslope. The rocky foreshore and Sam Pak beach display large quantities of detritus above the high water line. Recent hill fires have denuded the upper hill slopes of

vegetation, whereas the lower slopes display a regenerating and diverse scrub/woodland.

6.3.7 **Yi Pak Valley** comprises 3 principal landscape areas:

- the lower valley floor to the rear of Yi Pak Wan beach with its marshland, mangrove and rock lined stream bed;
- the grassland upper valley floor, with its extensive areas of disturbance, including roadways, storage yard, cut slopes and platforms; and
- the wooded flanks of the Parkland Drive spur.

6.3.8 The site is no longer in active agricultural use, although the presence of banana trees on the valley floor, now 'captured' by regenerating scrub woodland indicates that at least part of the area was once in productive agricultural use.

6.3.9 A small plant nursery is located on an elevated platformed area in the centre of the Yi Pak Valley. Other land uses are limited to the open storage of building materials and limited recreational use by adjoining residents e.g. exercise and dog walking. There is no apparent recreational use of either beach given their relative inaccessibility, the presence of sea born debris and the poor water quality.

Topography

6.3.10 The development site comprises the lower portion of a major east-facing coastal valley complex. The southern part of which forms part of a natural amphitheatre (Yi Pak Valley) and the northern half an elongated hill (Yi Pak Hill).

6.3.11 The Yi Pak Valley is enclosed by a low (+50 mPD) coastal headland to the south (Hai Kam Tsui), the Lau Fa Tung range to the west (rising to +378 mPD) and the Tai Che Tung range to the north (+302 mPD). The development site extends from sea level to approximately the 50m level of the surrounding hill slopes.

6.3.12 Yi Pak Hill rises to +76.5 mPD and forms an elongated free-standing feature on the valley floor within the wider valley landscape. Orientated east-west, the hill's seaward slopes form a headland which separates Yi Pak Wan in the south from Sam Pak Wan to the north. Hill slopes are generally in the region of a 30° gradient.

6.3.13 The Yi Pak Valley floor, prior to recent platforming, formed a flat plain at +4-5 mPD elevation to the rear of Yi Pak beach. Extensive platforming of the upper valley floor has radically altered its topography to form a series of platforms with steeply sloping side slopes. The lower valley floor, however, remains undisturbed to the rear of the Yi Pak beach.

Natural Drainage

6.3.14 The wider Yi Pak Valley displays a typical dendritic drainage pattern, which is split into two systems: north and south of Yi Pak Hill and the Tai Che Tung ridge. Recent earthworks and road construction within the valley have, however, involved the diversion and culverting of a number of stream courses. Part of the undisturbed lower valley floor to the rear of Yi Pak beach may comprise abandoned agricultural fields which have regenerated to form a marshland habitat.

Access and Circulation

6.3.15 The Yi Pak Valley is currently used as a plant nursery and as a deposit for surplus fill. It is also used by local residents for dog walking and access to the adjoining hills and beaches.

6.3.16 Vehicular access is via 3 tracks off the north, centre and south ends of the Discovery Bay Road. A vehicular roadway extends to each platformed area. There is no footpath access to Yi Pak beach; access is possible at low tide by walking along the foreshore. Sam Pak beach can be reached via the Sam Pak access track.

Features

6.3.17 The principal landscape features of value which characterise the Discovery Bay North site include:

- scrub woodland on the lower slopes of Yi Pak Hill;
- woodland on the Hai Kam Tsui headland side slopes;
- estuarine/mangrove/beach ecosystem on the valley floor;
- rocky shoreline to Yi Pak Hill; and
- Sam Pak beach.

Views

6.3.18 The visual envelope (or Zone of Visual Influence) of the development site is shown in Figure 6.1. The development site's land-based visual envelope is largely determined by Lantau's mountainous terrain. Thus, views of the site extend to the surrounding ridge top footpaths and spurs. The site's visual envelope is drawn in closest along the Hai Kam Tsui headland to the south of Yi Pak Wan. Partial views of the site are possible from Peng Chau, Siu Kau Yi Chau and Kau Yi Chau. To the east, medium distance views into the site are also possible from the Sz Pak Tsui headland, whilst distant views from the western approaches to Hong Kong harbour may be obtained on clear days.

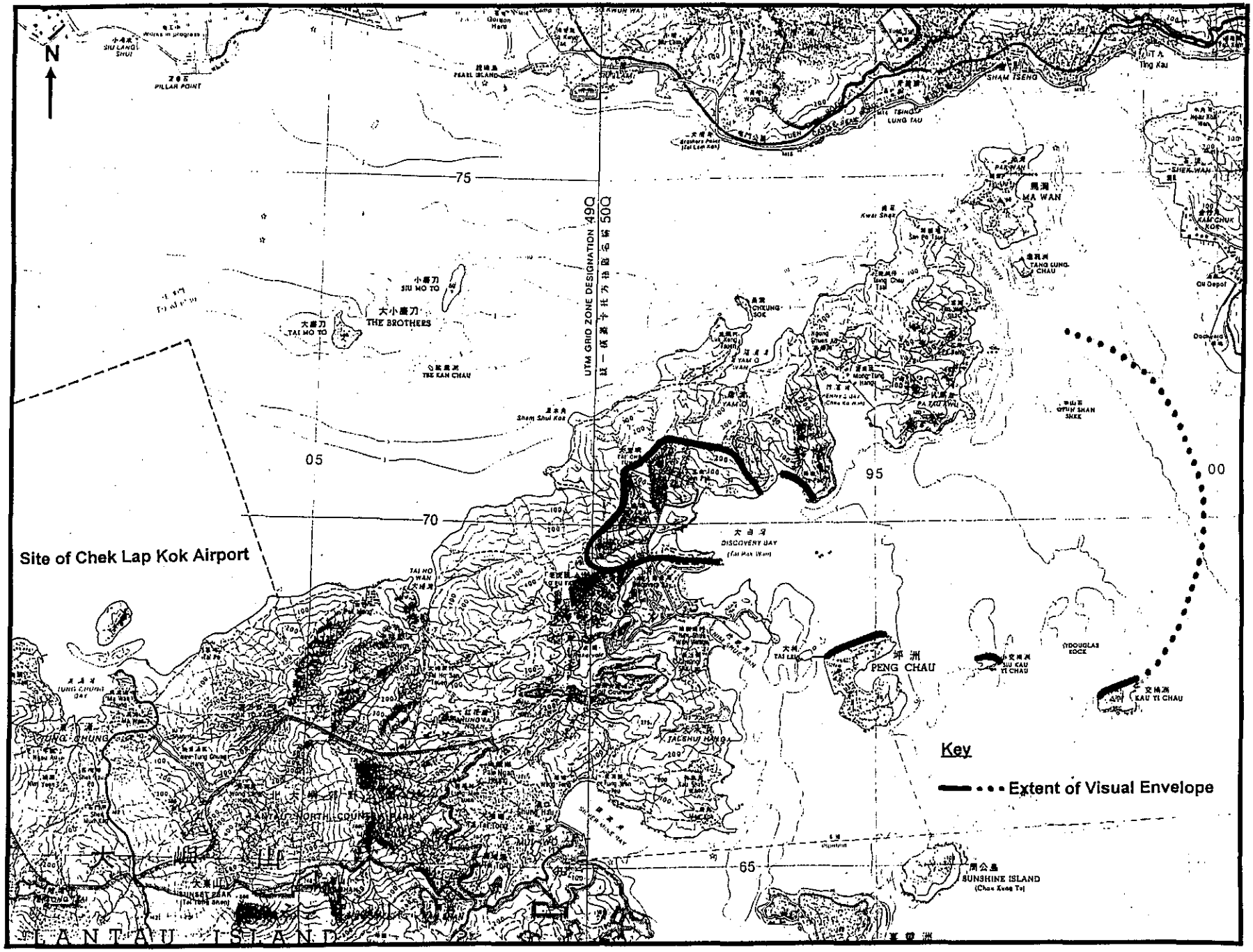


Figure 6.1
Extent of Visual Envelope - Discovery Bay North

Landscape Character and Perception

6.3.19 The landscape character of the development site is essentially that of an urban/rural fringe area. The extensive disturbance of natural landform and vegetation, particularly in the western half of the valley, detracts from its landscape quality. Beach detritus, open storage compounds and extensive areas of tipping combine to degrade the valley's intrinsic landscape character. As outlined in Section 6.3.6, however, the site displays a number of positive landscape features of significance. Individuals' (i.e. local residents) perception of the area may be influenced by their proximity and direction of view. Thus, whilst more distant, lower angled views (from the eastern end of Hai Kam Tsui) may view the site as contiguous with the adjoining hills and coastline. Residents overlooking the area from the Greenvale Village high-rise apartments to the west will be more aware of the site's degraded nature.

6.4 Methodology

General

6.4.1 For the purposes of the environmental assessment process, a distinction is drawn between *landscape* and *visual* impacts:

- *landscape impacts* relate to the effects of development upon the physical fabric or components, which form that landscape; and
- *visual impacts* relate to the changes arising from development to individual 'receptor groups' views of that landscape.

6.4.2 The methodology adopted for this study (see Figure 6.2) is suitable for assessment of developments of the scale and nature of the Discovery Bay North Development and comprises the following steps:

Stage 1: Establish baseline conditions

6.4.3 To establish a 'control' scenario against which effects may be assessed, the baseline conditions are defined and projected forward to predict a 'no development' alternative to the residential development and related components. The baseline landscape and visual conditions are assessed through an appraisal of the site's:

- landscape context;
- landuse, settlement and vegetation;
- topography;
- natural drainage;
- access and circulation;
- features;
- views; and

- landscape character and perception.

Stage 2: Identify Potential Impacts

6.4.4 Impacts are considered in terms of landscape and visual impacts (both positive and negative) and various receptor groups during construction, at opening, and in Year 10 of operation. Impacts are distinguished on the basis of temporary, permanent, cumulative, long-term and short-term effects.

Stage 3: Evaluation of Impacts

6.4.5 Impacts are categorised as being either direct impacts i.e. within the study area or visual envelope, or indirect impacts e.g. off-site visual impacts of construction traffic movements or borrow areas. Impacts are then assessed as being low, moderate or severe.

Landscape Impacts

6.4.6 Landscape impacts are assessed at three levels in terms of:

- the impact upon individual landscape features;
- the aggregate impact upon discrete areas of the site (Landscape Character Areas, LCAs); and
- the overall impact of development upon the site.

6.4.7 This approach 'builds up' an overview of landscape impact across the site.

6.4.8 Landscape impacts are predicted primarily on the basis of the order of change to baseline conditions prevalent at the time of assessment. No attempt is made to 'quantify' what is essentially a subjective but systematic and structured assessment. However a simple 'coding' system has been applied in order to cross-relate and summarise impacts across the site at three points in time.

Visual Impacts

6.4.9 The assessment of visual impact is structured by individual receptor groups. Each receptor group's sensitivity to changes in the nature of their views is evaluated. Receptors are identified through the definition of a Visual Envelope, or 'Zone of Visual Influence', within which views of the development are possible, and the categorisation of individuals into 'receptor groups' within that envelope area. The sensitivity of receptors is categorised as being high, moderate or low. Highly sensitive receptors include existing residents of Discovery Bay. Moderately sensitive receivers include hikers on the North Lantau mountain trails whilst low sensitivity receivers, would for example, include passing ferry passengers.

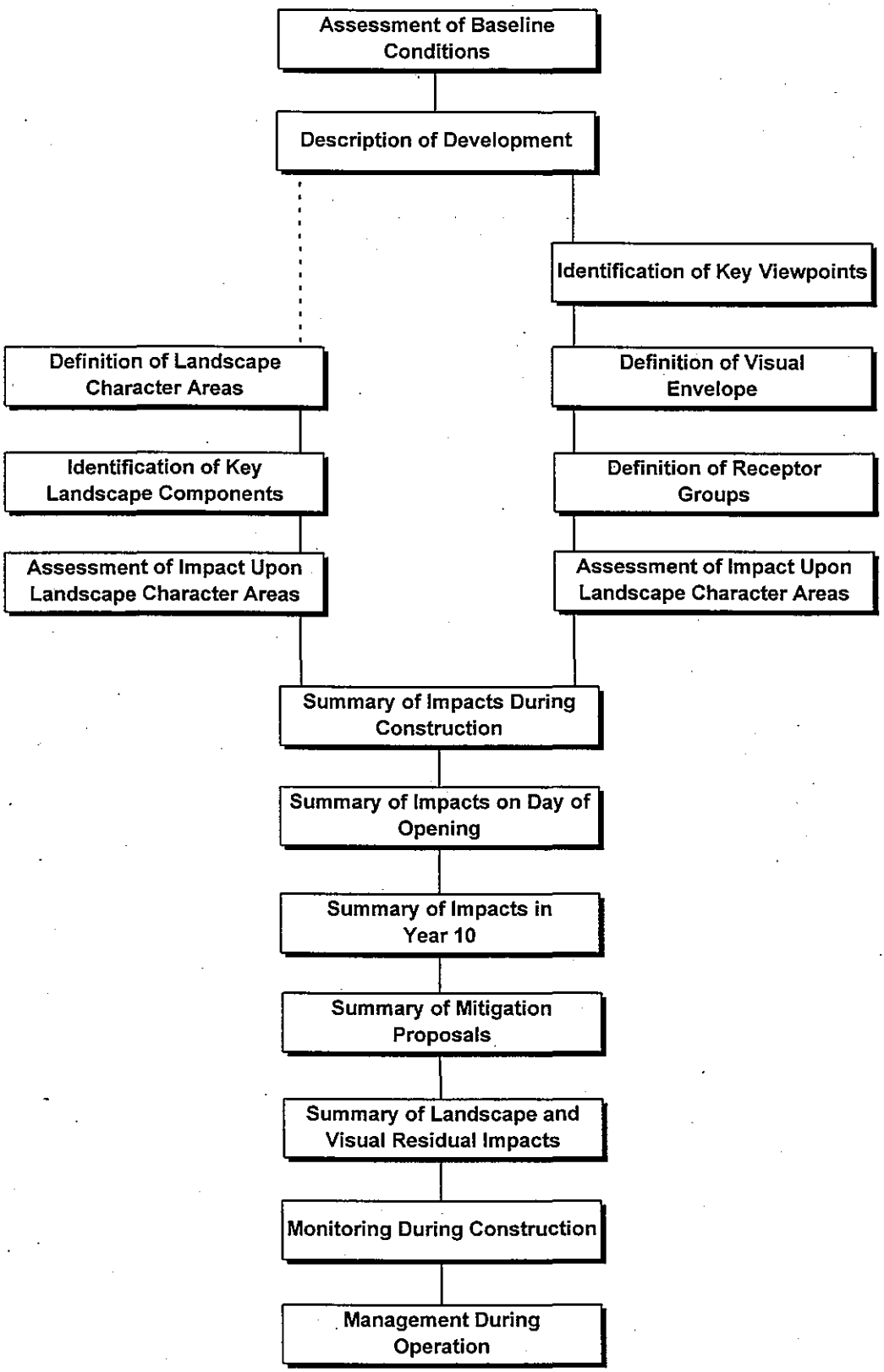


Figure 6.2
Landscape and Visual Assessment Methodology

Assessment Criteria

6.4.10 The criteria utilised in order to define potential impacts into the three generic categories of Severe, Moderate and Low are given below.

6.4.11 The degree of impact on landscape resources depends on:

- the character and quality of existing landscape;
- key features of the existing landscape;
- the nature of predicted impacts;
- the degree of change to key features;
- the ability of the landscape to accommodate change (i.e. sensitivity); and
- the significance of change within a local, regional and national context.

6.4.12 The degree of impact on visual amenity depends on:

- the value of existing views;
- the degree of change to existing views;
- proximity of the receptor;
- sensitivity of the receptor;
- number of receptors in group; and
- availability and amenity value of alternative views

6.4.13 The effects of the development which are considered negligible in their impact (i.e. **low**) are termed *insignificant* whereas **moderate** and **severe** impacts are termed *significant.*

Mitigation Measures

6.4.14 As a result of the highly interdependent nature of the effects of development, proposals to mitigate unacceptable landscape and visual impacts are considered together.

6.4.15 Significant landscape and visual impacts identified during the assessment process (i.e. those impacts categorised as either Moderate or Severe) have, where possible, been the subject of specific mitigation proposals and are thus 'designed out' of the masterplan. These proposals, in the case of landscape and visual impacts, may vary in scope from the redesign of areas to the introduction of specific revegetation proposals. Additional mitigation proposals are outlined for the construction and operational phases of the development.

6.4.16 Mitigation proposals in relation to both landscape and visual impacts may in some instances, only be effective in the long term (i.e. by Year 10) e.g. through the provision of screen planting to shield a view. A reassessment of impacts, post mitigation, will result in the identification of residual impacts which cannot be effectively mitigated against.

6.5 Potential Landscape and Visual Impacts

Landscape Impacts

6.5.1 In order to assess the potential landscape impacts of the Discovery Bay North development, the site has been subdivided into discrete Landscape Character Areas (LCAs) each of which has a clearly identifiable landscape character (Figure 6.3). The assessment of landscape impact is undertaken in relation to the potential impact on each LCA during construction (1996-2004), on completion (2004), and in Year 10 of operation (2014).

6.5.2 The results of this assessment are then brought together to form an overview of landscape impacts within each LCA and subsequently for the whole site over a 19 year period. Reference should be made to the Master Layout Plan when considering this assessment.

Landscape Character Area 1 (LCA 1)

6.5.3 LCA 1 comprises the Sam Pak Wan Valley South (see Figure 6.4). This small 'V' shaped valley emerges on the coastline north of Yi Pak Hill to form the southern half of Sam Pak Wan beach. A small stream flows eastward down the valley floor and crosses the beach immediately to the north of the rocky Yi Pak Hill headland.

6.5.4 The rural character of this potentially valuable feature has been compromised by the presence of the Sam Pak access track, an extensive area of recent infilling at the mouth of the valley, the destruction of much valley side vegetation by wildfire and an accumulation of sea born debris on Sam Pak beach.

6.5.5 The proposed development retains most of the scrub woodland covered lower slopes of Yi Pak Hill as a valuable landscape feature. However, the Indoor Recreation Centre, Neighbourhood Community Centre, hotel, transport interchange and tunnel access road will result in **severe** construction and day of opening impacts. Planting in the Sam Pak Valley help to mitigate the overall landscape impacts in LCA 1 to a **moderate** level by Year 10.

Landscape Character Area 2 (LCA 2)

6.5.6 LCA 2 comprises mainly the upper slopes of Yi Pak Hill i.e. above the +50 mPD contour (see Figure 6.5). This area has suffered repeated and recent hillfires, which has reduced vegetation cover to course grasses and low scrub. The elongated hill top forms an east-west orientated ridge.

6.5.7 The development proposals include the lowering of this +76.5 mPD high ridge to between +35 and +40 mPD and the cutting back of part of the Yi Pak Hill spur. This will result in **severe** construction and day of opening landscape impacts with the resultant loss of natural landform. However, by Year 10 the retained peripheral scrub woodland and new planting on the hill slopes will have mitigated this impact to a **moderate** level.

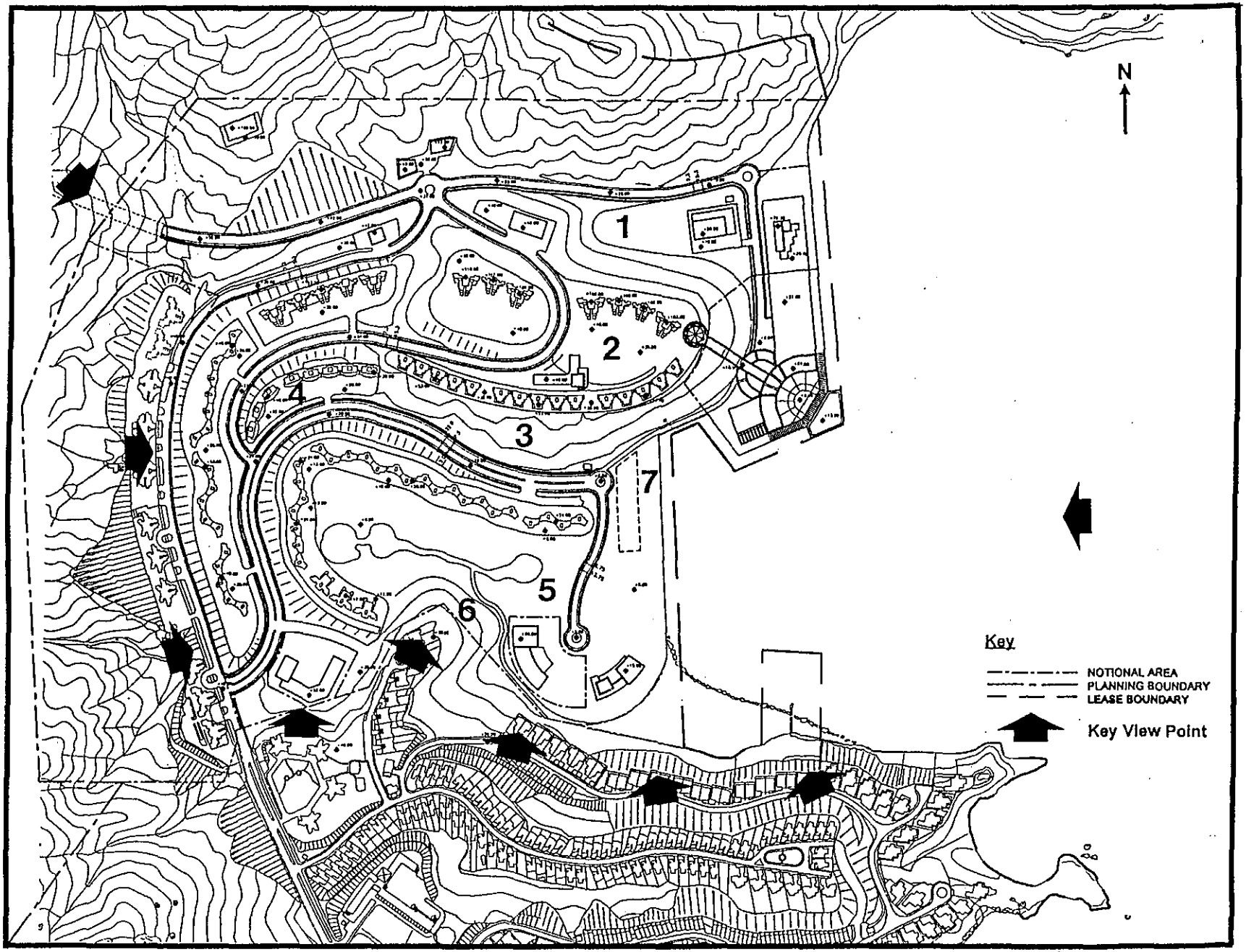


Figure 6.3
Landscape Character Areas and Key View Points

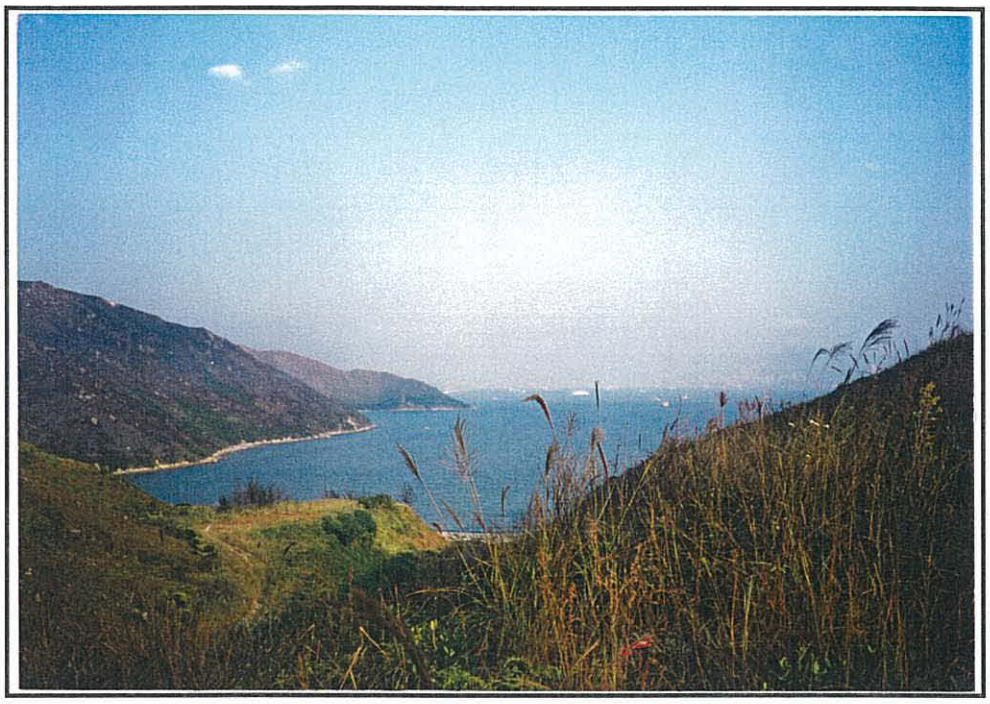


Figure 6.4
Landscape Character Area 1 (LCA 1)
Sam Pak Valley South

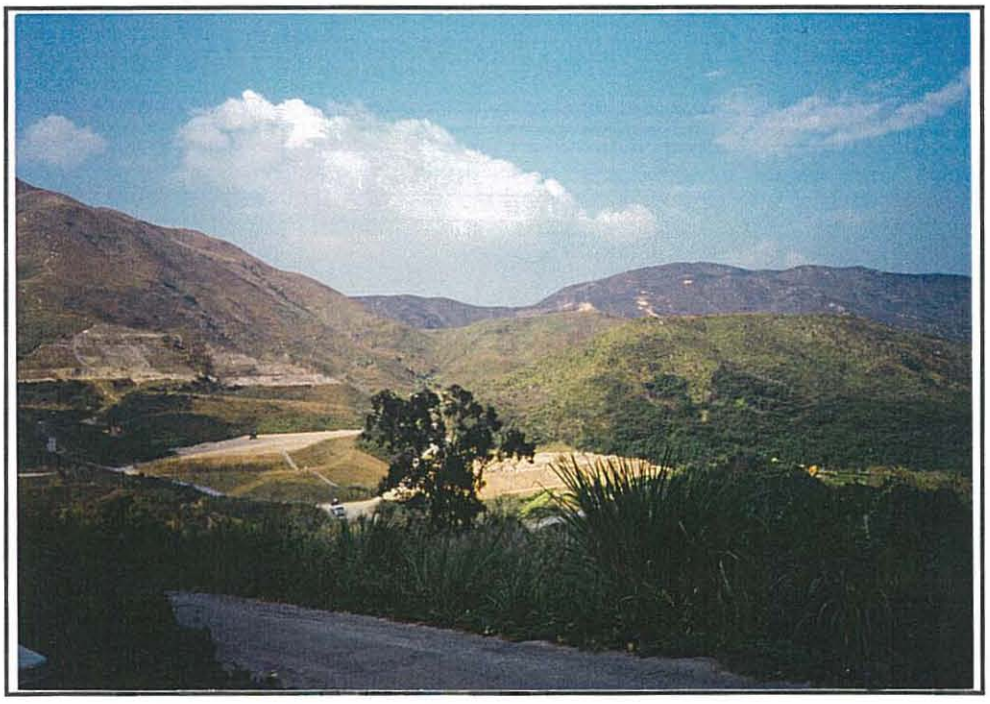


Figure 6.5
Landscape Character Area 2 (LCA 2)
Yi Pak Hill (Upper Slopes)

Figure 6.6
Landscape Character Area 3 (LCA 3)
Yi Pak Hill (Lower Slopes)

Figure 6.7
Landscape Character Area 4 (LCA 4)
Upper Yi Pak Valley

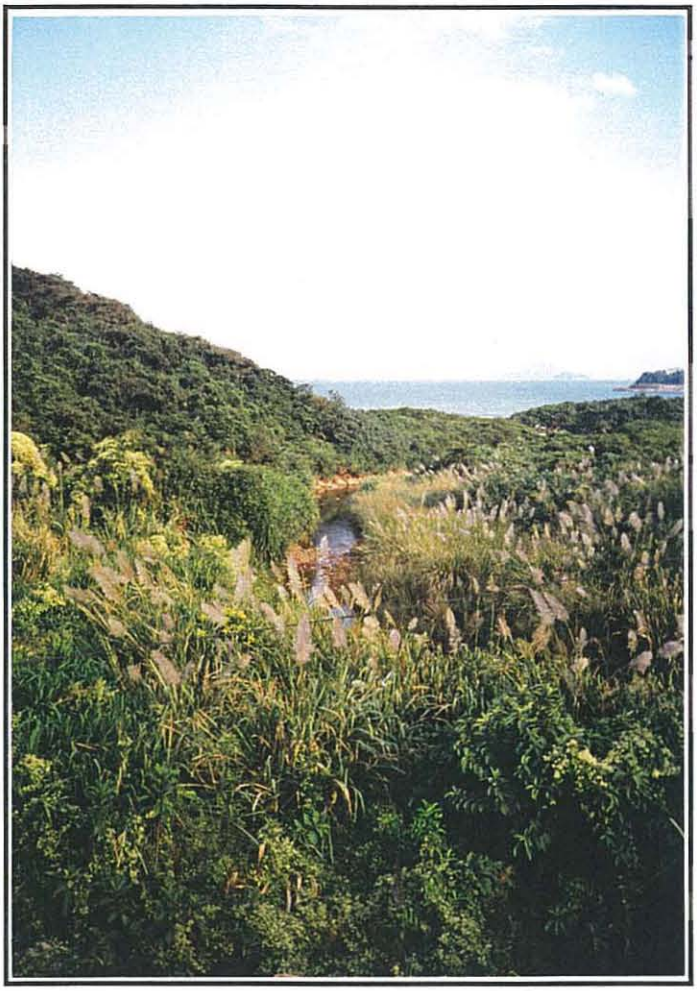


Figure 6.8
Landscape Character Area 5 (LCA 5)
Lower Yi Pak Valley

Figure 6.9
Landscape Character Area 6 (LCA 6)
Parkland Drive Spur

Figure 6.10
Landscape Character Area 7 (LCA 7)
Yi Pak Wan (upper photo) and Sam Pak Wan (lower photo)

Landscape Character Area 3 (LCA 3)

6.5.8 LCA 3 is formed by the lower, south facing slopes of Yi Pak Hill. These slopes have escaped recent hillfires, and are covered by well established, naturally regenerating, scrub woodland (Figure 6.6).

6.5.9 Considerable care has been exercised in formulating Master Plan 6.0(A) in order to retain this feature within the development. However, the construction of a building platform at the top of the slope, and a road at the toe of the slope is likely to result in a **moderate** construction and day of opening impacts as a result of peripheral vegetation loss and alteration to landform. This impact, however, will be reduced to a **low** level by Year 10.

Landscape Character Area 4 (LCA 4)

6.5.10 LCA 4 is located on the higher ground to the west of Yi Pak Hill. This large area has been the subject of extensive earthworks to form an irregular series of platforms, access roads and entrained stream courses. Vegetation cover consists of largely rough grasses. The area is unsightly including apparently abandoned, construction sites (Figure 6.7). The landscape impact of development in this area will be **low**.

Landscape Character Area 5 (LCA 5)

6.5.11 LCA 5 comprises a complex, small scale, estuarine ecosystem. The area to the rear of Yi Pak Wan beach includes mangroves, marsh and woodland, traversed by a semi-tidal boulder lined stream course (Figure 6.8). The current development proposal will involve the loss of this area as the site formation levels are raised by 6m resulting in a **severe** construction impact. The progressive maturation of a replacement habitat/ecosystem within the development's central open space and in the mangrove transplantation area will, by Year 10 of operation, have reduced this landscape impact to a **moderate** level.

Landscape Character Area 6 (LCA 6)

6.5.12 The hill slopes which surround Parkland Drive support a well developed woodland cover (Figure 6.9). The infilling of the valley floor to create construction platforms to a maximum elevation of +30 mPD will involve the loss of the lower slopes and vegetation, resulting in a **moderate** landscape impact. The extension of woodland cover around the edges of the construction platforms will assist in reducing impact to a **low** level by Year 10.

Landscape Character Area 7 (LCA 7)

6.5.13 The proposed Discovery Bay North development includes the reclamation of Yi Pak Wan and the southern section of Sam Pak Wan (Figure 6.10). The infilling of this area will result in the loss of Yi Pak beach, half of Sam Pak beach, associated intertidal zones, areas of open water and the rocky coastline of Yi Pak Hill. The construction and long-term landscape impacts of reclamation will be **severe**.

Summary of Landscape Impacts

6.5.14 Table 6.1 summarises the potential landscape impacts of the proposed Yi Pak development for each landscape Character Area during construction, on day of opening and in Year 10 of operation.

Table 6.1 Summary of Landscape Impacts

LCA	Construction (1996-2004)		Day of Opening (2004)		Year 10 (2014)	
1	Severe	3	Severe	3	Moderate	2
2	Severe	3	Severe	3	Moderate	2
3	Moderate	2	Moderate	2	Low	1
4	Low	1	Low	1	Low	1
5	Severe	3	Severe	3	Moderate	2
6	Moderate	2	Moderate	2	Low	1
7	Severe	3	Severe	3	Severe	3

6.5.15 Table 6.1 indicates that, whilst development will fundamentally alter the landscape characters of Yi Pak/Sam Pak Wan, some specific impacts can be successfully mitigated against in the long term, whilst others will remain significant (i.e. severe or moderate).

6.5.16 The following significant, long-term landscape impacts are identified:

- loss of Sam Pak Wan Valley South natural landform and vegetation;
- lowering of Yi Pak Hill and cutting of the Yi Pak Hill spur;
- the loss of the lower Yi Pak Valley ecosystem; and
- the loss of the natural coastal features of Yi Pak Wan and part of Sam Pak Wan.

Visual Impacts

Visual Envelopes

6.5.17 The Visual Envelope (or Zone of Visual Influence) for the Discovery Bay North site is shown in Figure 6.1. Elevated views of the development site will be possible from within the wider valley settings and sea level views from neighbouring island and coastal waters.

Figure 6.11
Key View Point - Headland Drive

Figure 6.12
Key View Point - Parkland Drive

Figure 6.13
Key View Point - Yi Pak Au

6.5.18 The extent of the seaward visual envelope from Yi Pak Wan is variable, dependent upon visibility/air quality and the sun's angle in relation to the viewer (receptor). Beyond a distance of approximately 5km, however, the proposed development will form an insignificant component of the wider view.

6.5.19 The area within which views of Discovery Bay North will be possible are limited by:

- Hai Kam Tsui headland;
- Sz Pak Wan headland;
- Lau Fa Tung ridge;
- Tai Che Tung ridge;
- Sam Pak Au saddle;
- Lai Pik Sham ridge;
- Peng Chau ;
- Siu Kau Yi Chau; and
- Kau Yi Chau.

Key Viewpoints

6.5.20 Figure 6.3 identifies a number of key viewpoints from which open views of the site are clearly visible. Viewpoints from Headland Drive, Parkland Drive and Yi Pak Au are illustrated in Figures 6.11 to 6.13, respectively.

6.5.21 The development site itself is overlooked by:

- residents of Headland Village;
- residents of Parkland Drive;
- residents of Parkridge Village;
- residents of Greenvale Village;
- hikers on the adjoining mountain trails; and
- boat passengers off Discovery Bay.

Receptor Groups

6.5.22 The receptor groups identified within the site's visual envelope and their sensitivity to change are categorised as follows:

High Sensitivity Receptor: residents of Headland Village; residents of Parkland Drive; residents of Parkridge Village; residents of Greenvale Village;

Medium Sensitivity Receptor: hikers on mountain trails; and

Low Sensitivity Receptor: boat passengers.

6.5.23 The sensitivity of receptor groups is classified as a function of:

- the proximity of the receptor;
- the size of receptor group;
- the quality of the existing view;
- the availability of alternative views;
- the period of exposure to view; and
- the receptor group's function.

Visual Impact Assessment

High Sensitivity Receptors: Existing residents of Discovery Bay (Receptor Group 1) (Headland Village, Parkland Drive, Parkridge Village and Greenvale Village)

6.5.24 The development of Discovery Bay North will result in **severe** construction visual impacts for existing residents who overlook the site. The proximity and elevated nature of adjoining residents' views prohibits effective, long-term screening of development, whilst the proposed development will fundamentally alter the character of existing residents views from an open, essentially rural aspect, to that of a 'suburban' residential development, resulting in a **severe** operational visual impact. The severity of this impact will not be mitigated in the long term by new planting, the revegetation of the existing borrow area cut slope or the 'improvement' of LCA 4.

Medium Sensitivity Receptor: Hikers on mountain trails (Receptor Group 2)

6.5.25 Lantau Island remains a popular destination for weekend hikers, notwithstanding the current extent of development works on the island's north coast. Planning policy for Lantau is, in part, based upon the use of the island's mountainous hinterland to visually and physically separate the new airport and its associated development from the recreational and residential users to the south. Hill walking by both residents and visitors is based upon a ridgeline network of tracks, typical of rural Hong Kong.

6.5.26 The visual impact of the proposed Discovery Bay North development upon hill walkers (both the access road and residential development) will be **moderate** during the construction phase but will be mitigated to a **low** level by Year 10 of operation. The visual impact on hikers will be, in part, a function of the total visual disturbance arising from the PADS developments visible from Lantau's mountain tracks.

Low Sensitivity Receptor: Boat Passengers (Receptor Group 3)

6.5.27 The construction and operational visual impacts of the development upon those receptors passing Discovery Bay by boat (e.g. ferry passenger) will be **low** as a function of their low sensitivity, distance offshore and length of exposure to the view.

Summary of Visual Impacts

6.5.28 Table 6.2 summarises the potential visual impacts of the development upon each of the identified receptor groups during construction, on day of opening and in Year 10 of operation.

Table 6.2 Summary of Visual Impacts

Receptor Group	Construction (1995-2004)		Day of Opening (2004)		Year 10 (2014)	
High Sensitivity Receptor Group 1	Severe	3	Severe	3	Severe	3
Medium Sensitivity Receptor Group 2	Moderate	2	Moderate	2	Low	1
Low Sensitivity Receptor Group 3	Low	1	Low	1	Low	1

6.5.29 From this table it may be seen that whilst the long-term visual impact of the Discovery Bay North upon medium and low sensitivity receptors will be **low**, the impact upon the existing residents will remain **severe**.

6.6 Mitigation Proposals

Landscape and Visual Impact Mitigation

6.6.1 The principal features of the Master Landscape Plan which aim to mitigate the visual impact of the Discovery Bay North development upon residents of Headland Village and Parkland Drive relate to the provision of a continuous landscape 'buffer' between the Hai Kam Tsui headland and the proposed residential blocks. This area of open space will accommodate a formal seafront park with recreational facilities and an informal natural stream. This wetland park will seek to replace the visual quality of the existing estuarine, habitat/ecosystem of the valley floor.

6.6.2 It should be noted that the new central landscape feature will be of a quite different character to the existing area. The park will compensate for the existing areas in terms of recreational uses and open space, but in a different form of use. For example, the existing Yi Pak beach has a certain appeal but is covered with litter and is little used. The proposed waterfront area would have a quality promenade and would be well used, but would inevitably have developed character.

6.6.3 Other landscape mitigation proposals include the provision of peripheral planting belts to building platforms, the revegetation of the existing and proposed cut and fill slopes and the planting of building surrounds. The landscape revegetation plan is presented in Section 6.7.

6.6.4 The retention of the lower scrub-woodland covered slopes of Yi Pak Hill, which face the Hai Kam Tsui headland, also seeks to reduce the visual impact of development upon existing residents and the landscape impact of development upon the site.

Protection of Existing Vegetation

6.6.5 Retention of existing scrub woodland on the site is an important mitigation measure and a key component of the proposed landscape framework. Adequate safeguards should, therefore, be employed to ensure the trees are protected. No changes in level or excavation should take place within the area defined by the edge of the tree canopy. During construction, all trees to be retained will be clearly marked. Scrub woodland to be retained will be protected by the installation of temporary fencing beyond the tree canopy. No disturbance, grading or stock piling of material should take place within this area. Trees to be retained should be pruned to remove any damaged or diseased limbs.

Monitoring Proposals

6.6.6 The provision of protective fencing and construction works will be the subject of regular monitoring by the Environmental Monitoring Team. Particular emphasis will be placed upon the protection of existing vegetation and the control of site works in order to avoid unnecessary damage to adjoining hill slopes.

Long-Term Management Proposals

6.6.7 A detailed Landscape Management Plan will be formulated and submitted to Government on project approval in order to ensure the success of the long-term objectives of the Landscape Master Plan.

6.6.8 The Management Plan will address landscape management issues of financial, manpower and equipment resources and maintenance specifications and schedule for each landscape type.

6.7 Landscape Revegetation Plan

Introduction

6.7.1 Based on the proposed master landscape plan, six categories of habitats to be restored have been identified as follows and as shown on Figure 6.14:

- woodland near the Yi Pak tunnel portal;
- woodland within the development areas;
- riparian planting;
- lakeside planting;
- main road corridors; and
- amenity planting.

6.7.2 A list of tree and shrub species suitable for each habitat is provided in the revegetation specifications sections. Recommended tree and shrub species were selected on the basis of the existing woodland vegetation on the site, and on the expected condition of the areas to be revegetated following completion of construction.

6.7.3 Hydroseeding would be required on the sites where existing vegetation is to be completely cleared. The hydroseed mix should be applied immediately after completion of construction works. Watering will be required if planting is undertaken during the dry season. This will ensure rapid establishment of ground cover which will aid in the prevention of soil erosion. Specifications for the hydroseeding mix are given in Table 6.3.

Table 6.3 Components of Hydroseeding Mix

Ingredients	Composition/Description	Rate (g/m^2)
Seed Mix	*Paspalum notatum* *Cynodon dectylon* *Paspalum conjugatum/Lolium perenne*[1]	10 15 5
Mulch	Cellulose fibre mulch	100
Fertilizer	Quick release granular (18:18:10)	60
Soil binding agent		25

[1] Replace *Paspalum conjugatum* when sown in winter (September to March).

6.7.4 On sites where the natural vegetation will be retained (such as along the lower slopes of Yi Pak Hill), planting of shrubs and trees can be conducted immediately following completion of construction. Planting in such locations will involve interplanting between existing shrubs and trees with the objective of increasing total vegetation cover and enhancing species diversity.

6.7.5 Each species of tree and shrub should be planted in groups of 10 to 25 individuals per group whenever possible (AFD, 1994). This planting scheme will help avoid interspecific competition due to differential growth rates and demands for light. Group plantings will enhance species establishment, thereby ensuring the availability of seed sources for future colonisation.

Planting Sites

Woodland Near the Discovery Bay Tunnel Portal

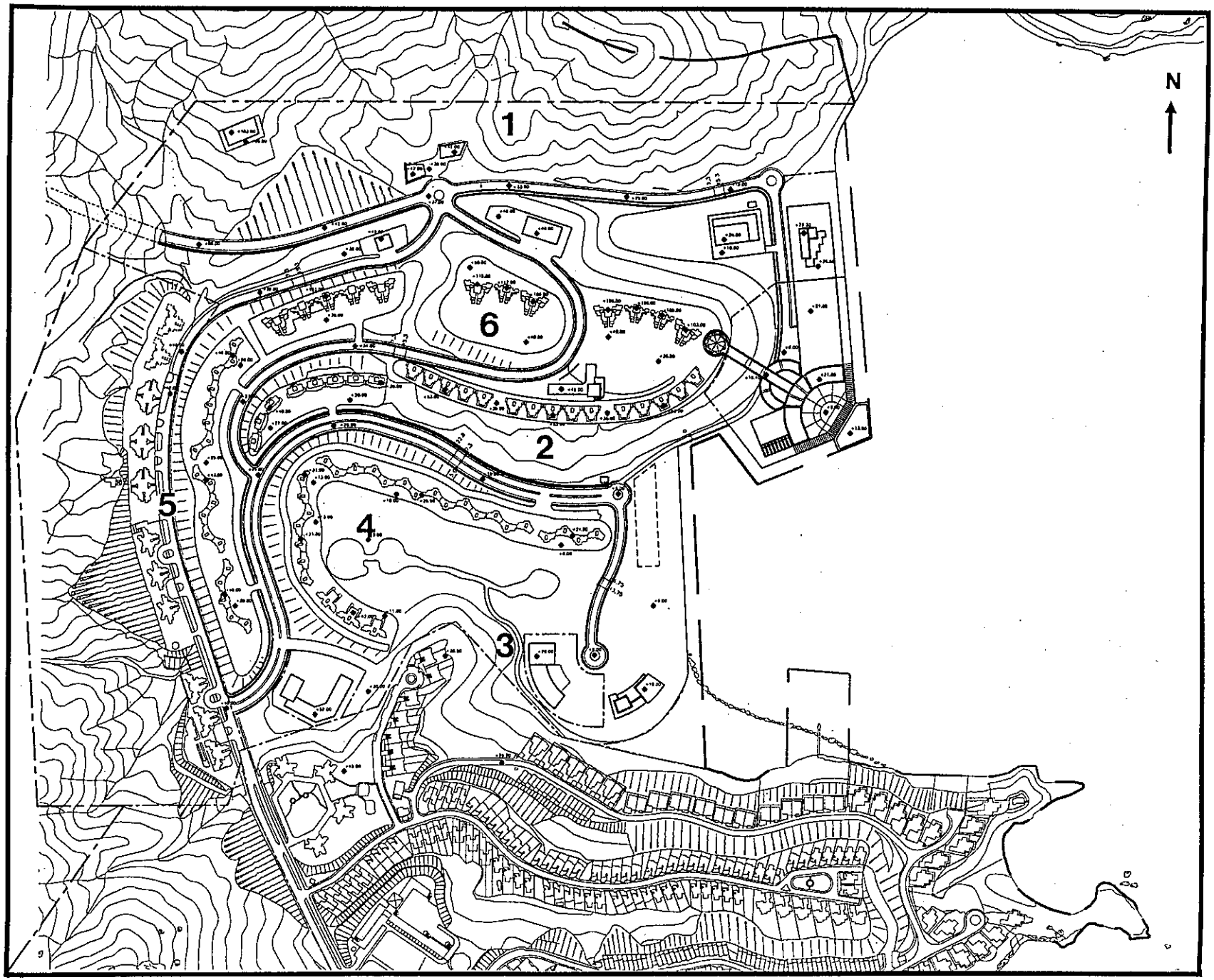
6.7.6 This site consists of the areas above and below the link road and the tunnel portal, together with its retaining wall. This area is a transitional belt between the natural hillside and residential area. The existing vegetation on this site is grassland which has been maintained by frequent fire and/or construction disturbance. This vegetation can naturally develop to shrubland and forest if protected from disturbance and fire. Natural succession of such habitats could take up to 30 years to achieve a mature woodland. To facilitate more rapid restoration of natural habitats, native tree and shrub species should be planted according the specifications listed in the following sections.

6.7.7 As the constructed slope of this area will be steep, it is recommended that some fast-growing exotic species be included in the plantation mix. These would include species such as *Leucaena leucocephala* and *Acacia confusa.* Both are nitrogen-fixing plants which tolerate poor soil conditions and readily establish on steep slopes. Use of these fast-growing species can accelerate the process of revegetation.

6.7.8 Rapid restoration of woodland cover will not only prevent soil erosion, but will also reduce visual impacts by screening views of the Discovery Bay tunnel portal. The native species selected for planting are common pioneer species in Hong Kong. The fruit/seeds of these species are documented forage items for local wildlife. Incorporation of these species in the planting scheme will provide seasonal wildlife forage sources and potentially facilitate colonisation of surrounding sites by native tree and shrub species. Some species tolerant of fire should be included within the mix as insurance against damage by wild fire.

Woodland Belts Within the Project Area

6.7.9 This area covers the steep slopes between the terraced building platforms. The existing habitat is covered by a young successional stage of secondary forest. Much of the existing shrub/woodland will be destroyed by the fill in the Yi Pak area (+6.0 mPD). In order to control soil erosion, planting of trees and shrubs should be performed soon after the completion of construction works. Slopes should also be stabilised as required with erosion-control matting



Key

1	Woodland Belt 1
2	Woodland Belt 2
3	Riparian Planting
4	Lakeside Planting
5	Main Road Corridors
6	Amenity Planting

Figure 6.14
Planting Sites

made of natural fibres. Creation of a belt of natural woodland will help screen views of neighbouring properties from lower level apartments and will also provide habitats for wildlife. Hydroseeding or erosion-control matting may be required prior to planting for slopes which are cleared during construction.

6.7.10 On the lower slopes of Yi Pak Hill, native shrubs will be planted near the residences, and native trees will be planted near the roadways. This will provide taller vegetation (trees) on the lower slopes to screen views of roadways from residences above. It will also provide shorter vegetation (shrubs) in front of residences to minimise the extent to which sea views would be blocked.

6.7.11 The shrub species chosen for planting in front of residences (*Rhododendron simsii, Lespedeza formosana, Melastoma candidum, Raphiolepis indica* and *Rhodomyrtus tomentosa*) are native plants which bear showy and fragrant flowers and which will enhance the landscape values near residential areas. The fragrance and visual appeal of *Baeckea frutescens* will also soften the landscape appearance.

6.7.12 The lower slopes of Yi Pak Hill will be planted with fast-growing pioneer native trees to form a natural visual screen. *Psychotria rubra*, a common shrub in Hong Kong which occupies a wide range of habitats, will be interplanted among the trees to create natural multi-layered structure in the restored woodland.

Riparian Planting

6.7.13 A rocky stream will be created along the south side of the development to compensate for loss of the natural main Yi Pak stream channel. The stream channel will be constructed of native materials and will consist of large boulders alternating with cobble and sand. Revegetation of the stream banks will be accomplished using native and common riparian species such as *Cleistocalyx operculata, Sterculia lanceolata* and *Syzygium jambos.* These trees should be planted in a random pattern along either bank.

6.7.14 Shrubs to be planted along the stream banks will also be native species which are common along Lantau Island streams. Recommended species include those listed in the following revegetation specifications.

Vegetation for the Central Landscape Feature

6.7.15 Vegetation will form one of the most important parts of the landscape feature design. Ornamental species with high landscape values will be selected for planting in the water feature garden and viewing terrace areas. These species include *Callistemon viminalis, Eleocarpus hainanensis, Sterculia lanceolata* and *Salix babylonica.* Most of these species are well suited to waterside habitats and also possess colourful flowers (*Callistemon viminalis* and *Eleocarpus hainanensis)*, fruits (*Sterculia lanceolata*) or shoots (*Salix babylonica*). Areas surrounding the water feature and the trees will be hydroseeded where possible to avoid excessive paving and to provide a natural environment for the public.

Main Road Corridors

6.7.16 Tree species with large canopies are required to screen major roads from the residential areas and to provide shade. Light standard trees of *Cinnamomum camphora*, *Crataeva religiosa, Bauhinia blackeana, Ficus microcarpa* and *Schima superba* have been selected. In addition, some deciduous species, such as *Liquidambar formosana* and *Sapium sebiferum,* which exhibit seasonal variation and have colourful foliage during autumn, are also recommended. Except *Crataeva* and *Bauhinia*, all others are native species which will enhance the ecological value of these areas.

Amenity Planting

6.7.17 Open spaces around parking lots, clubhouses and residential areas will receive amenity plantings of ornamental species to provide an attractive landscape and to soften the impact of multiple residential buildings in close proximity. Sizeable trees such as *Bombax malabaricum, Cinnamomum camphora, Ficus microcarpa, Ilex rotunda, Michelia alba* and *Rhodoleia championii* will be used in these locations for their natural appeal and potential for the provision of shade as they mature. Each of these species is characterised by a large crown and/or beautiful, fragrant flowers. Therefore, they are good plant materials for gardens and landscaping. *Bombax* is a species commonly used by birds as nesting sites. In addition, *Cinnamomum, Ficus* and *Ilex* are native species which are useful for local birds.

Specifications for Revegetation

Woodland Belt 1 (Discovery Bay Tunnel Portal and Surroundings)

6.7.18 Planting Methodology

- Tree whips and shrub seedlings will be used.
- Trees : Shrubs = 75% : 25%.
- Planting distance = 1.5m between trees; 0.5m between shrubs; 0.75m between shrubs and trees.
- Planting patterns: plant in groups (10 per group for trees and 25 per group for shrubs).
- Groups to be arranged randomly.

6.7.19 Species List

Trees

- *Castanopsis fissa*
- *Ficus hispida*
- *Leucaena leucocephala**
- *Litsea glutinosa*
- *Lophostemon conferta**
- *Macranga tanarius*
- *Mallotus paniculatus*
- *Schefflera octophylla*

Shrubs

- *Gordonia axillaris*
- *Rhodomyrtus tomentosa*

Woodland Belt 2 (Slopes Between Terraced Building Platforms)

6.7.20 Planting Methodology

- Tree whips and shrub seedlings will be used.
- Trees : Shrubs = 75% : 25%.
- Planting distance = 1.5m between trees; 0.5m between shrubs; 0.75m between shrubs and trees.
- Planting patterns: plant in groups (10 per group for trees and 25 per group for shrubs).
- Groups of shrubs (except *Psychotria rubra*) to be planted on upper slopes; groups of trees and *Psychotria* to be planted on lower slopes.
- Groups to be arranged randomly.

6.7.21 Species List

Trees

- *Acacia confusa**
- *Bischofia javanica*
- *Bridelia tomemtosa*
- *Machilus breviflora*
- *Sapium sebiferum*
- *Schima superba*
- *Viburnum odoratissimum*

Shrubs

- *Baeckea frutescens*
- *Lespedeza formosa*
- *Melastoma candidum*
- *Psychotria rubra*
- *Raphiolepis indica*
- *Rhododendron simsii*
- *Rhodomyrtus tomentosa*

Stream Banks

6.7.22 Planting Methodology

- Whip trees will be used.
- Trees : Shrubs = 75% : 25%.
- Planting distance = 1.5m between trees.
- Planting patterns: plant in groups (10 per group for trees).
- Groups to be arranged randomly.

6.7.23 Species List

Trees

- *Ficus fistulosa*
- *Cleistocalyx operculata*
- *Sterculia lanceolata*
- *Syzygium jambos**

Shrubs

- *Clerodendrum fragrans*
- *Melastoma sanguineum*
- *Rhodomyrtus tomemtosa*
- *Illicium dunnianum*

Lakeside Planting

6.7.24 Planting Methodology

- Light standard trees will be used.
- Planting distance = 1.5m between trees.
- Planting patterns: plant in groups (10 per group for trees).
- Groups to be arranged randomly.

6.7.25 Species List

Trees

- *Callistemon viminalis**
- *Eleocarpus hainanensis**
- *Salix babylonica**
- *Sterculia lanceolata*

Main Road Corridors

6.7.26 Planting Methodology

- Light standard trees will be used.
- Planting distance = 2m between trees.
- Planting patterns: plant in two rows.

6.7.27 Species List

Trees

- *Cinnamomum camphora*
- *Crataeva religiosa**
- *Bauhinia blackeana**
- *Ficus microcarpa*
- *Liquidambar formosana*
- *Sapium sebiferum*
- *Schima superba*

Amenity Planting (Open Spaces, Around Houses etc.)

6.7.28 Planting Methodology

- Light standard trees will be used.
- Planting patterns: depend on the specific requirement, but planting in groups as possible (10 per group for trees).

6.7.29 Species List

Trees

- *Bombax malabaricum**
- *Cinnamomum camphora*
- *Ficus microcarpa*
- *Ilex rotunda*
- *Rhodoleia championii*

* Exotic or naturalised species.

6.7.30 The standards for the nursery stock for species used in the landscape plan are shown in Table 6.4.

Table 6.4 Standards for Nursery Stock

Stock	Age (years)	Overall Height (mm)	Stem Diameter (mm)	Root Ball Size (mm)	Characteristics
Seedlings	1-2	150-160		75 x 100 (container grown)	Single slender stem with vigorous root system.
Whip	2-3	900-1750		125 x 150 (container grown)	Single central stem with elementary branch system.
Light Standard	3-4	1751-2750	15-25	350 x 300	Strong, upright and straight unpruned stem, furnished with side branches.

Source: Adapted from Webb (1991).

6.8 Conclusions of the Landscape/Visual Assessment

6.8.1 The proposed Discovery Bay North development will fundamentally alter the open, rural character of the Yi Pak valley, resulting in an number of clearly identifiable landscape and visual impacts on sensitive receivers.

6.8.2 The following long-term landscape impacts identified include:

- the loss of Sam Pak Wan Valley South natural landform and vegetation;
- lowering of Yi Pak Hill and cutting back of the Yi Pak Hill spur;
- the loss of the lower Yi Pak Valley ecosystem; and
- the loss of natural coastal features in Yi Pak Wan and part of Sam Pak Wan.

6.8.3 Severe long-term visual impacts will remain for existing residents as a consequence of their proximity and elevated views over the Yi Pak Valley and the Discovery Bay North development.

6.8.4 Regarding potential visual impacts, whilst the long-term visual impact of the Discovery Bay North development upon medium and low sensitivity receptors will be low, the impact upon existing residents will remain severe.

6.8.5 Mitigation of the visual impact on existing residents is provided through the project design, in particular the continuous landscape buffer between the Hai Kam Tsui headland and the proposed residential blocks. In addition, the retention of the lower scrub-woodland covered slopes of Yi Pak Hill, which face the Hai Kam Tsui headland, will reduce both the visual intrusion upon existing residents and the landscape impact of the development upon the site. The central landscape feature in Yi Pak valley will compensate for the existing area in terms of recreational facilities and open space but will have a more developed character.

6.8.6 Severe long- term visual impacts will, however, remain for some residences as a consequence of their proximity and elevated views over the Yi Pak Valley. The overall design is directed to minimise the visual impact of the development, and the overall impact of the development is considered to be acceptable.

7.

ECOLOGY

7. Ecology

7.1 Introduction

7.1.1 The core study area contains a wide range of habitats. All of the area has been influenced by the proximity to residential areas in Discovery Bay. Some areas are highly modified, others retain an essentially natural character. Given the proximity to Discovery Bay, the opportunity to manage the area for long-term conservation would be difficult.

7.2 The Regulatory Environment

Hong Kong Regulations and Guidelines

7.2.1 The Hong Kong Government regulations relevant to the present project include the following:

- the Forests and Countryside Ordinance (Cap. 96) which protects both natural and planted forests, including mangroves;
- the Forestry Regulations which provide for protection of specified local wild plant species;
- the Wild Animals Protection Ordinance (Cap. 170) which provides for the protection of listed species of wild animals (excluding fish and marine invertebrates) by prohibiting the disturbance, taking or removal of such animals, their nests and eggs; and
- the Fisheries Protection Ordinance (Cap. 171) which is intended to promote the conservation of fish and other forms of aquatic life within the waters of Hong Kong, to regulate fishing practices and to prevent activities detrimental to the fishing industry.

Ramsar Treaty

7.2.2 Through the United Kingdom, Hong Kong is a Party to *The Convention on Wetlands of International Importance Especially as Waterfowl Habitat* (the *Ramsar Convention*). Contracting parties to the Ramsar Treaty are required to designate at least one wetland for inclusion in a 'List of Wetlands of International Importance.' Within Hong Kong, the Mai Po/Inner Deep Bay wetland was the first wetland considered for Ramsar Convention listing. It was proposed for designation as a Ramsar Wetland of International Importance in March 1995. None of the wetlands in the Master Plan 6.0(A) study area are known to qualify as Ramsar Convention wetlands.

7.2.3 Article 1 of the Ramsar Convention defines wetlands as 'areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters.' All wetland habitats in the study area, including intertidal coastlines, mudflats, mangroves, and estuaries, qualify as wetlands under this definition.

7.2.4 Article 3.1 of the Ramsar Convention provides that the contracting parties 'shall formulate and implement their planning so as to promote as far as possible the wise use of wetlands in their territory'. The wise use concept was defined in 1987 as 'the sustainable utilisation of wetlands for the benefit of humankind in a way compatible with the maintenance of the natural properties of the ecosystem'.

Country Parks, SSSIs and Special Areas

7.2.5 There are no Country Parks, Sites of Special Scientific Interest (SSSIs) or Special Areas near the proposed development area. The nearest such area is Lantau South Country Park, some 4km south-west of Yi Pak Wan. There is, however, a proposed extension of Lantau North Country Park which would bring its eastern boundary within 400m of the development area at Yi Pak Wan and within 200m at Sam Pak Wan (AFD Map: *Lantau North Extension*, Plans 1c & 1d, dated 5/93). The proposed Country Park extension was under consideration by AFD at the time of writing.

7.3 Study Materials and Methods

Flora

7.3.1 The initial studies were conducted in autumn 1994 to identify the key ecological issues. Field surveys were performed on the proposed Discovery Bay North development site on 17 and 23 November, 1994. The rocky shore of Yi Pak Wan and Yi Pak Hill were surveyed non-systematically. Major habitats of terrestrial vegetation were noted and dominant flora were recorded. The objective was to establish the conservation significance of the study area, and particularly to determine whether species of plants which are protected by local regulations or international convention occur in the study area. Plants were identified to species level where possible.

7.3.2 Further field surveys were conducted for major habitats in April 1995. Major habitats of terrestrial vegetation were classified according to commonly used criteria (Hong Kong Government, 1968). Plants were identified to species level where possible to determine the presence of protected, rare or endangered species. The purposes of the second study were:

- to supplement the initial baseline information with detailed vegetation surveys during winter 1994/95 and spring 1995;
- to determine the conservation importance of vegetation in the study area; and
- to examine whether plant species which are protected under local regulations occur within the study area.

7.3.3 Marine macroalga were surveyed as part of transect studies of the boulder and cobble shore within the study area. A general shoreline survey was also performed to assess intertidal algal diversity. These surveys were conducted during winter and spring seasons in early 1995 in response to a request from AFD at the Environmental Study Management Group meeting to discuss the IAR (HKR, 1994a).

Fauna

7.3.4 Aquatic fauna were surveyed using hand nets and traps in the streams and estuaries. The occurrence and distribution of organisms along the boulder and rocky shoreline were surveyed using belt transects. Terrestrial and avian fauna were surveyed non-systematically to cover all available habitats and to maximise species representation in the sample results.

7.3.5 Avifauna surveys were conducted in January, February, March and April, 1995 to document species presence in the study area and to identify important bird habitats. Surveys were conducted in all habitats to be affected by the proposed development at Yi Pak Wan and Sam Pak Wan. Nests, perches, roosts, feeding areas and other important bird habitats were recorded. Species presence and abundance estimates were made visually and through vocal recognition.

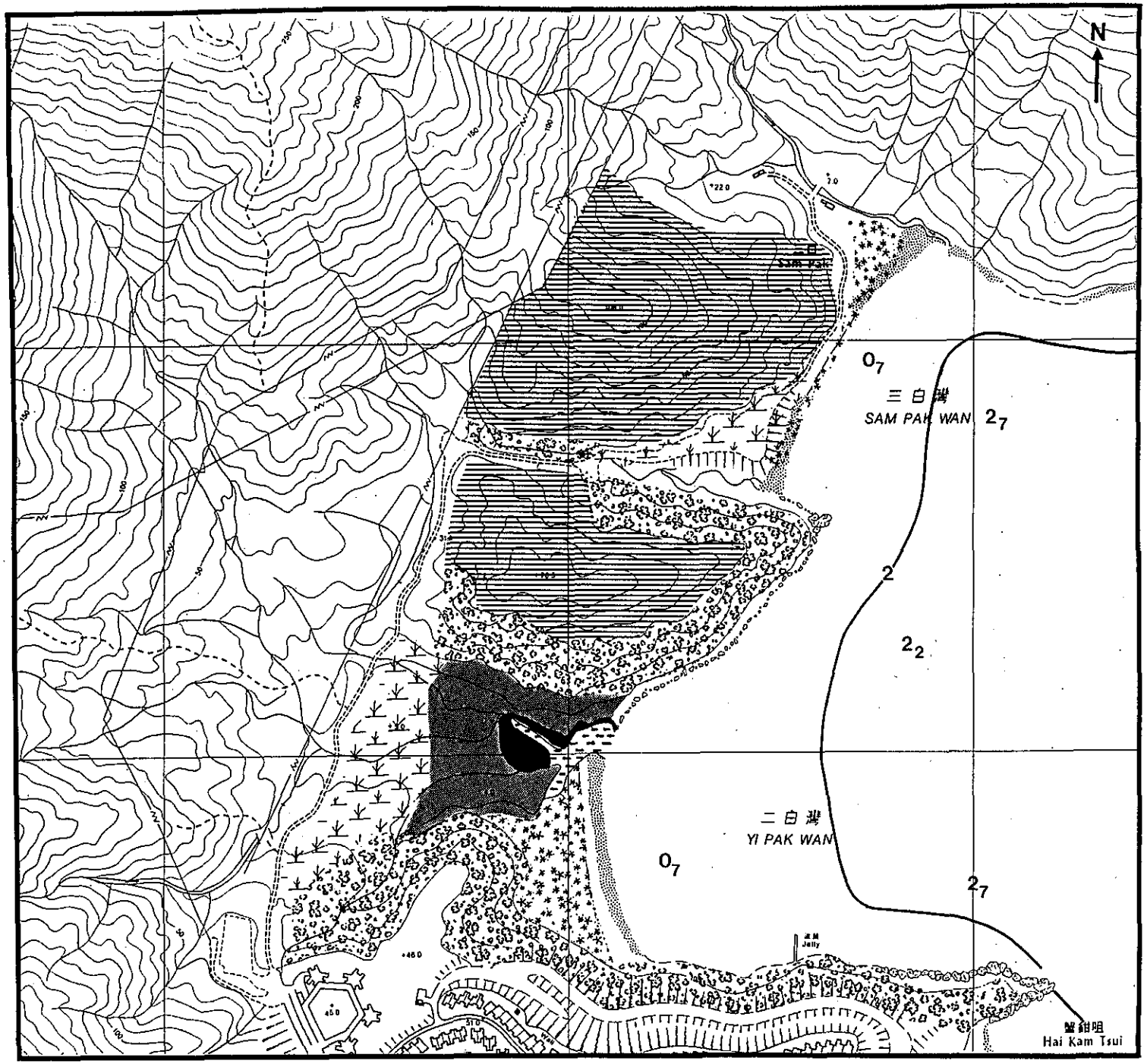
7.3.6 Amphibian, reptilian and mammalian fauna were surveyed by searching for animals or their burrows, trails, droppings or other signs of regular use. All major habitats were surveyed.

7.4 Existing Flora

General Study Area Flora

7.4.1 Five major types of vegetation in the study area were identified: shrub woodland, shrub grassland, grass/disturbed areas, mangroves/mangrove associated vegetation and backshore vegetation (Figure 7.1).

7.4.2 In general, the site is a frequently disturbed area. Much of the vegetation in the area has been subject to surface disturbance by construction or fire in recent years. The most recent fire occurred between November 14 to 16, 1994. This fire extensively burned the study area including Tai Che Tung, Yi Pak Au and down to Lau Fa Tung. Only the relatively mesic habitats such as the backshore, ravine, riparian and foothill regions survived the fire. The plant species recorded during the 1994 and 1995 surveys are listed in Table 7.1.



Key

- Backshore vegetation
- Shrub woodland
- Shrub grassland
- Mangroves
- Mangrove associated vegetation
- Lagoon
- Boulder shore
- Sandy shore
- Grass/disturbed area

2_2 Depth in metres (i.e. 2.2m) reduced to Chart Datum (approx. level of Lowest Astronomical Tide) Source: Admiralty Chart No. 1919, July 1994.

Figure 7.1
Discovery Bay North Habitat Map

Table 7.1 Species List and Abundance of Flora at the Discovery Bay North Development Site

Scientific Name	Habit	Habitat			
		Woodland	Grass/ shrubland	Streamside	Coastal area
Acronychia pedunculata	tree	++			
Adina pilulifera	shrub	++			
Adinatum flabellatum	fern	+			
Aporusa dioica	tree	++			
Aralia chinensis	tree		++		
Archidendron lucidum	tree	++			
Ardisia punctata	shrub	++			
Artocarpus hypargyreus	tree		+, planted		
Arundinella setosa	grass		+++		
Aster baccharoides	herb		++		
Baeckea frutescens	shrub		+++		
Berchemia lineata	shrub			++	
Bidens pilosa	herb		++		
Blechnum orientale	fern	++	++	++	+
Breynia fruticosa	shrub		++		
Bridelia tomentosa	tree	++		++	
Cassytha filiformis	climber		++		
Casuarina equisetifolia	tree	rare	++, planted		
Cerbera manghas	tree	+			
Chrysanthemum indicum	herb	++			
Cleistocalyx operculatus	tree			+++	
Conyza bonariensis	herb		++		
Cratoxylum cochinchinense	tree	++		++	
Daphniphyllum oldamii	tree	++			
Desmos cochinchinensis	climber	++			
Dianella ensifolia	herb		++		
Dicranopteris linearis	fern	+++	+++		
Embelia laeta	climber		+++		
Embelia longifolia	climber	++	++		
Emilia sonchifolia	herb		++		
Erythrina variegata	tree		+, planted		
Eucalyptus tereticornis	tree		+, planted		
Eupatorium japonicum	herb		++	++	
Eurya chinensis	shrub	+++			
Ficus fistulosa	tree	++		++	
Glochidion eriocarpum	shrub	+	++		
Glochidion lanceolatum	tree	++		++	
Glochidion wrightii	tree			++	
Gynura bicolor	herb		++		
Helicteres angustifolia	shrub		++		
Hibiscus tiliaceus	tree				+++
Ilex asprella	shrub	+++			
Ipomoea brasiliensis	climber				+++
Ischaemum indicum	grass		+++		
Lantana camara	herb	++	++	+++	++
Lespedeza formosa	shrub		+		
Leucaena leucocephala	tree		++, planted		
Litsea glutinosa	tree	+++			
Litsea rotundifolia	tree	+++	++	++	
Lonicera confusa	climb	++			
Lygodium japonica	fern	+++	++		
Macaranga tanarius	tree			++	
Maesa japonica	shrub	+			

Table 7.1 Species List and Abundance of Flora at the Discovery Bay North Development Site (continued)

Scientific Name	Habit	Habitat			
		Woodland	Grass/ shrubland	Streamside	Coastal area
Melastoma sanguineum	shrub		++		
Microcos paniculata	tree	+++			
Mikania guaco	climber	+++	+++	+++	+++
Miscanthus floridulus	grass	+++			
Musa sp.	herb		++, planted		
Mussaenda pubescens	climber		++		
Neyraudia reynaudiana	grass		+++	++	
Paederia scandens	climber	++	++	++	
Panicum sarmentosum	grass		++		
Pennisetum polystachyum	grass		+++		
Phoenix hanceana	palm	+	+		
Phyllanthus cochinchinensis	shrub	++			
Phyllanthus emblica	tree		++		
Psychotria rubra	shrub	++		++	
Pteridium aquilinum	fern		++		
Pteroloma triquetrum	climber			++	
Pueraria phaseoloides	climb	++		++	++
Rhaphiolepis indica	tree	+++	++		
Rhodomyrtus tomentosa	shrub	++	+++		
Rhus hypoleuca	tree	++	++		
Rhus succedanea	tree	++	++		
Rhyncospora rubra	sedge		++		
Rourea microphylla	climb	+++			
Rubus reflexus	climber	++	+++		
Sapium discolor	tree	++			
Sarcandra glabra	herb	+			
Scaevola sericea	tree				++
Schefflera octophylla	tree	++		++	
Scleria herbecarpa	sedge		+		
Scolopia chinensis	tree	+			
Smilax china	climber	++	++	++	
Smilax lanceifolia	climber	++	+++	++	
Sterculia lanceolata	tree	++		++	
Strophanthus divaricantus	shrub		++		
Symplocos laurina	tree	++	++		
Tetracera asiatica	climb	+++			
Thespesia populnea	tree			+	
Trema orientalis	tree	+		+	
Vaccinium bracteatum	shrub		+		
Wedelia prostrata	climber			++	
Wikstroemia indica	shrub		+		
Youngia japonica	herb		+		
Zanthoxylum avicennae	tree	+			
Zanthoxylum scandens	climber	++	++	++	

Boldfaced species were recorded during April 1995 surveys.
Abundance: +rare; ++occasional; +++common.

Shrubland and Grassland

7.4.5 This is the major vegetation type in the study area of Yi Pak Au and Yi Pak Hill. These large areas of shrubland/grassland have been maintained by frequent hill fires. Within these areas, continuous successional stages from grassland/fernland to shrubland were recorded. They were all very similar in composition, but varied in species dominance. Therefore, they are described together in this report.

7.4.6 In general, the grassland was dominated by *Arundinella setosa, Cymbopogon citratus* and *Ischaemum* spp. with some shrub species such as *Rhodomyrtus tomentosa, Rhaphiolepis indica* and *Eurya chinensis*. The fernland was dominated by *Dicranopteris linearis*, with a mixture of other grass and shrub species. The shrubland was dominated by *Rhodomyrtus tomentosa, Rhaphiolepis indica, Gardenia jasminoides* and *Diospyros vaccinioides* mixed with some ferns and grasses.

Coastal and Estuarine Flora

7.4.7 The proposed development site encompasses areas of backshore, mangrove, estuarine, intertidal and sub-tidal habitats. Backshore habitats are represented by the sand berm and mangrove associated vegetation, and small estuaries are formed by the tidal lagoons and sand spits at the mouths of both Yi Pak and Sam Pak streams. Sand and boulder shorelines are represented in the intertidal zone.

Mangrove

7.4.8 The stand of mangroves is mainly confined to the site behind Yi Pak beach which is inundated by the tide via the lagoon and its drainage channel at the northern tip of the beach. Freshwater enters the stand through four streams. The major species in this mangal are shown in Table 7.2. *Aegiceras corniculatum* is the dominant species, closely followed by *Kandelia candel.* There were also good numbers of *Bruguiera gymnorrhiza* and *Acanthus ilicifolius* at the site. Only a few individuals of *Avicennia marina* were found. There was no clear evidence of spatial zonation of species in this mangal, although *Excoecaria agallocha* was mainly confined to the landward fringes. Excluding *A. marina*, individual trees of other species reached 3m in height. This height is typical for western Hong Kong mangroves. Some trees of *B. gymnorrhiza*, *A. corniculatum* and *K. candel* were over 3m in height.

Table 7.2 Mangrove Species Represented in Yi Pak Stand, Lantau Island, November 1994

Species	Abundance Rank (1 = highest)
Acanthus ilicifolius	5
Aegiceras corniculatum	1
Avicennia marina	6
Bruguiera gymnorrhiza	4
Excoecaria agallocha	3
Kandelia candel	2

7.4.9 Propagules of *B. gymnorrhiza*, *K. candel* and *A. corniculatum* had established on the seaward edge of the mangal. All three species were subjected to deposition of up to 0.3m of coarse sand at the seaward periphery of the mangal during autumn 1994. Affected trees survived through the winter. Mature *K. candel* trees produced many immature propagules during early winter and spring 1995. Both *K. candel* and *A. corniculatum* are widespread in Hong Kong and typically occur in mangals throughout the Territory. *A. marina* and *B. gymnorrhiza* are considered to be of relatively limited distribution in Hong Kong. *A. marina* reproduction has been limited in recent years throughout Hong Kong due to poor production of propagules possibly resulting from insect herbivory of the flowers.

7.4.10 The area of the mangrove was estimated to be about 0.6 ha from 1:5000 scale topographic maps and 1993 aerial photos (Survey and Mapping Office, Buildings and Lands Dept.).

Backshore and Mangrove Associated Vegetation

7.4.11 The beach at Yi Pak Wan has a typical profile, with a berm of sand at the top of the beach colonised by backshore vegetation. The common species are listed in Table 7.3. On the landward side of the berm, the backshore vegetation merges with the enclosed mangrove stand behind the beach.

Table 7.3 Backshore Vegetation Behind Yi Pak Beach, Lantau Island, November 1994 to April 1995

Species	Common Name
Hibiscus tiliaceus	Hibiscus
Pandanus tectorius	Screw-pine
Caesalpinia cristia	Gray Nickers
Vitex rotundifolia	
Scaevola sericea	Sea Lettuce
Cerbera manghas	Cerbera
Ipomoea brasiliensis	
Pueraria phaseoloides	Wild Kudzu vine
Zoysia sinica	Seagrass
Saccharum arundinaceum	
Pennisetum sp.	

7.4.12 Around the landward fringes of the mangroves, there is a transition from mangrove to hillside vegetation with the higher zoned mangrove *Excoecaria agallocha* and common mangrove associates such as *Pandanus tectorius* giving way to grasses (*Saccharum arundinaceum, Neyraudia reynaudiana),* shrubs (*Phoenix hanceana)* and some cultivated species (*Musa paradisiaca*).

7.5 Existing Fauna

Overview

7.5.1 The core study area contains a wide range of habitats ranging from upland grass/ scrub cover to estuarine areas. Some habitats are highly modified while others remain relatively undisturbed.

Yi Pak Stream Fauna

7.5.2 The main stream draining into Yi Pak lagoon is channelled in the section immediately below the existing Discovery Bay residential area for approximately 200m. The lower 200m remains in its natural state. However, the stream has been heavily impacted by runoff from nearby earthworks and previous construction activities. Little remained of interest ecologically. While there were many juvenile marine fish (e.g. *Mugil cephalus, Pampus argenteus*) in the lower, tidal reaches of the stream, only freshwater gobies

(*Ctenogobius duospilus)* and a flat-headed goby (*Glossogobius giuris)* were recorded in the upper reaches.

Estuarine Fauna

7.5.3 The fauna of the mangrove and the estuary was neither abundant nor diverse. Mudskippers (*Periophthalmus cantonensis*) were present, and many small sesarmid crabs inhabited the softer mud along the edges of drainage channels within the mangrove. The mangrove floor was rather hard-packed earth, which may deprive the usual array of mangrove/mudflat invertebrates of suitable habitat. There was also a marked absence of gastropod species. A shell belonging to the maritime pulmonate snail *Ellobium polita* was found, which may indicate the presence of this species in the mangrove stand, although no live specimens were recorded. This species is of limited distribution in Hong Kong.

Yi Pak Beach Fauna

7.5.4 The profile of Yi Pak beach consists of a berm at the very back of the beach covered in characteristic vegetation (Table 7.3), an upper beach and a lower beach. The fauna was restricted to Ocypodid crabs with their burrows on the upper beach, along with strandline fauna such as litter cockroaches (*Opisthoplatia orientalis*). The high number of shells on the lower beach testifies to sub-littoral populations of *Tapes philippinarum* and *Donax* sp. The low diversity of the beach fauna is typical for such a habitat.

Sub-Tidal Fauna

7.5.5 The sub-tidal substrate of Discovery Bay is generally soft silt and sand. Average values for the particle size distribution of the sediment are shown in Table 7.4.

Table 7.4 Particle Size Analysis (%) of Discovery Bay Sub-Tidal Sediment

Gravel	Sand	Silt	Clay
1	10	57	31

Source: APH, 1993.

7.5.6 As is generally the case in Hong Kong, polychaetous annelids and molluscs dominate the benthic infauna. Benthic surveys carried out as part of the Lantau and Western Harbour Development Studies Environmental Survey (APH, 1993) indicated that the benthic community at Discovery Bay was of low diversity and species richness relative to samples from, for example, Chi Ma Wan further south. The values of H^{l} are similar to those reported by Shin (1988) for the infauna of beach sediments in Hong Kong. The five dominant species during the winter were all polychaetes (*Notomastus latericeus,*

Paraprionospio pinnata, Glycera chiori, Terebellides stroemi and *Aglaophamus lyrochaeta).* During the summer survey, *Glycera* and *Terebellides* were replaced by *Lumbrinereis* spp. and a nemertean (*Nemertea* sp.) in the list of the five dominant species.

7.5.7 The abundance and biomass of the benthic infauna shows strong seasonal trends, with far greater numbers of organisms during December than June (Table 7.5). As is typical of such communities in Hong Kong, diversity does not vary as much, but may be affected by variations in the abundance of some species (Ong Che and Morton, 1991).

Table 7.5 Benthic Community Statistics, Discovery Bay, December 1991 and June 1992

	Species per 0.15 m^2	Individuals per m^2	Wet weight	H' *	J' **	SR ***
December 1991	5	80	11.25	1.23	0.77	1.61
June 1992	3	20	2.80	1.09	1.00	0.66

Source: APH, 1993

* Shannon-Weaver Diversity Index
** Pielou Evenness Index
*** Margalef's Species Richness Index

Intertidal Fauna

Boulder

7.5.8 The exposed stretch of boulder shore to be affected by the proposed development runs from the southern section of Sam Pak Wan to the southern end of Yi Pak Wan. This type of shoreline is very common in Hong Kong. High-zoned on these boulders were species of *Nodolittorina* and the hydrobiid *Zebina tridentata*, plus many sea-slaters (*Ligia exotica).* Numerous crabs were present, such as the sesarmid *Parasesarma pictum,* and grapsids *Grapsus albolineatus* and *Gaetica depressa*. The most numerous gastropod was the top-shell, *Monodonta australis*, with *Lunella coronata* and *Nerita* sp. also abundant lower down the shore. Also common was the limpet *Colisella dorsuosa.* Lower down the beach, the attached fauna was dominated by rock oysters (*Saccostrea culcullata*), many with a surrounding stubble of the red alga *Gelidium pusillum.*

Cobble/Mud

7.5.9 The shoreline to be affected along the southern edge of Yi Pak Wan is more sheltered than the boulder shore to the north. The high shore is again bedrock/boulder, but the mid and lower intertidal zones are of a shallow gradient, with many small to medium rocks embedded in fine sand and mud. *Nodolittorina* sp. again dominated the upper eulittoral, with *Nerita albicella* appearing slightly lower down. In the lower half of the intertidal zone, rocks embedded in the mud were thickly covered with the bivalve *Chama reflexa,* with clusters of *Barbatia viriscens* growing in crevices. The dominant gastropods here were *Lunella coronata* and the whelk *Morula musiva*. Large aggregations of *M. musiva* (over 1000 per m^2) could be found on the lower faces of some larger rocks. Also recorded was the common anemone *Haliplanella luciae*, with a second, burrowing species also present, possibly *Paracondylactis hertwigi.*

Intertidal Alga

7.5.10 The macroalga in Hong Kong are seasonal in nature, being most abundant during the winter/spring months and all but disappearing during summer (Hodgkiss and Lee, 1983). This was found to be the case during surveys of the Yi Pak Wan shoreline, where no alga were recorded during the autumn survey, but were in evidence during late winter/spring. During March, the rocks in the lower eulittoral and sub-tidal zones along the northern edge of Yi Pak Wan were thickly covered with the brown algae *Petalonia fascia*. Areas of *Gomontia* sp. were found higher up the shore. Patches of *Brachytrichia maculans* were also recorded. Detached specimens of *Colpomenia sinuosa* were collected from Yi Pak beach. None of these species are rare in Hong Kong.

Fisheries

7.5.11 Yi Pak Wan falls within the northern sub-area of the Western Harbour sector of Hong Kong's fishing grounds. Medium intensity demersal, pelagic and fry fishing occurs in the Western Harbour sector (P. Gaiger, pers. comm.; Fisheries Officer, Agriculture & Fisheries Department, Hong Kong). Shallow embayments such as Yi Pak Wan are known to be nursery grounds for marine fish (e.g. Snapper, Sea-bream), where the fry are seasonally concentrated between March and April, sometimes extending into June (APH, 1993). The coastal waters of Discovery Bay and Penny's Bay are also used by penaeid shrimp and hang-net (mid-water) trawlers (P. Gaiger, pers. comm.), and small craft from Peng Chau, Cheung Chau and Mui Wo also fish these waters. The estimated quantity and value of fish caught in the northern sub-area by small craft during 1989-90 were: adult fish - 2181 tonnes / HK$30.82M; fry - 1.31 million/HK$ 2.74M (APH, 1993).

Birds

7.5.12 Birds were surveyed on the site during summer (May 16, June 5 and 7, 1994), autumn (November 17 and 24, 1994), winter (January 12, February 2 and 26, 1995), and spring (April 5, 15 and 17, 1995). Surveys were conducted from within one hour of sunrise through sunset. Sightings and vocalisation records of birds were documented. Survey routes were followed to cover all major habitats. The results of bird surveys are shown in Table 7.6.

7.5.13 51 species of birds were recorded on the site over all seasons. 31 species were recorded during summer and autumn and 20 additions were made during winter and spring. 27 families were represented. Two families were represented by four species each (*Alcedinidae* or kingfishers, and *Motacillidae* or pipits and wagtails). All other families were represented by three or fewer species. 16 species were recorded during summer 1994, 15 additional species were recorded during autumn 1994 and 19 species were added during winter 1994/95 and spring 1995. Most of the species recorded are common residents or seasonal visitors to Hong Kong, and would be expected to occupy habitats such as those in the study area.

7.5.14 Of particular interest with regard to the utility of the area for birds feeding on aquatic prey are the Cormorant, the egrets and Night Heron, the four species of kingfisher and the Common Sandpiper. These birds were observed foraging on Yi Pak Wan, the sand beaches, in the lagoons behind the beaches and along the streams feeding the lagoons. Foraging by these species demonstrates that the bay and the estuaries support vertebrate prey selected by avian predators. Additionally, the presence of four species of kingfisher within the relatively small survey area suggests that the site is a preferred foraging habitat. Only the White-breasted and Common Kingfisher were observed during spring 1995 surveys, suggesting that these species may nest in the vicinity. The four species of kingfisher recorded on the study site represent all the resident species of kingfisher in Hong Kong.

7.5.15 A pair of Black-eared Kites was observed during November 1994 perched in the woodland above the Yi Pak Wan estuary and in a large *Eucalyptus* sp. tree. Courtship behaviour was not observed during autumn, but one bird was observed carrying nesting material. During April 1995, a nest was located in the *Eucalyptus* sp. tree in the estuary and one young Black-eared Kite was observed in the nest. Both adults were observed either in the nest tree perched above the nest or foraging over scrub-grass habitats nearby. Neither bird tended the nestling during observations on April 17, 1995, as the chick was apparently old enough that brooding was no longer required. The nest was checked on May 9, 1995. The chick was still in the nest and was attended by both adults. The post-natal moult was nearly complete and down feathers were visible only on portions of the chick's body. The chick could not yet fly. The nesting attempt is considered to have been successful.

Table 7.6 Results of Bird Surveys at Yi Pak and Sam Pak, Lantau Island, Summer and Autumn 1994, Winter 1994/95 and Spring 1995

Common Name	Species	Status[1]	Abundance[2]	Habitat[3]
Cormorant	*Phalacrocorax carbo*	W	1	bay
Little Egret*	*Egretta garzetta*	R	1	beach, estuary
Night Heron*	*Nycticorax nycticorax*	R	1	estuary
Reef Egret*	*Egretta sacra*	R	1	estuary
Black-eared Kite*	*Milvus lineatus*	R	1	estuary, scrub-grass
Bonelli's Eagle	*Hieraaetus fasciatus*	R	1	soaring over all areas, coast
Unidentified accipiter	*Accipiter* sp.	?	1	soaring over scrub-grass
Kestrel	*Falco tinnunculus*	WV	1	soaring over scrub-grass, coast
Chinese Francolin*	*Francolinus pentadeanus*	R	2	shrubland
White-breasted Waterhen*	*Amaurornis phoenicurus*	R	2	estuary
Common Sandpiper*	*Actitis hypoleucos*	R	1	beach
Spotted Dove*	*Streptopelia chinensis*	R	3	estuary, woodland, shrubland
Rufous Turtle Dove	*Streptopelia orientalis*	PM/WV	2	estuary, woodland, shrubland
Emerald Dove*	*Chalcophaps indica*	R	1	woodland
Koel*	*Eudynamis scolopacea*	R	2	woodland, estuary
Indian Cuckoo*	*Cuculus micropterus*	S	1	woodland
Greater Coucal*	*Centropus sinensis*	R	3	backshore, estuary, woodland
Lesser Coucal*	*Centropus bengalensis*	R	1	estuary
Collared Scops Owl*	*Otus lempiji*	R	1	Sam Pak Wan coastal woods
Pied Kingfisher*	*Ceryle rudis*	R	1	estuary
Common Kingfisher*	*Alcedo atthis*	R	1	estuary, bay
Black-capped Kingfisher*	*Halcyon pileata*	R	1	estuary, bay
White-breasted Kingfisher*	*Halcyon smymensis*	R	1	estuary
Barn Swallow	*Hirundo rustica*	S,M	3	estuary, shrubland, woodland
Tree Sparrow*	*Passer montanus*	R	3	scrub-grass, woodland, residential
Richard's Pipit	*Anthus richardi*	R,M,W	1	scrub-grass
Olive-backed Pipit	*Anthus hodgsoni*	WV	1	residential park
Grey Wagtail	*Motacilla cinerea*	WV	1	revegetated slopes
White Wagtail	*Motacilla alba*	WV	2	estuary, disturbance area
Crested Bulbul*	*Pycnonotus jocosus*	R	4	woodland, estuary, scrub-grass,
Chinese Bulbul*	*Pycnonotus sinensis*	R	4	woodland, estuary, scrub-grass
Red-vented Bulbul*	*Pycnonotus aurigaster*	R	3	open pine scrub, woodland/ orchard
Magpie Robin*	*Copsychus saularis*	R	3	woodland, scrub-grass, estuary

Table 7.6 Results of Bird Surveys at Yi Pak and Sam Pak, Lantau Island, Summer and Autumn 1994, Winter 1994/95 and Spring 1995 (continued)

Common Name	Species	Status[1]	Abundance[2]	Habitat[3]
Blackbird	*Turdus merula*	WV	1	estuary, coastal woods
Yellow-bellied Prinia*	*Prinia flaviventris*	R	2	scrub-grass, stream
Plain Prinia*	*Prinia inomata*	R	2	estuary, scrub-grass
Dusky Warbler	*Phylloscopus fuscatus*	WV	2	estuary, scrub-grass
Narcissus Flycatcher	*Ficedula narcissina*	PM	1	woodland
Common Tailorbird*	*Orthotomus sutorius*	R	3	woodland, shrubland
Black-faced Laughing Thrush*	*Garrulax perspicillatus*	R	3	woodland, estuary, shrubland
Great Tit*	*Parus major*	R	2	estuary. woodland
Japanese White-eye*	*Zosterops japonica*	R	3	woodland, estuary, shrubland
Rufous-backed Shrike*	*Lanius schach*	R	1	scrub-grass, backshore
Black Drongo*	*Dicrurus macrocercus*	SV	2	estuary, shrubland
Hair-crested Drongo*	*Dicrurus hottentottus*	SV	1	estuary, shrubland
Magpie*	*Pica pica*	R	3	estuary, shrubland
Blue Magpie*	*Urocissa erythrorhyncha*	R	2	backshore shrubland, estuary
Jungle Crow*	*Corvus macrorhynchus*	R	1	estuary, scrub-grassland
Crested Mynah*	*Acridotheres cristatellus*	R	4	shrubland, estuary, woodland
Masked Bunting	*Emberiza spodocephala*	WV	2	woodland, estuary, shrubland
* = species potentially breeding on site				
[1]R = resident; PM = passage migrant; WV = winter visitor; SV = summer visitor				
[2]1 = 1 to 5 birds; 2 = 5-10 birds; 3 = 10-50 birds; 4 = 50-100 birds				
[3]Habitat use ranked in order of importance				

7.5.16 The Hong Kong Bird Watching Society reported a pair of adults and one juvenile Brown Fish Owl (*Ketupa zeylonensis*) at Yi Pak Wan in 1988 (Chalmers, 1988). This was the first record of Brown Fish Owl nesting in Hong Kong. Since then, a second nesting pair produced one young in Sai Kung during spring 1993 (Leven *et al.*, 1994). Although no indication of current use of the Yi Pak Wan site by Brown Fish Owls was observed, this species is considered difficult to locate. It is secretive, nocturnal and typically not vocal (G. Carey, pers. comm.; Hong Kong Bird Watching Society). Therefore, it may have been overlooked during surveys conducted to date. The probability of observing Brown Fish Owls at Yi Pak Wan may be greater during late spring and early summer if there is a nesting pair which produces young.

7.5.17 Observation of an individual Collared Scops Owl at Sam Pak Wan suggests that this area may be used by nesting owls. A breeding attempt may have occurred in spring 1995.

7.5.18 Observation of the Narcissus Flycatcher on 5 April 1995 was interesting in that the species is considered 'scarce but widespread' in Hong Kong (Viney *et al.*, 1994). It is a passage migrant typically observable in April. It was observed foraging for insects on mature trees (with closed canopy) around the village ruins west of the estuary at Yi Pak Wan.

7.5.19 Habitats preferred by wintering birds were the estuary and associated woodland or shrubland. Upland slopes and hill tops such as Yi Pak Hill were not preferred habitats.

7.5.20 13 of the 51 recorded bird species are not likely to nest on the site (Table 7.6). The remaining 38 species may nest within the study area. All birds, their nests and nest contents are protected by the Wild Animals Protection Ordinance (Cap. 170).

Reptiles and Amphibians

7.5.21 The Asiatic Painted Frog (*Kaloula pulchra*) was recorded calling in the Yi Pak and Sam Pak areas during spring 1995. In both cases, the habitat used was the lower reach of the stream near the estuary. This species is common in Hong Kong, particularly in the New Territories (Karsen *et al.*, 1986).

Mammals

7.5.22 No evidence of mammals was recorded within the study area. As reported following summer 1994 surveys (HKR, 1994a), small mammal burrows were seen on the hill immediately north of the Yi Pak streams. These were probably rat burrows, possibly those of the Chestnut Rat (*Niviventer fulvescens*), a common hillside rat in Hong Kong.

7.5.23 Droppings of a civet (probably the Masked Palm Civet, *Paguma larvata*) were recorded in Yi Pak during the early 1990s (D. Melville, pers. comm.; Executive Director, World Wildlife Fund for Nature, Hong Kong). The Masked Palm Civet is protected in Hong Kong under the Wild Animals Protection Ordinance (Cap. 170). In India, the species is protected under Appendix III of CITES (Convention on International Trade in Endangered Species) (Wilson and Reeder, 1993). In Guangdong Province, China, the Masked Palm Civet is not listed as a protected species. No signs of Masked Palm Civets were recorded during winter/spring 1995.

7.6 Potential Impacts on Ecological Resources

Potential Impacts on Terrestrial Flora

7.6.1 No protected or endangered species were recorded in the study area during winter/spring 1995 or during earlier surveys. Habitat loss due to construction of the development is estimated in Table 7.7.

Table 7.7 Coastal/Marine Habitat Loss due to Construction and Operation of Discovery Bay North

Habitat	Approximate Length/Area
Mobile sand beach	0.47 km
Rocky shore	0.31 km
Mangrove	0.6 ha
Mangrove associated vegetation	2.1 ha
Backshore vegetation	2.3 ha
Sub-tidal	5 ha

7.6.2 A major portion of the proposed development will be constructed on shrubland and grassland. Loss of these habitats is not predicted to be a significant impact because they have been disturbed by previous earth moving projects or by fire. Low species and structural diversity of these habitats results in low conservation significance. No plant species of conservation interest were recorded in these habitats during winter/spring 1995.

Potential Impacts on Terrestrial and Avian Fauna

7.6.3 The greatest impact to avifauna will be the loss of habitat. Both breeding and wintering bird communities can be expected to decline in species representation and population numbers due to habitat loss. Birds using the site are known to feed on flying insects, arboreal insects, fruits, freshwater/marine vertebrates and invertebrates, and carrion. The availability of all of these forage sources would decline under the existing development design. In particular, relatively undisturbed natural vegetation would be lost in both Yi Pak and Sam Pak Wan, thereby reducing the extent of available habitat in these areas. Species which rely on the estuarine habitat would be lost, and species with broader ranges of habitat preference and greater tolerance for human habitation would dominate.

7.6.4 The nest site of greatest conservation importance in a territorial context may be that of the Black-eared Kites in the Yi Pak Wan estuary. Although Black-eared Kites may number over 1000 birds in Hong Kong during winter, the number of breeding pairs is considered to number only around 30 (Viney *et al.*, 1994). The Black-eared Kite is a secretive nester, selecting remote sites. The availability of nesting habitat for the Black-eared Kite in Hong Kong has declined due to progressive urbanisation of remote, forested sites with mature trees (Viney *et al.*, 1994). The breeding season for Black-eared Kites in Hong Kong extends from December through May. As noted above, the pair nesting at Yi Pak Wan began courtship and territory establishment during November 1994. The chick was not fully feathered when observed in mid-April 1995 and was still in the nest in May. The breeding attempt was successful.

7.6.5 Should the project proceed as planned, the Yi Pak pair of Black-eared Kites would be displaced. The nest and nest tree would be lost as they are located in the Yi Pak Wan estuary. The only potential alternative nest sites in the vicinity are at Sam Pak so it is possible (although unlikely) that the birds would relocate there. However, general construction disturbance and increased human activity would probably preclude continued use of the site and would result in abandonment of the nesting territory. Removal of the Black-eared Kite nest from Yi Pak requires a permit from AFD and should be undertaken before the breeding season which usually extends from January to April. There is no historical precedent for such a permit due to the small number of sites supporting nesting Black-eared Kites in Hong Kong.

7.6.6 Should the Brown Fish Owls still occupy Yi Pak, they would also probably be displaced by the proposed development. These owls are also secretive nesters with apparently very restrictive criteria for nesting territory selection. There is only one other known nesting territory in Hong Kong due to the limited availability of suitable nesting sites for Brown Fish Owls.

7.6.7 The Collared Scops Owl may occupy a breeding territory at Sam Pak. This species is reasonably common in Hong Kong and its distribution may be underestimated (Chalmers, 1989). The Sam Pak area would be developed only to a limited extent so it is possible that a nesting pair of Collared Scops

Owls would continue to occupy this territory following completion of the development.

7.6.8 Impacts on mammalian fauna would be primarily loss of habitat for burrowing small mammals. This would apply also to mid-sized mammals such as the Masked Palm Civet if it still occupies the site.

Reptiles and Amphibians

7.6.9 Reptiles and amphibians were not recorded during the November 1994 surveys, but the Asiatic Painted Frog was recorded during spring 1995. Reptiles and amphibians are not active during late autumn and early winter. Any amphibians and reptiles occupying the areas which will be disturbed by the Discovery Bay North development would potentially be subject to significant impacts due to their relatively low mobility and narrow range of habitat preference. The availability of mesic, lowland habitats will decline within the site boundary following completion of the project.

Potential Impacts on the Proposed Country Park Extension

7.6.10 It is not anticipated that the proposed development will encroach onto areas included in the proposed extension to the North Lantau Country Park. The western limit of the Discovery Bay North development would be located within 400m of the park extension near Yi Pak and within 200m at Sam Pak. In both cases, areas within the proposed Country Park extension would be at higher elevations than the proposed residential development. Therefore, park visitors would have a view seaward over the development. This would be similar to the existing situation in South Lantau Country Park, and in many other country parks in the Territory.

Potential Impacts to Coastal Zone Habitat Resources

Coastal Shrubland and Woodland

7.6.11 The rocky shore and coastal vegetation between Yi Pak Wan and Sam Pak Wan would be lost due to construction. This type of coastal habitat is not uncommon in Hong Kong and is not of conservation concern based on its simple floristic composition. The *Hibiscus/Cerbera/Scaevola* association typical of this habitat is widespread throughout the Territory and was not found to be of conservation importance based on species composition.

Mangrove/Estuary

7.6.12 The primary impact of the development would be loss of the estuary and associated vegetation at Yi Pak. The species group of greatest concern at Yi Pak Wan is the mangroves. Occurrence of at least five mangrove species in this small estuary indicates that the site is of conservation interest. The mangrove/mangrove associate/backshore vegetation community represents a potentially valuable wetland ecosystem. Such coastal wetland habitats represent an increasingly rare vegetation type in Hong Kong due to the development of coastal infrastructure projects including the Chek Lap Kok

airport and associated developments. Absence of mangrove vegetation from the remaining undeveloped portions of the Lantau coastline contributes to the conservation interest of Yi Pak Wan.

7.6.13 Mangroves are a local and regional conservation concern due to loss of mangrove habitat resulting from urbanisation (Yipp *et al.*, 1993). Mangroves occur at 4 other locations along the South Lantau shoreline, at Chi Ma Wan, Pui O, Yi O San Tsuen and Tai O. Only the Yi O San Tsuen site is relatively unaffected by anthropogenic habitat degradation. However, mangrove cover at this site is sparse and the area of closed canopy is limited. The Tai O site has been considered as a potential mangrove restoration site by AFD to compensate for mangroves lost at Tung Chung due to construction of the Chek Lap Kok airport.

7.6.14 Loss of mangroves is known to result in ecological impacts on estuarine food chains (Odum *et al.*, 1982), fisheries (Lewis *et al.*, 1985; Meynell and Qureshi, 1993) and shoreline stabilisation (Carlton, 1974; Meynell and Qureshi, 1993; Villacorta and van Wetten, 1993). Mangroves can provide important habitats for resident and migratory avifauna and thus enhance local biodiversity. The near absence of mangrove vegetation from the remaining undeveloped portions of the Lantau coastline contributes to the conservation interest of Yi Pak Wan.

7.6.15 The 1993 estimate for the total extent of mangrove habitat in Hong Kong was 270 ha (RHKJC, 1994). 0.6 ha of mangrove habitat would be lost due to the Discovery Bay North development. This loss constitutes 0.22% of the remaining total mangrove habitat in the Territory estimated in 1993. The development plan includes proposals to compensate for the loss of mangrove by establishment of new mangrove plantings (see Section 7.7)

Shoreline

7.6.16 The proposed development will lead to the loss of approximately 310m of intertidal boulder shore between Yi Pak Wan and Sam Pak Wan. This is not considered to be a significant impact. Mitigation will be possible through the recreation of a boulder shore along suitable stretches of the new shoreline of the development (see Section 7.7).

7.6.17 The rocky shore and coastal vegetation between Yi Pak Wan and Sam Pak Wan would also be lost. However, this type of coastal habitat is not uncommon in Hong Kong and is not of conservation concern based on its simple floristic composition.

Beach Habitat

7.6.18 The 280m long natural sand beach at Yi Pak Wan would be lost as well as the large sand berm running along the back of this beach. The berm supports a plant community typical of such habitats. 190m of sand beach as well as primary and secondary sand spits and lagoons at the southern end of Sam Pak beach would also be lost. These areas provide shelter for juvenile marine fish.

Sub-Tidal Zone

7.6.19 The reclamation proposed under Master Plan 6.0(A) would cover an estimated 5 ha of the inshore seabed. The significance of this impact in relation to the local fisheries is discussed later in this section.

Summary of Potential Coastal Habitat Impacts

7.6.20 Unavoidable adverse impacts of the proposed development on the coastal areas of Yi Pak and Sam Pak will therefore be the combined loss of:

- Yi Pak and Sam Pak beaches - a total of 470m of natural sand beach;
- beach-associated vegetation - the large sand berm running along the back of Yi Pak beach supports a plant community typical of such situations, but increasingly rare in Hong Kong;
- primary and secondary sand spits and lagoons on Yi Pak and Sam Pak beaches which provide shelter for juvenile marine fish;
- wetland behind Yi Pak beach and associated with the tidal lagoon; this includes a diverse stand of mangroves, including at least 5 of the 8 mangrove species occurring in Hong Kong, plus mangrove associates and reeds;
- Yi Pak stream, providing freshwater input to the mangroves and associated vegetation; and
- approximately 5 ha of seabed and the subsequent possible impacts to local fisheries.

7.6.21 There are no potential areas on-site, and none known off-site, which would compensate entirely for the loss of the areas listed above. Thus, the Discovery Bay North development would have residual impacts on the Yi Pak and Sam Pak coastal habitats.

Potential Impacts to Commercial Fisheries

Cumulative Impacts of Projects in the Area

7.6.22 Construction of Container Terminals 10 and 11 (CT10/11) will result in a significant loss of coastal habitat and will undoubtedly have some negative impacts on the local fisheries. The proposed development at Discovery Bay North is much smaller than CT10/11 but will contribute to the cumulative negative impacts on fisheries in the Discovery Bay area (Table 7.8).

Table 7.8 Cumulative Coastal/Marine Habitat Loss of Importance to Fisheries due to Construction of CT10/11 and Discovery Bay North

Habitat	Approximate Length or Area Lost		Cumulative Total Loss
	CT10/11	Discovery Bay	
Mobile sand beach	0	0.47 km	0.47 km
Rocky shore	3.5 km	0.31 km	3.81 km
Mangrove	0	0.6 ha	0.6 ha
Sub-tidal	27 ha	5 ha	32 ha

7.6.23 Cumulative impacts on fisheries will arise from loss of benthic habitat and associated organisms (many of which are prey species for fish), a probable decline in water quality leading to reduced primary productivity, declining fish stocks and the loss of fishing opportunities due to reclamation and restrictions on fishing due to increased vessel activity in the area. This may lead to increased fishing pressure on other areas. The loss of shallow sub-tidal areas within Discovery Bay will reduce the preferred habitat of juvenile fish, as will the loss of intertidal rocky and sandy shorelines, with their associated flora and fauna, which are used by juvenile fish at high tide.

7.6.24 Further negative impacts to local fisheries arising solely from the Discovery Bay North development will result from the destruction of two tidal lagoons behind the Yi Pak and Sam Pak beaches, and the associated mangrove/marsh area at Yi Pak. Estuarine and mangrove habitats have special importance because they serve as significant nursery areas and their productivity supports important food webs. Mangroves provide ideal habitat for juvenile fish and crustaceans, where the abundance of decomposing detritus from the plants and epibionts growing on the submerged plant surfaces provide a rich source of food (Norse, 1993; Ledec and Goodland, 1988). In other parts of the world, destruction of such habitats has led to corresponding decreases in fish/crustacean yields offshore, while conversely the creation/restoration of similar habitats has produced improved yields (Norse, 1993; Davis, 1993). Economic evaluations of the dollar value of mangroves for fisheries ranges from US$133/km^2 for crabs in Sabah, Malaysia, to US$277,235/km^2 for shrimp and finfish on the Malaysia peninsula (Thorhaug, 1990).

7.6.25 The loss of rocky shore and mangrove areas can be compensated. However, the sandy shore will be a net loss due to the project. The feasibility of creating viable new rocky shore and mangrove habitat has been demonstrated in several recent projects in Hong Kong.

7.7 Impact Avoidance and Mitigation

Mitigation for Losses of Upland Flora

7.7.1 Loss of upland habitats on the site is unavoidable with development of Discovery Bay North. Loss of shrubland and grassland can be mitigated by revegetation of disturbed sites peripheral to the development immediately following completion of construction. A plan for restoration of vegetation on the site is included in Section 6.

7.7.2 Native species of trees and shrubs indigenous to the site and valuable to wildlife are specified for use in the revegetation plan. Disturbance of the surrounding areas during construction should be minimised. All areas of woodland and shrubland vegetation not required for project construction should be fenced so as to preclude access by heavy equipment.

7.7.3 Shrubland and grassland, if protected from fire, will succeed to more diverse secondary forest and can provide more valuable habitats for wildlife. In view of the devastation to the northern portion of Lantau Island during November 1994 caused by wildfire, it is recommended that provision be made for fire fighting in natural areas around the construction site throughout the construction phase. This would include the development of protocols for requesting assistance from the Government departments responsible for fire control. On-site provisions for fire fighting should include tools and equipment for manual fire control. Construction contractors should be required to assign personnel to fire fighting duty when needed. The use of fire by contractors should be controlled.

7.7.4 As recommended in Section 6, the planting of shrubs and trees on upland sites adjacent to the development would accelerate the successional process on degraded sites and contribute to impact mitigation. In addition to these proposals, restoration of the 0.45 ha former plant nursery area at the northern end of Sam Pak should be carried out as part of the proposed development. Extensive shrub and tree planting using the species included in the planting scheme for Woodland Belt 1 (see Sections 6.7.18 and 6.7.19) should follow general clean-up of the site to remove the remaining evidence of the nursery. Although the site is extensively forested with exotic species (*Acacia* sp., *Casuarina* sp.), there is abundant potential for habitat enhancement using indigenous species. The result of habitat enhancement would be increased diversity of wildlife use of the area.

Mitigation for Loss of Estuary and Mangrove

Review of Options and Approaches

7.7.5 Loss of the Yi Pak Wan estuary and associated vegetation would be complete. Avoidance options are not available under the development plan which calls for a fill to +6 mPD in the estuary area. Mitigation of mangrove habitat loss is proposed in the form of a mangrove mudflat to be created at the south-eastern corner of the development along the southern coast of Yi Pak Wan.

7.7.6 The following paragraphs discuss wetland mitigation projects which have been carried out locally, regionally and in other areas of the world. The purpose of this review is to provide a background against which the merits of the proposed mangrove restoration plan can be judged.

7.7.7 Transplantation of mangroves to mitigate habitat losses in Hong Kong has been employed at Tin Shui Wai Creek (Chan, 1993) and at Kau Sai Chau (RHKJC, 1994). Mangrove creation or restoration is also proposed as mitigation for losses at Tung Chung due to construction of the Chek Lap Kok airport. However, this project has not yet begun.

7.7.8 The Tin Shui Wai Creek site was transplanted using *K. candel* propagules during the summers of 1990 and 1991. The purpose of the project was to mitigate the impacts of mangrove loss due to river channelling. The project was considered successful based on high survival rates of planted propagules plus facilitation of natural mangrove colonisation of the site due to the impact of the seedlings grown from planted propagules (Chan, 1993).

7.7.9 The Kau Sai Chau project began in summer 1994 and continues to date. Both propagules and seedlings of *K. candel* and *B. gymnorrhiza* were transplanted at four sites. Each of the four sites supported mangroves and was undisturbed by any form of human impact. The objective was to extend the mangrove coverage at each of the sites. Survival rates varied from 32% to 100% 4 to 6 months after transplanting.

7.7.10 These projects suggest that mangrove transplantation is a viable mitigation strategy for Hong Kong in areas where the transplanted mangrove forms an extension of an existing mangrove habitat. In both cases, the planted mangrove occupied an area contiguous with undisturbed mangroves. In such circumstances, it should be expected that the probability of success would be higher than when attempting to create a new mangrove stand on a site where none existed. This expectation is supported by restoration projects elsewhere.

7.7.11 Extensive mangrove transplantation projects in Pakistan and the Philippines have been implemented with positive results in cases where mangroves were replanted in areas degraded only by excessive cutting (Lewis *et al.*, 1985 in Lewis, 1990a; Meynell and Qureshi, 1993; Villacorta and van Wetten, 1993). In these projects, the impetus for restoration arose from loss of fish production or from accelerated soil erosion following the removal of mangroves.

7.7.12 In North America and the Caribbean, mangroves have been transplanted with varying degrees of success since the late 1960s. Technical guidelines have been formulated for planning and implementation of mangrove creation and restoration based on the long history of experimentation (Lewis, 1990a and 1990b). Critical factors for successful wetland establishment were listed by Lewis (1990a) as follows:

- correct elevations for the target plant species;
- adequate drainage provided by gradual slopes and sufficient tidal connections;
- appropriate site selection to avoid wave damage;
- appropriate plant materials; and
- protection from human impacts.

7.7.13 Recolonisation by wetland fauna may be more problematic. Comparisons of fauna on created versus control wetlands suggest that up to 15 years may be required for macrofauna in the created marsh to resemble that of control marshes (Sacco et al., 1988 in D'Avanzo, 1990).

Mangrove Restoration at Yi Pak Wan

7.7.14 It is proposed that a mangrove stand be created at Yi Pak to mitigate loss of the existing mangrove behind the Yi Pak beach (Figure 7.2). Restoration would involve the creation of an entirely new mangrove; thus, it is doubtful whether the ecological function of the Yi Pak mangrove stand could be replaced. This is due to the differences between the existing and proposed sites in terms of the surrounding landscape and vegetation, hydrology and the degree of exposure to wave action.

7.7.15 The creation of a new mangrove area will not fully replace the form and function of the existing Yi Pak wetland. It will, however, provide a comparable mangal habitat within a secure management situation. Together with the created rocky shoreline, the general ecological function of the existing shoreline can be maintained in a way which will be compatible with the development of Discovery Bay and the Lantau Port.

7.7.16 The Yi Pak site lies partially within the leased land boundary and presents fewer land or management issues than alternative sites. Restoration at this site is technically feasible.

7.7.17 Creation of a mangrove habitat at Yi Pak would require construction of a mud flat behind a seawall. Prior to the design and construction of a replacement mangrove mudflat, the existing Yi Pak mangrove stand should be thoroughly described. Total area, species richness, relative dominance, plant height and stem diameter should be recorded or estimated prior to disturbance.

7.7.18 The design of the replacement mangrove area should aim for an area approximately 3 times larger than the area to be lost due to development. This replacement ratio would meet the general expectation of AFD for mitigation of impacts to woodlands, and is in agreement with mitigation expectations elsewhere (Kruczynski, 1990).

7.7.19 Creation of a mangrove estuary at Yi Pak would require completion of the following tasks:

- design and construction of a seawall to contain the mangrove substrate (dredged marine muds);
- design and construction of a salt/fresh water control gate in the seawall to regulate levels of freshwater and tidal flows;
- design and installation of a solid waste exclusion device to prevent the accumulation of floating solid waste in the estuary;
- sourcing and deposition of dredged sediments in the estuary for use as a mangrove planting and growth substrate;
- sourcing and planting of mangrove propagules on the created mudflat;
- monitoring mangrove (and other plant) survival and growth; and
- replacing plants which do not survive.

7.7.20 Creation of mangrove planting substrates behind seawalls or other wave barriers is practised in Hong Kong at Kau Sai Chau, and at North American locations. Lewis (1990a) noted that it is '...well documented that mangroves are not generally suitable plant materials for exposed or eroding shorelines unless some offshore protection is provided.' For the proposed project, a seawall would serve two purposes. Firstly, it would enclose the mudflat to prevent a seaward loss of sediments. Secondly, a seawall would reduce wave energy, simulating the role of the berm at the back of the existing Yi Pak beach.

7.7.21 The design and installation of water control structures would be a routine engineering and construction task. It would, however, be important to incorporate a feature for excluding floating solid waste from the mangrove. The solid waste trap would, unfortunately, be likely to prevent the natural establishment of mangrove propagules brought in on the tide from other Hong Kong locations. Therefore, it would be important to collect such propagules and plant them during the monitoring phase of the mangrove creation project. The trap must be designed to allow the passage of fish between the bay and estuary.

7.7.22 Sediments for use in construction of the planting substrate should be sourced from the Yi Pak Wan estuary. This would ensure the provision of sediments which are suitable for mangrove establishment and growth. It will, however, constrain the construction programme to the extent that sediments must be either moved directly to the created mangrove site or stockpiled elsewhere for later transfer.

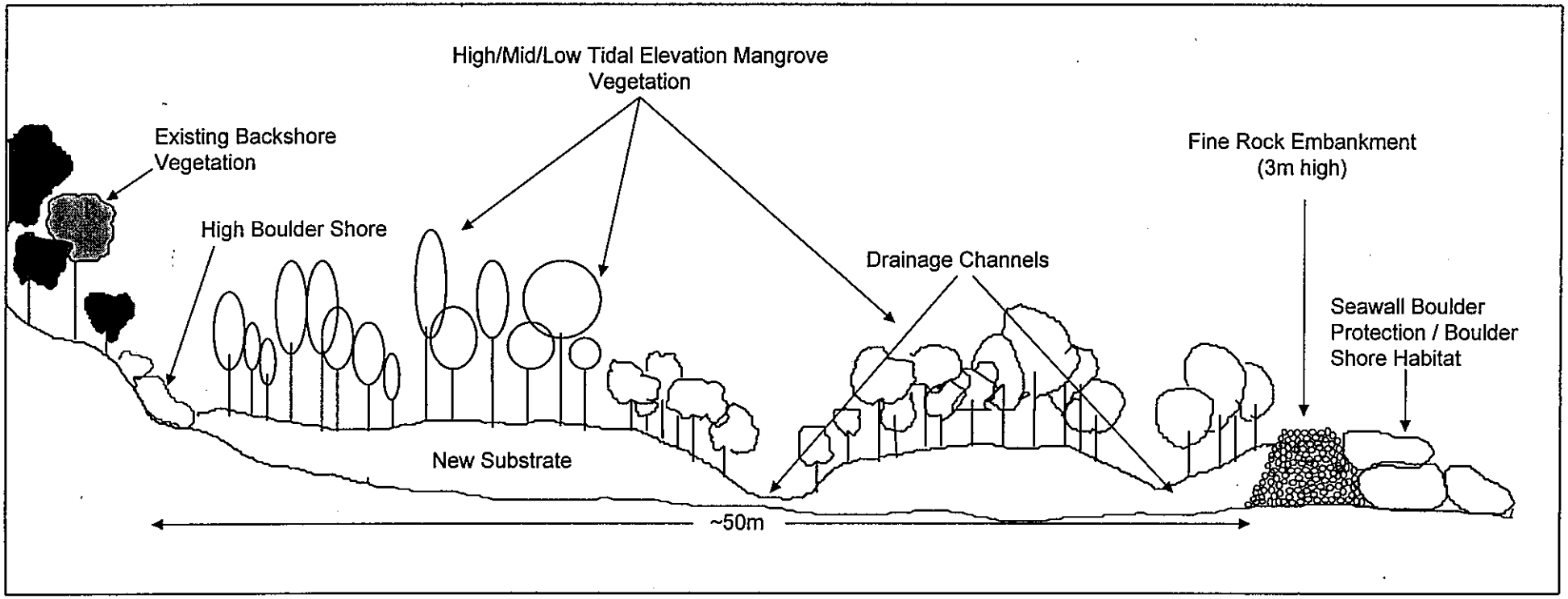


Figure 7.2
Cross-Section of Mangrove Restoration Area at Yi Pak (conceptual)

7.7.23 The detailed specification of the planting substrate should be incorporated into the detailed design of the created mangrove. In general terms, the substrate should not be flat, but should provide variations in levels. The stream feeding the mangrove with fresh water should follow a sinuous path across the substrate. This will ensure the provision of sub-surface fresh water supply across the mangrove area.

7.7.24 Sourcing planting materials, planting and monitoring would be the same for any site in the Discovery Bay area. The primary considerations include sourcing and planting propagules or seedlings in proportions which, allowing for mortality, will result in an approximation of the existing community composition. Propagules and seedlings can be collected locally or purchased from Guangdong Province sources.

7.7.25 The creation of the mangrove transplantation area at Sam Pak was considered at an early stage of the project. The Sam Pak area is a more suitable mangrove transplantation site due to the more favourable physical characteristics of the bay (in terms of topography, natural freshwater supply, less seaward exposure) in comparison to the Yi Pak site. However, the Sam Pak site is outside the area of the seabed leased to Hong Kong Resort Company Limited. Given Government land policy, access to the Sam Pak site will probably not be possible. Consequently, detailed plans for the creation of the mangrove mudflat at the Yi Pak site have been progressed.

Mitigation for Loss of Shoreline

7.7.26 Restoration of the boulder shoreline along the new seawall for the Discovery Bay North development will be a relatively straightforward mitigation measure that will enhance the value of the area for marine life and help mitigate the high impact of the project on the coastline of Yi Pak and Sam Pak. Factors important in restoring the diversity of microhabitats available to intertidal and sub-tidal biota are:

- the overall gradient of the shoreline - this will determine the width of the eulittoral zone and thus the area available for colonisation;
- the elevation of the new shoreline - the top of the shore should extend to above the mean spring high tide level to provide the full range of conditions in relation to tidal inundation/aerial exposure; and
- the variety of boulder/stone size and relative distribution of sizes down the shore - natural rocky shorelines provide a wide variety of shelter/exposure regimes and a corresponding diversity of available habitats. These conditions need to be restored if the new shoreline is to replace to any extent the function of the original.

7.7.27 The simplest way to meet these requirements is to survey the existing shoreline before the start of construction and record the factors detailed above. A photographic record will also help to achieve realistic habitat restoration.

7.7.28 The length of the boulder shore lost with Master Plan 6.0(A) would be approximately 310 m^2. A similar length (265m) of replacement rocky shore is proposed. The new boulder shore would form part of the seawall for the mangrove transplantation area at Yi Pak and should compensate for the loss of the existing section of rocky shore.

7.7.29 Habitat enrichment can also be achieved in the design of any submerged structures such as jetty pilings and support structures.

Mitigation of Impacts on Terrestrial and Avian Fauna

7.7.30 The primary impacts to birds will be the loss of nesting and wintering habitats in the Yi Pak Wan estuary. Of the 51 species of birds recorded on the site, 38 species probably nest locally. Most important from a conservation perspective are the Black-eared Kites and possibly the Brown Fish Owls.

7.7.31 To mitigate impacts to the Black-eared Kite, it is recommended that the nest be relocated to the Sam Pak area prior to onset of construction at Yi Pak. A comparable nest tree should be selected and the existing nest relocated. Site preparation should include bracing and other supports as needed. Nest relocation should be undertaken only after fledging of the young from any breeding season. Under no circumstances should the nest be moved at any time if occupied by adults or young or between November and May, even if unoccupied. A written permit from AFD is required to authorise the movement of any bird nests in Hong Kong. It must be emphasised that nest relocation will not ensure that the Black-eared Kites will continue to occupy the Yi Pak territory during or after project construction.

7.7.32 Should nesting Brown Fish Owls be located at Yi Pak, a similar procedure should be carried out for relocation only if the nest is located such that it would be destroyed during construction.

7.7.33 Mitigation of impacts to other avifauna, reptiles, amphibians and mammals can be best achieved by habitat enhancement on the slopes above the works area and in the Sam Pak catchment, particularly a 0.3 ha hillside/riparian area to the north-west of Sam Pak beach (Figure 7.3). Recommended procedures include the use of the shrub and woodland planting mixes recommended in Section 6 for woodland areas. Planting at Sam Pak will include areas of off-site mitigation outside the planning boundary. However, as there are few suitable sites for extensive woodland habitat restoration on-site, off-site mitigation areas are necessary to minimise the impact of habitat loss. Early revegetation of the hill slopes within HKR's lease boundary should be considered to provide some cover for birdlife displaced from the site.

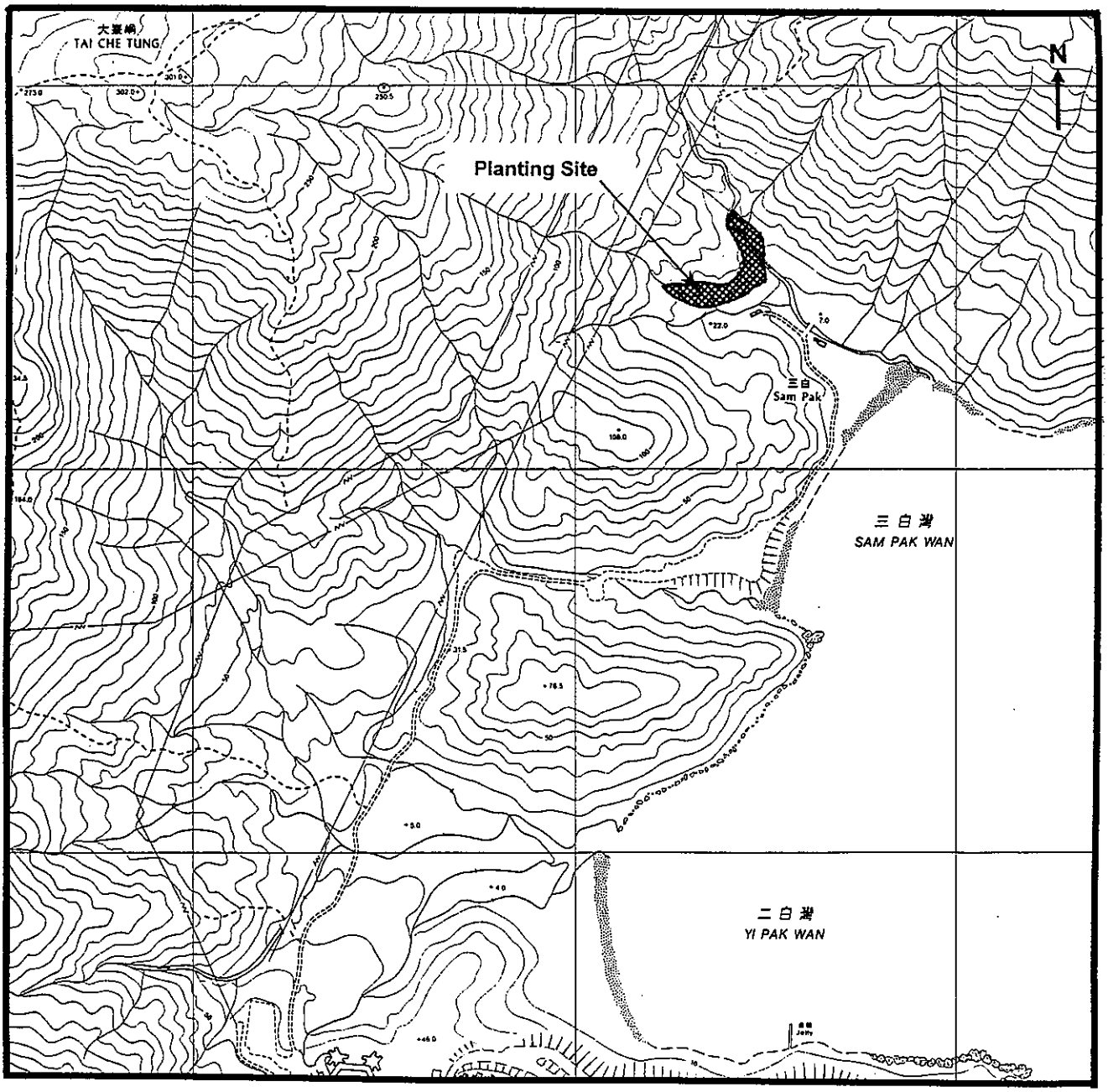


Figure 7.3
Sam Pak Catchment Planting Site

Mitigation of Impacts on Commercial Fisheries

7.7.34 Mitigation of the impacts on local fish nurseries from the loss of the Yi Pak mangrove stand, lagoon and inshore shallows centres around the creation of habitats that will perform the same function in the life cycles of marine life in terms of complexity and productivity. A range of microhabitats can be created by placement of suitably sized rocks and boulders sub-tidally along the new shoreline of the development. This can be addressed as part of the boulder shore mitigation plan. Alternatively, reef modules constructed from bamboo poles, concrete and old tyres provide shelter for fish and settlement opportunities for algae and invertebrates that the fish may then feed on.

7.7.35 Other mitigation methods include the placement of fish decoys constructed from bamboo and palm leaves and floating in an upright position. Algal growth on the poles and leaves would provide food for juvenile/small fish. These methods have proven effective in the Philippines (Villacorta and van Wetten, 1993), and could play a role here in preventing any impacts to the local fisheries that may result from the development.

Yi Pak Stream Restoration

7.7.36 The stream channel between the proposed water feature and the proposed Yi Pak mangrove transplantation site should be designed and constructed with the objective of restoring ecological function as far as possible. The following guidelines are adapted from National Research Council (1992) for stream restoration, and should be followed for design of the Yi Pak stream:

- Restore the natural sediment and water regime. *Regime* refers to at least two time scales: the daily to seasonal variation in water and sediment loads, and the annual to decadal patterns of floods and droughts. Organisms in large flood plain rivers in tropical and temperate zones depend on highly predictable seasonal flooding;
- Restore a natural channel geometry, if restoration of the water and sediment regime alone does not;
- Restore the natural riparian plant community, which then becomes a functioning part of the channel geometry and floodplain/riparian hydrology. This step is necessary only if the plant community does not restore itself upon achievement of objectives 1 and 2; and
- Restore native aquatic plants and animals if they do not recolonise on their own.

7.8 Residual Impacts

7.8.1 Residual ecological impacts of the proposed development would be the loss of coastal, intertidal and estuarine habitats. These habitats are subject to sustained development pressure in Hong Kong and throughout East Asia (Scott and Poole, 1989) and it is therefore important that all possible measures are taken to compensate for the losses. There may also be residual ecological impacts on birds of prey through the loss of breeding territory.

7.8.2 Given the development of the Lantau Port and other infrastructure projects on North Lantau, the current proposals include compensation measures to maintain coastal ecological resources within the plans for ongoing development of the Port area. The loss of ecological habitat is significant but the proposals provide maximum compensation for loss of habitats and opportunities for long-term protection for the compensating areas.

8.

WATER QUALITY

8. Water Quality

8.1 Introduction

8.1.1 This section reviews the potential impacts on marine and fresh water quality. Proposals for sewage treatment are addressed separately in Section 9. The study area contains fresh estuarine and marine water resources of interest to the assessment. The potential impacts on the estuarine environment are detailed in Section 7, Ecology.

8.2 Legislation And Guidelines

Water Quality

8.2.1 The core environmental legislative provision for protecting Hong Kong's watercourses is the Water Pollution Control Ordinance (WPCO, Cap. 358). The WPCO sets the Water Quality Objectives (WQOs) and discharges are controlled by the WPCO to ensure that WQOs are achieved.

8.2.2 Discharges into inland waters, marine waters and to public sewers are controlled by the *Technical Memorandum on Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters*, as issued under section 21 of the Water Pollution Control Ordinance. The TM defines acceptable discharge limits for receiving waters and sets discharge standards. Any discharges from the development site will need to comply with the standards stipulated in the TM.

Contaminated Sediment

8.2.3 A licence will be required from the EPD for the disposal of marine mud. Dredged sediments can be classified into three groups according to their level of contamination by toxic metals (Table 8.1). Classification will refer to Technical Circular No. (TC) No. 1-1-92, Classification of Dredged Sediments for Marine Disposal.

Table 8.1 Classification of Sediments by Metal Content (mg/kg dry weight)

	Cd	Cr	Cu	Hg	Ni	Pb	Zn
Class A	0.0-0.9	0-49	0-54	0.0-0.7	0-34	0-64	0-140
Class B	1.0-1.4	50-79	55-64	0.8-0.9	35-39	65-74	150-190
Class C	1.5 or more	80 or more	65 or more	1.0 or more	40 or more	75 or more	200 or more

8.3 Existing Environment

Surface Water Quality

8.3.1 There are five natural stream courses that bisect the project area. These are labelled A to E in Figure 8.1. The streams are fed by surface water runoff from the slopes at the western and northern boundaries of the site. Flow patterns reflect the steep topography and low retention times of the catchment. The streams are typically slow flowing or are intermittent except during storm conditions. After periods of regular rainfall, the streams have good flows, and following significant rainfall events are at or above capacity.

8.3.2 Baseline surveys of the streams indicated that they contain limited aquatic fauna and have little ecological significance However, some of the streams supply fresh water to the Yi Pak estuary and the mangrove area and are important to the overall estuarine ecosystem. In addition, it should be noted that streams in Hong Kong are a diminishing natural resource and should be protected for this reason alone.

Marine Water Quality

8.3.3 The water quality in Hong Kong reflects the semi-estuarine nature of the Territory, the extent of the estuarine influence depending on the time of year.

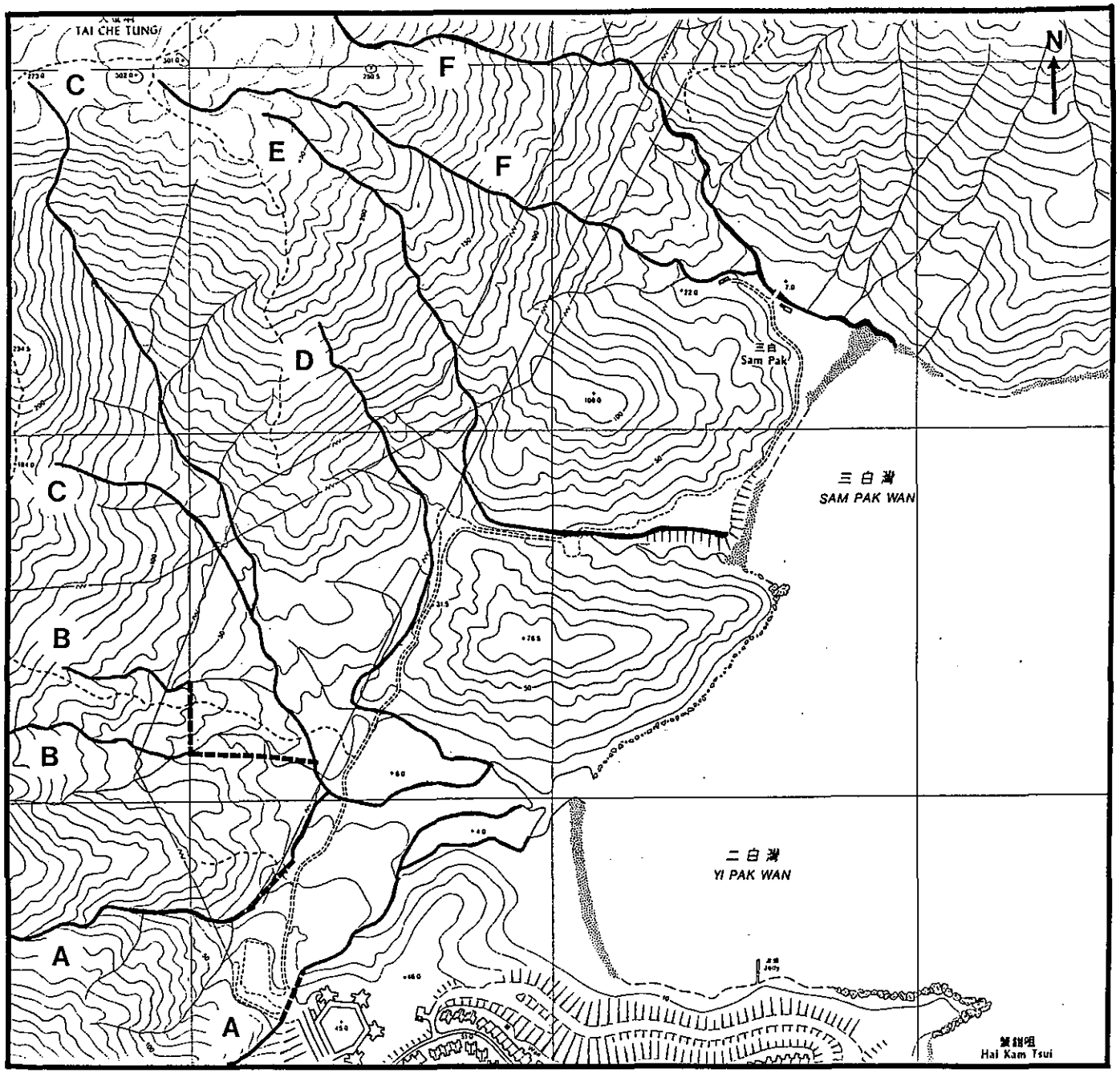
8.3.4 In summer (the wet season), Pearl River flows are predominant in the surface layers of much of the western and northern waters of the Territory. A stratified water column is present in these waters for most of the time. Salt waters derived from offshore oceanic waters underlie the freshwater outflow from the Pearl River. Mixing occurs throughout the estuary, but particularly in the Western Harbour and to the south-east of Hong Kong Island.

8.3.5 In winter (the dry season), the outflow from the Pearl River is much reduced and vertical stratification is generally either absent or minor in its extent.

8.3.6 The marine waters in the study area fall within the Southern Water Control Zone (WCZ) which was gazetted in 1988 and has been fully regulated since August 1989. The present water quality in the study area is well documented, having been the subject of regular monitoring since 1972.

8.3.7 Summary water quality data for 1993 is now available as of April 1995 (EPD, 1994). This data shows that the marine water quality in the Discovery Bay area is generally in compliance with the Water Quality Objectives (WQOs) for the Southern Waters Control Zone.

8.3.8 The Southern Waters WQOs state that annual mean depth-averaged inorganic nitrogen concentrations should not exceed 0.1 mg/l, and that nutrients 'shall not cause excessive algal growth'. The present concentrations of total nitrogen in Southern Waters of the Territory are generally slightly less than 0.1 mg/l, and inorganic nitrogen levels will be lower than these. However, there is little scope for significant increases in these levels of nitrogenous compounds if WQOs are to be attained and



Key

Existing stream

Existing culvert

Figure 8.1
Existing Drainage System

maintained over the long term. In addition, it should be noted that the term *excessive* is not defined in the WQOs. However, algal blooms have apparently increased in incidence in the southern waters of Hong Kong over the last decade and concern over their impacts continues. Table 8.2 presents the WQOs for the Southern Waters Control Zone and the 1993 summary data for EPD's monitoring station at Discovery Bay.

8.3.9 Tai Pak beach at Discovery Bay is not gazetted but is well utilised as a recreational resource. The beach is regularly used as a base for water sports such as sailing and windsurfing. The water is rated as 'fair' in terms of bacteriological quality. The beaches at Yi Pak and Sam Pak are also not gazetted and are almost inaccessible from land. Seaward access is particularly difficult at Yi Pak due to the shallow water.

8.3.10 The sewage treatment plant at Discovery Bay has recently been improved through the commissioning of a Disinfection and Dechlorination Facility in October 1995. Under Master Plan 6.0(A), all Discovery Bay and Peng Chau sewage will be exported to the Siu Ho Wan Sewage Treatment Works.

Table 8.2 Water Quality Objectives for Southern Waters

PARAMETER	SOUTHERN WATERS WQO	SUB-ZONE	AVERAGE 1993 VALUES EPD STATION SM10
Offensive odour, tints and colours	Not to be present.	Whole zone	-
Visible foam, oil, grease scum, litter	Not to be present.	Whole zone	-
E. coli	-	Secondary contact recreation subzone and fish culture subzone - Annual geometric mean not to exceed 610/100 ml.	Mean 68/100 ml (range 11-320)
Dissolved oxygen within 2m of bottom Depth average dissolved oxygen	Not less than 2 mg/l for 90% samples. Not less than 4 mg/l for 90% samples. Not less than 5 mg/l for 90% samples.	Whole zone Whole zone except fish culture zone Fish culture zone	Surface mean value 99% saturation (range 62-137) Bottom mean value 79% saturation (range 63-100)
pH	To be in the range 6.5-8.5, change due to discharge not to exceed 0.2.	Whole zone except bathing beaches	Mean 8.2 (range 7.9-8.4)
Salinity	Change due to discharge not to exceed 10% of natural level.	Whole zone	Surface mean value 29.5 ppt (range 24-33) Bottom mean value 30.6 ppt (range 26.6-33)
Temperature change	Change due to discharges not to exceed 2°C.	Whole zone	Surface mean value 23°C (range 17.8-27.2) Bottom mean value 22.3°C (range 17.8-26.3)
Suspended solids	Discharge not to raise the natural ambient level by 30% nor accumulation of SS.	Whole zone	Mean value 9.4 mg/l (range 5.0-11.5)
Toxicants producing significant toxic effects	Not to be present.	Whole zone	-
Ammonia	Annual mean not to exceed 0.021 mg/l calculated as unionised form.	Whole zone	-
Nutrients	Quantity shall not cause excessive algal growth. Annual mean depth average inorganic nitrogen not to exceed 0.1 mg/l.	Whole zone	Total inorganic nitrogen mean value 0.31 mg/l (range 0.12-0.50) Total phosphate mean value 0.06 mg/l (range 0.05-0.09)

Marine Benthos

8.3.11 Marine benthic surveys undertaken for the Lantau Port study (APH, 1993) provide some useful background data from which to assess the significance of potential impacts. Polychaetes were by far the dominant species recorded in the study area, comprising over 80% of the total species recorded. This species composition is typical of soft sediment faunal communities in Hong Kong waters. No particular environmentally sensitive species were noted. The dominant species including the polychaetes *N. latericeus, T stroemi, G. chiori and P. pinnata* are ubiquitous in sediments with a high silt content.

8.3.12 It was apparent that more species and individuals were recorded in the winter survey than in the summer survey. This is considered to be principally due to the influence of the Pearl River.

8.3.13 Annelid and mollusk species tend to predominate in the soft subtidal sediments, but diversity and abundance parameters suggest a quite impoverished community which is probably due to the nature of the sediment and perhaps in part to fishing pressure.

Fishing Interests

8.3.14 Fishing for fry using a number of the methods occurs in the sheltered bays off the south Lantau coast. This typically occurs in shallow, inshore waters and is of seasonal occurrence. The fry are concentrated within these areas between March and April, sometimes extending into June. Fry are also caught as part of an incidental catch when fishing for adults and are sold to local fish culture farms. In addition, the fish farmers also catch their own fry to replenish stocks.

8.3.15 The nearest Fish Culture Zones to the Discovery Bay North development site are at Cheung Sha Wan, Ma Wan, Sok Kwu Wan and Lo Tik Wan. None of these are likely to be affected by the proposed works.

8.4 Potential Impacts due to Dredging

Potential Impacts on Marine Water Quality

8.4.1 Approximately 150,000 m^3 of marine muds will be dredged from the site of the reclamation prior to the placement of fill material.

8.4.2 Dredging activities will increase suspended solid loadings with a corresponding reduction in dissolved oxygen levels. The degree to which dredging activities affect turbidity is dependent on the method of dredging, the type of equipment, the physio-chemical characteristics of the material to be dredged, currents and the general working practices and procedures employed. The choice of dredging equipment is in turn dictated by a number of factors including the physical and chemical nature of sediments, water depth, cost, availability, and wind, wave and sea conditions. In environmental terms, the total amount of material suspended in the water column is the

important consideration. This will be affected by operating procedures and the implementation of good working practices.

8.4.3 The marine sediments in the reclamation area have been sampled and analysed to determine the extent of potential heavy metal contamination. The sediments are classified as Class A, i.e. uncontaminated, according to TC 1-1-92 *Classification of Dredged Sediments for Marine Disposal*. The Sediment Quality Report is included as Appendix 3 for reference.

8.4.4 Runoff from the advancing reclamation may contain not only suspended particulate material, but also contaminants arising from the reclamation process itself. Most notably, the latter include fuel derivatives from machinery employed in the reclamation.

Potential Impacts on Marine Ecology and the Fishing Industry

8.4.5 The immediate and obvious impacts of dredging upon marine ecology in general, and on the local fisheries specifically, is the smothering of local benthic organisms and the clogging of the gills of susceptible pelagic biota through the deposition and resuspension of suspended solids (from both dredging and reclamation activities). In addition, the consequent reduction in light penetration reduces oxygen generated by photosynthetic plants, reducing dissolved oxygen levels in the water column.

8.4.6 If significant quantities of nutrients are released during dredging and if these are (or become) bioavailable, it is conceivable that an increase in algal productivity could occur in the locality of the bay. However, no evidence exists to link algal blooms in Hong Kong to previous dredging events.

8.4.7 The removal of benthic organisms, which are entrained within the dredged muds, is not considered to be of major significance due to the impoverished nature of the fauna. The types of organisms found in the sediment are opportunistic species and as such will quickly recolonise a disturbed area. However, pelagic fish species (most of which are highly mobile) will generally avoid a cloud of high turbidity, although some do not exhibit such a response.

Transport and Disposal of Dredged Material

8.4.8 Dredged sediments will be used in the formation of the mangrove transplantation areas and in landscaping works. The sediments will be transported over short distances by barge or truck. The loss of dredged material to marine waters would increase suspended particulate levels. The potential loss of sediment during transit has not been quantified as spoil loss modelling was not considered to be appropriate due to the small scale of the dredging works proposed in Master Plan 6.0(A). The extent of potential spoil loss will be dependent on the mode of transport, equipment maintenance and working practices. Only minor losses are anticipated and will be minimised through the implementation of proper working practices.

8.5 Potential Impacts on Stream Courses

8.5.1 The impact on streams in Yi Pak will be severe. Due to the reclamation works, streams A, B, C and D will be either enclosed in culverts or diverted into new channels. The stream at Sam Pak (stream F) should be unaffected by the development proposals.

8.5.2 Streams A and B flow to the north and south respectively of the cut slope behind the existing high rise blocks in Area 7C (Figure 8.1). Both streams are currently culverted through the existing platform development area and across the access road. The streams then feed the major stream which flows to Yi Pak Wan.

8.5.3 These streams will be diverted (via a sand trap to remove suspended solids) to feed a series of freshwater pools and the realigned main Yi Pak stream at the foot of the ridge to the south of the development site. The lower section of the Yi Pak stream will fall through a series of weirs providing stretches of open water.

8.5.4 Streams C and D will also be diverted into the realigned Yi Pak stream and pool system but at slightly lower level.

8.5.5 Stream E will be diverted from below Road P1 but will not be affected above this point.

8.5.6 During the construction period, all streams within the actual development area will be significantly affected by the works. Stream sections above the development area will be unaffected. Potential impacts on the watercourses will be dominated by sedimentation due to runoff from the works areas.

8.5.7 As the streams will be totally lost due to the reclamation, the major concern will be to ensure that silt loads are not carried through to Yi Pak Wan. The emphasis during the construction phase will be to ensure that effective controls are incorporated in the works planning to prevent sediment entering Yi Pak Wan and to ensure that the new Yi Pak stream channel is created as early as possible in the works programme.

8.6 Potential Impacts of Stormwater Discharges

Construction

8.6.1 The major potential pollutant load in stormwater runoff during construction will be suspended solids particularly during site excavation, platform formation and reclamation works. Other potential pollutants may include site litter, accidental spills of chemicals and engine oils or fuels from construction plant.

Operation

8.6.2 The streams and runoff from the catchments within the site will be culverted and discharged to the sea via one or two outfalls. The stormwater drainage system will discharge into this system of culverts and hence be discharged to the sea from two outfalls. Stormwater drainage from the Yi Pak section of the Road and Tunnel Link will also connect into the stormwater drainage system. The land drainage network has been designed to meet the 1 in 200 year storm return period design standard and the stormwater drainage system to meet the 1 in 50 year storm return period design standard.

8.6.3 The calculated stormwater discharges during a 1 in 200 year storm event are 48 m^3/sec before development and 53 m^3/sec with the Discovery Bay North development. This represents a 10% increase in stormwater flows and is not considered to be significant. The increase in stormwater flows can be easily accommodated within the engineering design of the drainage system.

8.6.4 During operation of Master Plan 6.0(A), stormwater runoff will be relatively clean. The stormwater may contain small quantities of suspended solids, vehicle oils, organic matter (such as leaf material) and litter. Accidental spills or leaks of materials within the site could also potentially be washed away by any stormwater runoff.

8.7 Cumulative Impacts

8.7.1 Construction of Container Terminals 10, 11 and 12 of the Lantau Port and Western Harbour Development will have significant hydraulic and water quality implications for the Discovery Bay area. These issues have been extensively examined in the Environmental Impact Assessment for the Lantau Port and Western Harbour Development Studies (APH, 1993). The cumulative hydraulic and water quality impacts of the Lantau Port and Discovery Bay Master Plan 6.0(A) are examined below.

Hydraulics

8.7.2 The predominant tidal flow pattern at Discovery Bay is a north-south tidal flow past the mouth of the bay. Flow velocities within Discovery Bay itself are generally low (HKR, 1990).

8.7.3 Construction of the Lantau Port will create a partial embayment of the Discovery Bay area with a resultant reduced flushing of the bay. In order to reduce this impact on water circulation, the north-eastern end of the northern port basin will remain open to maintain natural tidal flushing.

8.7.4 The line of the reclamation proposed under Master Plan 6.0(A) has been designed to follow the existing coastline as far as possible to minimise any changes to water flows within the bay. The shape of the reclamation avoids any embayments or irregularities which could restrict water circulation or tidal movements. Due to the design and relatively small size of the reclamation, it will not have any significant local effects on water quality or on wider circulation patterns.

8.7.5 Thus, in terms of the cumulative hydraulic impact resulting from the Lantau Port and Master Plan 6.0(A), the major contribution will be from construction of the Lantau Port. Master Plan 6.0(A) will have only a minimal impact on water circulation within Discovery Bay.

Water Quality

8.7.6 The partial embayment of Discovery Bay by the Lantau Port may result in a deterioration in water quality in the bay. However, the results of the WAHMO modelling of the proposed port reclamation predicted that no unacceptable impacts to water quality would arise provided that the sewage loads from Discovery Bay, a proposed Discovery Bay extension at Yi Pak, and Peng Chau underwent secondary treatment or were discharged outside the embayed area (APH, 1993). Without additional sewage treatment or diversion of the sewage discharge, the embayment will lead to a deterioration in water quality in Discovery Bay through a reduction in the assimilative capacity of the bay.

8.7.7 A Disinfection and Dechlorination Facility at the existing Discovery Bay sewage treatment works was commissioned in October 1995. The Disinfection and Dechlorination facility will reduce the bacterial load of the sewage discharged from the Discovery Bay outfall and hence will improve the bacteriological/microbiological water quality in the local area.

8.7.8 Under Master Plan 6.0(A), it is proposed that all sewage arising in Discovery Bay will be transferred via the tunnel to North Lantau for treatment at the Siu Ho Wan sewage treatment works. Sewage from Peng Chau would also be exported via the tunnel link. The diversion of sewage from discharge via outfalls in Discovery Bay to the treatment works on North Lantau will result in a significant reduction in the pollutant load in the waters of the bay and a consequent improvement in water quality.

8.7.9 The water quality impact due to the SHWSTW are being addressed separately. The Discovery Bay sewage arisings will represent a very minor proportion of the total sewage load treated at Siu Ho Wan.

8.7.10 The WAHMO modelling for the LAPH study did not include stormwater discharges from the proposed Discovery Bay extension in Yi Pak. The pollutant load (suspended solids, oil, organic material and litter) of stormwater runoff and land drainage discharges from Discovery Bay North will be minimal due to the nature of the development and the environmental controls included in the drainage systems.

8.7.11 Upon completion of Master Plan 6.0(A), the water quality of Discovery Bay should improve particularly in terms of lower nutrient and *E. coli* levels as a result of the positive water quality impact of diversion of all sewage from Discovery Bay and Peng Chau to the SHWSTW. Master Plan 6.0(A) will help mitigate the potential water quality impacts resulting from construction of the Lantau Port. This should ensure that the WQOs for Discovery Bay are met in the future.

8.8 Mitigation of Dredging/Land Reclamation Impacts

Water Quality

8.8.1 The main impacts arising from dredging relate to increased turbidity and associated reduced levels of dissolved oxygen. It is anticipated that the level of dredging can be most efficiently undertaken using mechanical dredgers. The mitigation measures discussed below, therefore, refer to mechanical plant rather than suction dredgers. A common occurrence during dredging operations is that water with a high suspended solids content is allowed to overflow from the barge. This polluting activity in particular should be minimised wherever practicable. In addition, there are further general mitigation measures that can be employed including:

- the use of slower hoist speeds and grabs which close tightly to reduce the release of sediments into the water column;
- slowing the rate of dredging activities generally;
- dredging at certain states of the tide when current flow is at its lowest;
- avoidance of overflowing or degassing systems if trailing suction dredgers are used; and
- the use of silt curtains if necessary to prevent turbidity plume movement.

8.8.2 The practicality of these and other measures, either individually or in combination, will have to be assessed at the detailed design stage once details of the dredging plant and work programme are known. Conditions for dredging operations, e.g. state of tide and dredging rate, will be included in the relevant construction contracts.

8.8.3 The transport and disposal of dredged spoil to the mangrove transplantation area and other areas on site should be monitored to ensure that spoil losses are minimal through the use of correct working practices. The dredged material should be transferred directly from the dredging barge/platform to sealed trucks to minimise losses.

Marine Ecology and Fishing Industry

8.8.4 The reclamation and dredging works may have significant impacts upon local marine fauna and flora. Particular methods of dredging and disposal of marine sediments should be selected to minimise the creation of plumes of suspended materials which may smother benthic organisms or interfere with respiration in pelagic biota. Marine baseline studies undertaken for the Lantau Port Study have shown that species diversity and number of individuals is greater during the winter months. Therefore, dredging during the summer months would have less impact on the marine benthic community.

8.8.5 The Ma Wan Fish Culture Zone (FCZ) is considered to be sufficiently distant from the Development that no impacts on marine water quality are anticipated. However, it should be noted that the cumulative impacts of PADS projects, on the Ma Wan FCZ are likely to be more significant than the Discovery Bay North development.

8.9 Mitigation of Sediment Disposal

8.9.1 The sediments to be dredged are not contaminated (see Appendix 3) and therefore will be suitable for reuse in landscaping works (see Section 10.4) or in the creation of the proposed mangrove mudflat.

8.9.2 However, if there are no viable re-use options for dredged material on site or the sediments are contaminated, the following mitigation measures should be considered for off-site sediment transport:

- the loading of barges and hopper should be controlled to prevent splashing of dredged material to the surrounding water;
- barges and hoppers should not be filled to a level which will cause overflowing of the material or polluted water during loading or transportation;
- all barges and hoppers should have tight fitting seals at any bottom openings to prevent leakage; and
- excess material should be cleaned from the decks and exposed fittings before the barges and dredgers are moved.

8.10 Mitigation of Impacts on Stream Courses

8.10.1 All streams running through the site, with the exception of the lower portion of the main Yi Pak stream and stream F, will be culverted. The lower reaches of the main Yi Pak stream will be re-routed to flow through the southern portion of the site. The Yi Pak stream will flow across the restored mangrove mudflat. The culverting and stream diversion works will be carried out at an early stage in the construction programme and should coincide with the dry season when the streams carry low flows to minimise the potential problems associated with temporary drainage and flood control.

8.10.2 Stream F should be designated as a 'no go area' and should be clearly fenced off from construction activities. Similarly, the channel carrying the diverted section of the main Yi Pak stream should be protected from any encroachment of the ongoing construction works.

8.10.3 Chemicals stored on site should be clearly labelled and contained within bunded areas to collect accidental spills. This also applies to maintenance areas for repair/refuelling of plant and equipment.

8.11 Mitigation of Stormwater Discharges

Construction

8.11.1 The level of suspended solids in stormwater discharges during the construction phase can be reduced through the diversion of runoff through drainage channels and into settlement ponds. The design of such facilities should allow for persistent rainfall during storm conditions. Full consideration must be given to the flood storage capacity of temporary drainage facilities for any diverted stream courses. The drainage system will be designed in accordance with the *Practice Note for Professional Persons - Construction Site Drainage* (Ref. ProPECC PN1/94).

8.11.2 Topsoil and subsoil will be removed from cleared areas of the site and stored for future use in landscaping works. The soil stores will be covered and bunded to prevent soil erosion and contamination of site runoff. Site clearance and landscaping works should be programmed to occur outside the wet season.

8.11.3 Stockpiles of fine materials should be covered and bunded before storm events wherever possible. In addition, major earthmoving works should be programmed to avoid the wet summer season.

8.11.4 All fuels and chemicals should be stored on hard surfaces which should be bunded. Oil interceptors should be included in drainage channels serving fuel storage areas. The interceptors should be inspected and cleaned regularly to ensure that they are in good working order. Spill control plans should be prepared to clean up any accidental spills or leaks of chemicals or fuels.

8.11.5 Good site cleanliness and litter patrols will minimise the quantity of litter on site and thus reduce the chance of litter being washed into the surrounding marine waters during rain.

Operation

8.11.6 The sewerage system will not be connected to the stormwater drainage system at any point in order to prevent possible sewage contamination of the stormwater flows.

8.11.7 The following environmental controls will be included in Discovery Bay North drainage systems to protect the quality of the drainage effluent:

- **road gulley drains** will remove sediment and litter from the surface water draining from roads;
- **coarse screens** will be placed at the points where streams enter the land drainage culverts. The screens will prevent litter entering the drainage system and will also prevent unauthorised access to the culverts;
- **oil interceptors** will be installed in the stormwater drains at the Refuse Collection Point, fuel stores and at locations where vehicles are stationary such as the Transport Terminus and vehicle parking areas. The oil interceptors will remove oil contaminants in the first flush of a stormwater flow; the remaining stormwater will be comparatively oil free and will discharge directly to the stormwater drainage system without passing through the oil interceptors; and
- **silt traps** will be installed in the stormwater drains at the Refuse Collection Point.

8.11.8 The gulley drains, screens, oil interceptors and silt traps will require regular inspection and cleaning to maintain them in good working order.

8.11.9 The Dangerous Goods Store, fuel or chemical storage sites and any other areas containing potentially harmful substances should have a hard surface and should be bunded to prevent the leakage of any accidentally spilled material into the site drainage system. All fuel and chemical storage tanks should be adequately lined to minimise the possibility of leaks. Spill control plans should be prepared to rapidly clean up any spilled material.

8.11.10 Discovery Bay provides a clean and well maintained living environment. Regular litter patrols will collect any stray litter thus preventing it entering and potentially blocking or being discharged from the drainage system.

8.11.11 The drainage system has been designed so that it will drain completely at low tide thus preventing the formation of pools of water during periods of low flow. This will eliminate potential odour or mosquito problems.

8.12 Water Feature Design

8.12.1 The streams draining the Yi Pak catchment may contain high levels of iron which can lead to the growth of 'iron bacteria' during periods of low flow. The bacteria can metabolise reduced iron present in their aqueous environment and deposit it in the form of ferric hydroxide in or on their mucilaginous secretions (Greenberg *et al.*, 1985). The large amount of brown slime produced will impart a reddish tinge and an unpleasant odour to water and may result in frothing and increased turbidity.

8.12.2 The water feature planned in the central landscaped area in the Discovery Bay North development will be supplied with water from a culverted stream. Thus, there is the potential for the unsightly growth of bacterial slime in this water feature.

8.12.3 The earlier design for the water feature consisted of the formation of a lagoon. However, the still nature of such a water feature could accelerate the formation of the bacterial slime. In order to prevent this bacterial growth, the water feature should be designed as a free flowing stream with a series of polls and riffles. Such a stream would have few areas of still water in which bacterial growth could occur. The stream should be colonised with flora and fauna from nearby streams (for example stream F in the Sam Pak valley). The stream channel and riparian plantings should be the same as presented in Sections 6.7.13 and 6.7.14.

8.12.4 The volume of water entering the stream would be controlled by diverting water from a drainage culvert using an orifice flow control device known as a 'Hydrobrake'. This would protect the stream bed from the large volumes of water in the drainage culvert under storm conditions.

9.

SEWAGE DISPOSAL

9. Sewage Disposal

9.1 Background

9.1.1 Existing practice at Discovery Bay is to collect sewage and transfer flows by conventional gravity sewers or pumping stations to discharge via a 650m long outfall into the channel between Tai Pak and Peng Chau. Discharge is through 30 diffusers at a depth of approximately 12m and the outfall discharges continuously. Prior to October 1995, a screening facility provided the only sewage treatment prior to discharge into Discovery Bay.

9.1.2 In 1992, as the long-term strategy regarding sewage disposal had not been decided, EPD requested that Hong Kong Resort Company Ltd. undertake treatment additional to screening to improve the microbial quality of the effluent. AXIS Environmental Consultants Ltd. undertook the outline and detailed design of an interim facility to treat *E. coli*, the principal parameter of concern. Construction of a Sewage Disinfection and Dechlorination Facility commenced in December 1994, with commissioning in September 1995 and full operation by October 1995.

9.1.3 The proposed Discovery Bay North development will result in increased levels of domestic sewage. Following the recommendation of the Outlying Islands Sewerage Master Plan (OISMP), the preferred long-term strategy for sewage disposal is to discharge sewage arisings from Discovery Bay to the Siu Ho Wan Sewage Treatment Works (SHWSTW) via a connection through the Road and Tunnel Link proposed under Master Plan 6.0(A).

9.1.4 This section aims to clarify and demonstrate the following:

- that the long-term disposal of sewage to SHWSTW via a tunnel link is technically feasible, environmentally preferable to the current disposal practice and consistent with Government policy;
- that the additional sewage arisings resulting from the extensions to residential development in Discovery Bay, including Discovery Bay North, can be discharged to SHWSTW with acceptable environmental impact; and
- that modifications can be made to the Sewage Disinfection and Dechlorination Facility to accommodate additional sewage arisings resulting from the Discovery Bay North residential development, prior to the connection to SHWSTW being commissioned.

9.1.5 An update of the existing marine water monitoring schedule previously agreed with EPD is also proposed in order to monitor the impact of the additional flows due to Discovery Bay North being discharged via the Sewage Disinfection and Dechlorination Facility.

9.2 Legislation and Guidelines

9.2.1 There are 10 Water Control Zones in Hong Kong. Discovery Bay lies within the Southern Waters Control Zone (SWCZ). The Water Pollution Control Ordinance requires that all polluted discharges into the waters of Hong Kong be licensed and comply with the condition of the licence. The *Technical Memorandum on Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland Waters and Coastal Waters* (TMES) provides a guide for EPD in setting the conditions of the licence.

9.2.2 Discharge of sewage is subject to control and requires a licence issued by the Director of Environmental Protection. In deciding whether to grant a licence, the Authority's purpose is to meet WQOs set out in the Ordinance. The current discharge licence (No. EP860/W2/PG008) is valid until November 30, 1996.

9.3 Existing Situation

Water Quality

9.3.1 Pollution in the marine areas around North Lantau results from the cumulative effect of pollution from the Pearl River currents flowing through the West Lamma Channel and pollution loads from the west New Territories and Tsuen Wan. Sewage discharges from Discovery Bay, Peng Chau and Cheung Chau exacerbate the general problem and cause local water quality problems at Discovery Bay.

9.3.2 The most critical concern relates to bacteriological contamination and possible impacts on bathers at Discovery Bay beach. The beach is not gazetted but is used extensively by residents and visitors. Water quality at the beach was graded as 'Fair' during 1993 by the EPD monitoring programme, which analyses for *E. coli*, an indicator of bacterial pollution derived from animal or human faecal wastes.

9.3.3 Monitoring undertaken by EPD in the Southern Water Control Zone in 1992 showed dissolved oxygen levels to be satisfactory, while there was increasing inorganic nitrogen levels, with the annual mean depth averaged value exceeding the WQOs.

9.3.4 Water quality studies completed for LAPH indicated that the creation of a partial embayment of Discovery Bay by the port would restrict flushing capacity around Discovery Bay and predicted a deterioration in water quality within the embayment.

9.3.5 At present, sewage from Discovery Bay is discharged via a 650m long outfall into the channel between Tai Pak and Peng Chau. Before October 1995, there was no treatment prior to discharge apart from screening. The screening facilities comprise a coarse screen and mechanically raked fine screen together with a screening dewatering unit and bagging unit.

9.3.6 The outfall was designed to provide satisfactory dilution and dispersion utilising the high tidal velocities caused by the constriction between Peng Chau and Tai Pak. The outfall discharges continuously through 30 diffusers at a depth of approximately 12m. The predominant water flow in this area is north-south past the mouth of Discovery Bay and water movement within the bay is generally low.

Proposals for Improved Sewage Treatment

9.3.7 A two stage strategy to improve sewage treatment at Discovery Bay has been developed over the past 2 years and is now being implemented. This strategy comprises disinfection of the sewage discharge to reduce the risk of unacceptable bacteriological levels at bathing beaches and for water contact activities.

9.3.8 The Disinfection and Dechlorination Facility was commissioned in October 1995 and will effectively remove the risk of bacterial contamination at Discovery Bay Beach due to the sewage outfall.

9.3.9 Various options for a long-term improvement in sewage treatment and water quality at Discovery Bay have been investigated. Options for a permanent sewage treatment works within Discovery Bay have been assessed. The OISMP has recommended that sewage from South Lantau, including Discovery Bay and Peng Chau, should be directed to the Siu Ho Wan Treatment Works. The OISMP also recommends a submarine pipeline to carry sewage from Peng Chau to Discovery Bay for export to Siu Ho Wan.

9.3.10 The proposals for export of sewage from Discovery Bay to Siu Ho Wan have been adopted for Master Plan 6.0(A). The proposals are fully consistent with the intention of the OISMP. The early construction of the Discovery Bay Road and Tunnel Link proposed in Master Plan 6.0(A) will also permit the programme for the export of sewage from Peng Chau to be advanced. Discharge of Discovery Bay and Peng Chau sewage to the SHWSTW will improve water quality in Discovery Bay, and will be vital in preventing a deterioration in water quality which would occur with the Lantau Port development if the current method of sewage disposal is continued.

9.4 Technical Evaluation of Proposed Sewage Strategy

Framework for Evaluation

9.4.1 For the purposes of this environmental assessment, it has been assumed that the strategy outlined in the OISMP will be adopted and that the proposals included in Master Plan 6.0(A) for export of sewage from Discovery Bay to Siu Ho Wan are consistent with the Government's strategy for sewage disposal. The study is therefore focused on demonstrating the following:

- that the export of sewage from Discovery Bay to SHWSTW via the Road and Tunnel Link is technically feasible;

Table 9.1 Estimated Sewage Flows

Development Area	Average Flow (m^3/day)	Peak Flow (l/s)
Discovery Bay (MP 5.6)	6,398 *	223
Peng Chau **	1,747	61
Discovery Bay North MP 6.0(A)	2,973	103
Total	**11,118**	**387**

* Based on estimates in Volume 2, Engineering and Traffic Studies for Discovery Bay Master Plan 6.0 (HKR, 1994b).

** Based on 2011 population of 8,300.

9.4.6 **Delivery Requirements:** Preliminary designs for the delivery system provides for conveying sewage from both the existing Discovery Bay and Discovery Bay North to three pumping stations for the lift to the tunnel with a gravity sewer to SHWSTW. The design is outlined in the Engineering and Traffic Studies Report for Master Plan 6.0 (HKR, 1994b).

9.4.7 **Connections to SHWSTW:** Several options for connection to the SHWSTW have been identified through a review of the current design and discussion with TDD and their consultants. The option preferred on the grounds of programme and ease of engineering design is a 600mm pipe connection from Discovery Bay to a 1000mm wide by 800mm deep channel leading to the culvert section of the vortex chamber in the sewage works.

9.4.8 **Programme:** The outline programme provides for the tunnel to be commissioned by the end of 1998. The detailed programme for the tunnel will be confirmed as gazettal and detailed design progress.

9.4.9 The current level of planning has confirmed that connection of the sewer from Discovery Bay to SHWSTW by the end of 1998 is feasible. The capacity of the sewer can be planned to accommodate the projected demand from Discovery Bay and Peng Chau. All of the design options provide for the sewer to be laid under roads or modifications to existing works. No significant additional works areas would be required for the sewerage works.

Capacity of the Siu Ho Wan Sewage Treatment Works

9.4.10 The original design of the SHWSTW provides for the staged development of the facility to accommodate increasing sewage loads from developments on North Lantau. Phase 1 provides for screening and grit removal, and is introduced in stages as illustrated in Figure 9.1. Phase II treatment provides for primary sedimentation and was programmed to be introduced from 2006.

9.3.6 The outfall was designed to provide satisfactory dilution and dispersion utilising the high tidal velocities caused by the constriction between Peng Chau and Tai Pak. The outfall discharges continuously through 30 diffusers at a depth of approximately 12m. The predominant water flow in this area is north-south past the mouth of Discovery Bay and water movement within the bay is generally low.

Proposals for Improved Sewage Treatment

9.3.7 A two stage strategy to improve sewage treatment at Discovery Bay has been developed over the past 2 years and is now being implemented. This strategy comprises disinfection of the sewage discharge to reduce the risk of unacceptable bacteriological levels at bathing beaches and for water contact activities.

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9.3.10 The proposals for export of sewage from Discovery Bay to Siu Ho Wan have been adopted for Master Plan 6.0(A). The proposals are fully consistent with the intention of the OISMP. The early construction of the Discovery Bay Road and Tunnel Link proposed in Master Plan 6.0(A) will also permit the programme for the export of sewage from Peng Chau to be advanced. Discharge of Discovery Bay and Peng Chau sewage to the SHWSTW will improve water quality in Discovery Bay, and will be vital in preventing a deterioration in water quality which would occur with the Lantau Port development if the current method of sewage disposal is continued.

9.4 Technical Evaluation of Proposed Sewage Strategy

Framework for Evaluation

9.4.1 For the purposes of this environmental assessment, it has been assumed that the strategy outlined in the OISMP will be adopted and that the proposals included in Master Plan 6.0(A) for export of sewage from Discovery Bay to Siu Ho Wan are consistent with the Government's strategy for sewage disposal. The study is therefore focused on demonstrating the following:

- that the export of sewage from Discovery Bay to SHWSTW via the Road and Tunnel Link is technically feasible;

- that the SHWSTW has adequate capacity for the additional sewage loads from the Discovery Bay North development according to the development programme;
- that the interim Disinfection and Dechlorination Facility at Discovery Bay can be modified to accommodate the additional sewage arisings from Discovery Bay North development prior to the connection to SHWSTW; and
- that the interim Disinfection and Dechlorination Facility can be modified to accommodate sewage flows during any reasonable delays to the tunnel programme.

9.4.2 The effectiveness and adequacy of the interim Disinfection and Dechlorination Facility will be evaluated through water quality monitoring and a review at the end of 1996. The review will determine the performance of the disinfection system, the progress of the Road and Tunnel Link, sewage flows and the quality of the receiving water. The proposal to treat sewage arisings from Discovery Bay North for the short period prior to connection to the SHWSTW will be subject to the findings of this review and agreement with EPD. Although considered unlikely at this stage, alternative treatment/disposal arrangements may need to be developed.

Technical Feasibility of Export via the Tunnel Link

9.4.3 The details of the Road and Tunnel Link alignment options are presented in detail in the Final EIA Report for the Road and Tunnel Link (HKR, 1995d). The tunnel design includes a services duct to accommodate a range of utilities and services including a sewer capable of taking flows from all of Discovery Bay and Peng Chau.

9.4.4 The main elements of the outline technical design are summarised below and are described in more detail in Engineering and Traffic Impact Studies Report submitted as part of the Master Plan 6.0 planning submission in December, 1994 (HKR, 1994b). The sewage system design has not been altered in Master Plan 6.0(A).

9.4.5 **Capacity Requirements:** Estimated sewage flows from the Discovery Bay, Discovery Bay North, and Peng Chau are summarised in Table 9.1. The sewage main to SHWSTW has been designed to accommodate the maximum potential capacity from Discovery Bay and Peng Chau.

Table 9.1 Estimated Sewage Flows

Development Area	Average Flow (m^3/day)	Peak Flow (l/s)
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9.4.7 **Connections to SHWSTW:** Several options for connection to the SHWSTW have been identified through a review of the current design and discussion with TDD and their consultants. The option preferred on the grounds of programme and ease of engineering design is a 600mm pipe connection from Discovery Bay to a 1000mm wide by 800mm deep channel leading to the culvert section of the vortex chamber in the sewage works.

9.4.8 **Programme:** The outline programme provides for the tunnel to be commissioned by the end of 1998. The detailed programme for the tunnel will be confirmed as gazettal and detailed design progress.

9.4.9 The current level of planning has confirmed that connection of the sewer from Discovery Bay to SHWSTW by the end of 1998 is feasible. The capacity of the sewer can be planned to accommodate the projected demand from Discovery Bay and Peng Chau. All of the design options provide for the sewer to be laid under roads or modifications to existing works. No significant additional works areas would be required for the sewerage works.

Capacity of the Siu Ho Wan Sewage Treatment Works

9.4.10 The original design of the SHWSTW provides for the staged development of the facility to accommodate increasing sewage loads from developments on North Lantau. Phase 1 provides for screening and grit removal, and is introduced in stages as illustrated in Figure 9.1. Phase II treatment provides for primary sedimentation and was programmed to be introduced from 2006.

9.4.11 The recommendations of the OISMP, concerns on marine impacts in the waters to the north of Lantau Island, and the opportunity for earlier connection of sewage loads from Discovery Bay and Peng Chau have prompted a review of the facility which is likely to be upgraded to a Strategic Sewage Treatment Works with higher levels of treatment. The findings of this review are not yet available but are likely to provide scope for increasing both capacity and level of treatment.

9.4.12 The original planning for the SHWSTW anticipated connection of sewage loads from the current Discovery Bay Development in 2004. The anticipated sewage flow from Discovery Bay was 7,850 m^3/day based on a population of 16,500 and from Peng Chau was 1,575 m^3/day based on a population of 6,750. This totals 9,425 m^3/day in comparison to the flow of 11,118 m^3/day detailed in Table 9.1, an increase of 1,693 m^3/day, a relatively small flow when considering the overall capacity of 3380 l/s of the SHWSTW in 2001.

9.4.13 Planning for the first stage of the SHWSTW did not allow for connection of sewage loads from Discovery Bay in 1998. Early connection of the increased capacity based on Master Plan 6.0(A) raises two capacity issues:

- Can the SHWSTW accept loads from Discovery Bay in 1998 when export through the tunnel can be implemented, rather than 2004?
- Can the additional capacity generated by Discovery Bay North be accommodated?

9.4.14 The following considerations are relevant:

- The first stage of the SHWSTW provides only screening and grit removal. Based on discussions with TDD, the screening and grit removal equipment is adequate for the increased flow resulting from early connection in late 1998.
- The current design for Stage 1 of the SHWSTW includes 3 screens (2 duty, 1 standby) and 2 detritors (1 duty, 1 standby) which have capacity to treat the sewage inflow (including Discovery Bay sewage) until the end of 1999 (TDD, 1995). Two additional detritors and one screen will be commissioned in the future and the ultimate capacity of the works will be 5,100 l/s.
- The estimated flows for SHWSTW at various stages of the Discovery Bay North development programme are as shown in Table 9.2. The Siu Ho Wan flows are based on data on projected flows from Chek Lap Kok Airport, North Lantau Development and the Lantau Port Development projected by the STW designers. The Discovery Bay flows, which include flows from Peng Chau, have been factored to take account of the overall peaking factor for flows arriving at the SHWSTW.

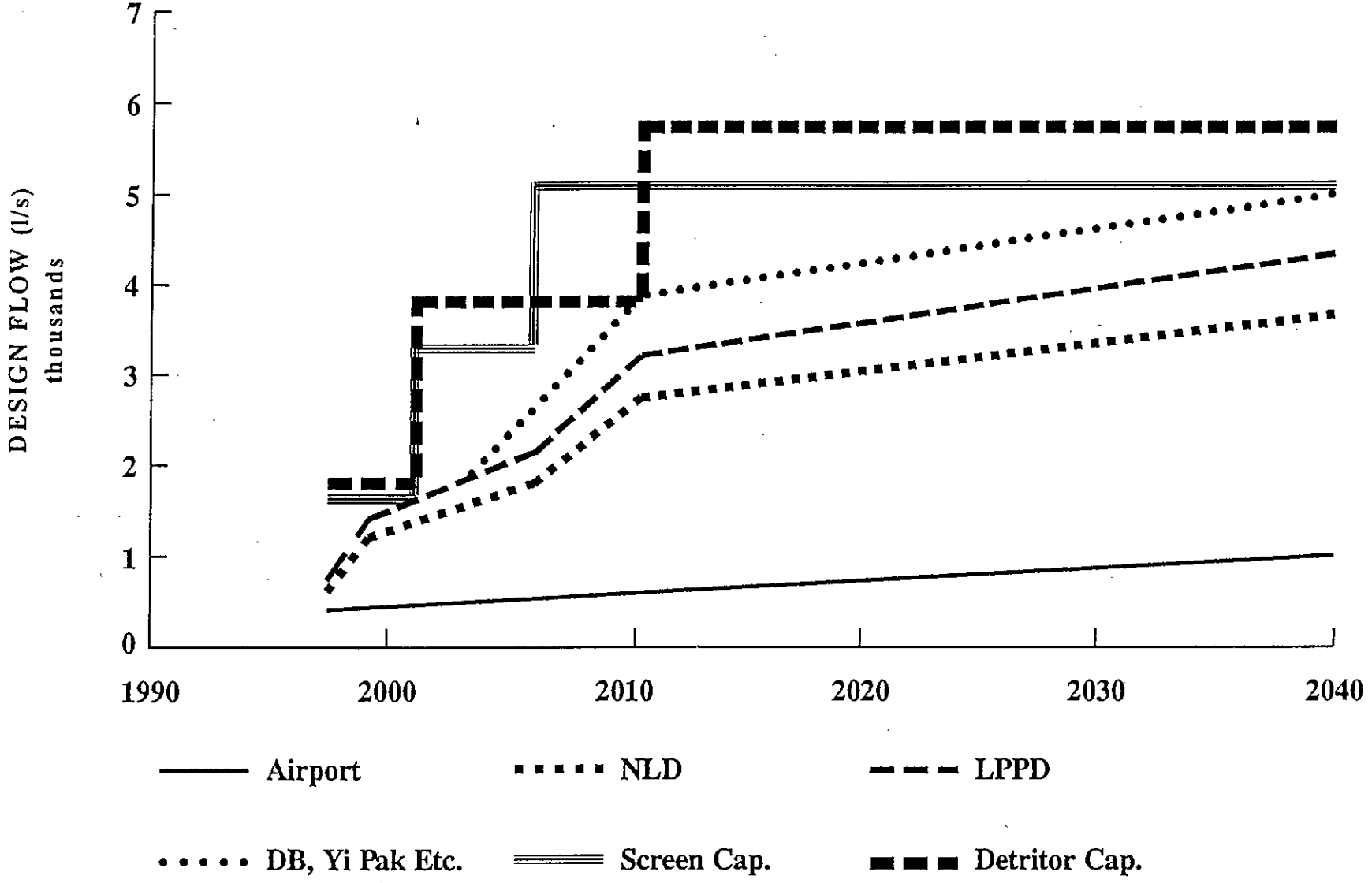

Figure 9.1
Siu Ho Wan Sewage Treatment Works Design Flows

Table 9.2 Siu Ho Wan STW - Capacity vs. Projected Flows

	1998	2000	2004
Peaking Factor	2.75	2.68	2.72
STW Limiting Capacity (l/s)	1,950	1,950	3,400
Estimated Flows (l/s)			
North Lantau Developments	1,101	1,549	2,099
Discovery Bay *	279	311	351
Total	**1,380**	**1,860**	**2,450**

* Including flows from Discovery Bay (MP 5.6), Discovery Bay North and Peng Chau.

9.4.15 Based on the above, there would appear to be adequate capacity at the SHWSTW to permit connection of loads from Discovery Bay in 1998. Given the anticipated review of SHWSTW and the relatively low contribution of Discovery Bay to the works it is also concluded that the SHWSTW could accept the additional load generated from Discovery Bay North.

9.4.16 TDD's consultant, Mott Connell Ltd., has carried out an independent assessment. Their report (TDD, 1995) confirms that the SHWSTW has the capacity to accept the additional sewage flow from Discovery Bay and Peng Chau.

Sewage Characteristics

9.4.17 Discovery Bay sewage will not change in nature or strength as a result of the Master Plan 6.0(A) development. The existing Discovery Bay developments include restaurants, laundries etc. and the sewage is typical of primarily residential developments. Master Plan 6.0(A) consists of a similar mix of uses. Discovery Bay sewage does not and will not contain industrial effluent. The SHWSTW should encounter no difficulty in accommodating the sewage load from Discovery Bay including the Master Plan 6.0(A) proposals as the sewage will be no stronger than standard sewage and as capacity is available at the SHWSTW.

Adequacy of Interim Disinfection and Dechlorination Facility

9.4.18 In 1992, EPD requested that Hong Kong Resort Company Ltd provide sewage treatment additional to screening to improve the microbial quality of the effluent. A Disinfection and Dechlorination system has been designed and was commissioned in October 1995.

9.4.19 The facility utilises dosing with Sodium Hypochlorite and a dechlorination facility (using Sodium Metabisulphate) to reduce *E. coli* levels and ensure that residual chlorine levels set in the discharge licence are not exceeded. The sewage discharge limits set by EPD in the discharge licence are given in Table 9.3. A maximum limit of 5,000 colony forming units (cfu's) per 100ml was set.

Table 9.3 Sewage Discharge Limits (Licence Expiry November 30, 1996)

Determinant	Unit	Maximum
Daily Flow Rate	m^3 per day	7,200
Total Residual Chlorine	mg/l	1
E. coli	count/100ml	5,000

The discharge/deposit shall not contain any other wastes such as polychlorinated biphenyls (PCB), polycyclic aromatic hydrocarbon (PAH), fumigant, pesticide or toxicant, radioactive substance, chlorinated hydrocarbon, flammable or toxic solvent, petroleum oil or tar, calcium carbide, uncontaminated condensing or cooling water, wastes liable to form scum or deposit in any part of the waters of Hong Kong, or to pollute/discolour waters of Hong Kong or to be harmful to the health and safety of any personnel engaged in the operation or maintenance of a sewerage system, and sludge, floatable substance or solids larger than the opening of the screen.

Source: EPD discharge licence EP860/W2/PG008, dated 1/12/94.

9.4.20 The disinfection process is illustrated in Figures 9.2 and 9.3. The Sodium Hypochlorite disinfectant will be dosed at Pumping Station No. 2 into the existing sewer main and the Sodium Metabisulphate will be dosed into the existing sewer main several hundred metres downstream to dechlorinate the sewage prior to discharge via the outfall.

9.4.21 The treatment design is based on there being adequate contact time between the sewage and the Sodium Hypochlorite disinfectant in the existing sewer main prior to dechlorinating with Sodium Metabisulphate. The adequacy of the contact time has been based on data from a series of laboratory disinfection trials. Based on the laboratory trials at 10 mg/l free chlorine, 8.5 minutes contact time would ensure levels of *E. coli* far less than the consent value of 5,000 cfu/100ml.

9.4.22 Compliance of the proposed scheme, with respect to the discharge limits, will be assessed by monitoring the effluent prior to discharge to marine waters. A baseline and compliance water quality monitoring programme is being implemented to assess the efficacy of the interim measures.

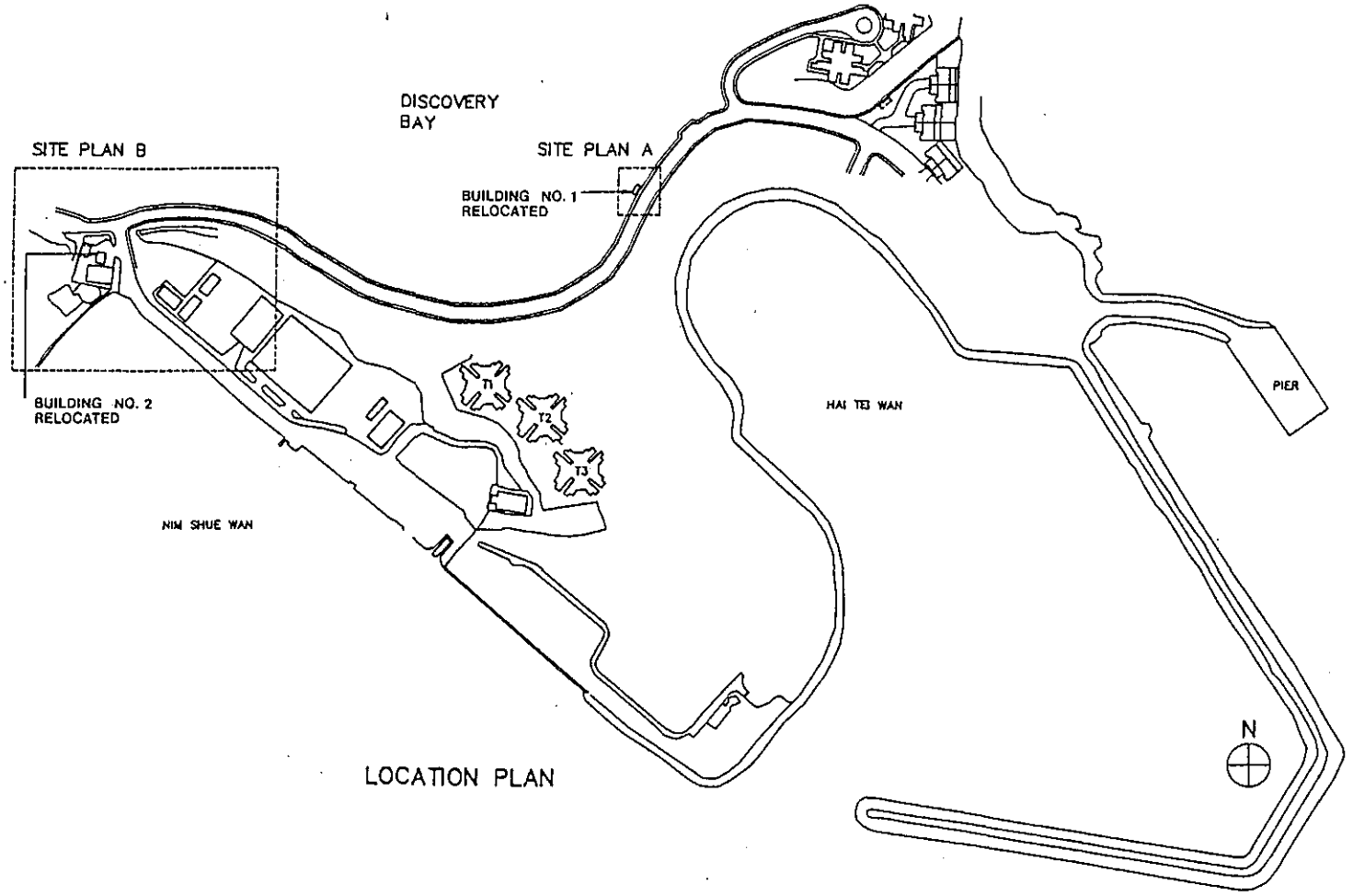

Figure 9.2
Location of Sewage Disinfection and Dechlorination Facility

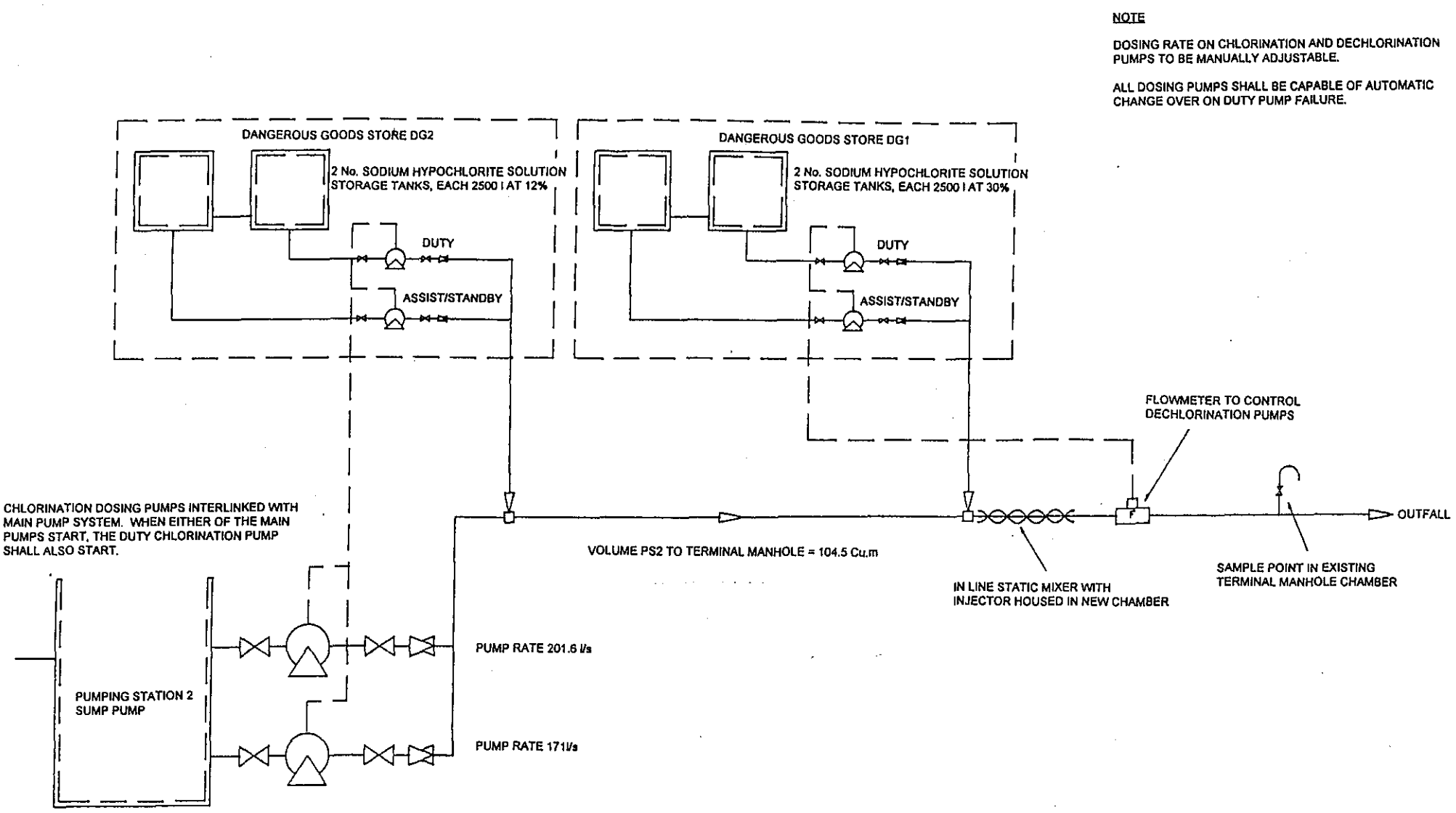

Figure 9.3
Sewage Disinfection and Dechlorination Facility Flow Diagram

9.4.23 Prior to the connection of Discovery Bay sewage flows to the SHWSTW via the tunnel, all Discovery Bay sewage will be treated by the sewage Disinfection and Dechlorination Facility. The projected population of the Discovery Bay, including Discovery Bay North is 18,750 by the end of 1998, producing an estimated average daily flow of 6,930 m^3/day and peak flow of 241 l/s (based on maximum per capita sewage flows and immediate 100% occupancy upon completion).

9.4.24 At these flow rates, during periods of peak flow the contact time of 8.5 minutes cannot be achieved, and the contact time will be reduced to approximately 7 minutes. Previous chlorination laboratory trials have shown that effective chlorination can still be achieved by increasing the dosage of chlorine above 10 mg/l.

9.4.25 Consequently, the sewage Disinfection and Dechlorination Facility should be capable of treating all sewage flows arising from Discovery Bay (including the occupants of Phase I of Discovery Bay North) up until the redirection of sewage to SHWSTW at the end of 1998.

Response to Possible Delays to the Tunnel Programme

9.4.26 In view of the complexity of the project, it is reasonable to allow for some unforseen delay to the tunnel programme. It is considered that the maximum delay which should reasonably be considered in contingency planning is 1 year (i.e. 33% slippage on the 3 year programme).

9.4.27 By the end of 1999, the population will have risen to 20,000, producing an average daily flow of 7,000 m^3/day and peak flow of 243 l/s (again based on maximum per capita sewage flows).

9.4.28 At these flow rates, during periods of peak flow the contact time may reduce to 6.3 minutes. Consequently, the dosage of chlorine will need to be increased. Previous laboratory trials have shown that increasing the dose from 10 mg/l free chlorine to approximately 15 mg/l free chlorine should be sufficient. Any residual chlorine would be removed by the treatment process.

9.5 Potential Environmental Impacts

Impacts During the Period of Interim Treatment

Baseline Conditions

9.5.1 In the immediate future, the marine water quality in the Discovery Bay area will improve owing to the operation of the sewage Disinfection and Dechlorination Facility from October 1995. Water quality is expected to be maintained within acceptable limits.

9.5.2 Other influences on water quality prior to connection to the SHWSTW in late 1998 include construction works for Phases I and II of the Lantau Port (CT10 and CT11). The embayment formed by the Port peninsula is not anticipated to affect water flows, and consequently water quality, until 2003 when Phases 3 and 4 are scheduled. Port Phases 1 and 2 are adjacent to the coast and will have less effect upon hydrology. The introduction of limited sewage treatment on Peng Chau in mid 1995 should also result in some improvement in local water quality.

Effect of Discovery Bay North

9.5.3 Until the export of sewage to the SHWSTW, the effect of sewage discharges from Discovery Bay North on the water quality of Discovery Bay will be a small increase in biological loads due to the additional population. The sewage load resulting from Discovery Bay North by the end of 1998 (the proposed date of connection to SHWSTW) will represent less than 4% of the overall Discovery Bay sewage discharge. Consequently, it is not considered that the Discovery Bay North sewage will have a significant impact on dissolved oxygen, inorganic nitrogen, and the risk of eutrophication/algal bloom. The Disinfection and Dechlorination Facility will prevent any additional accelerated microbiological impacts provided that the dose rate of disinfection chemical is increased to compensate for reduced contact time.

9.5.5 The outfall was designed to provide satisfactory dilution and dispersion and the additional load will be effectively assimilated.

9.5.5 The environmental impact of Discovery Bay North on Discovery Bay water quality during this period is not considered to be significant.

9.5.6 A more regular marine water monitoring programme is recommended during this period (Section 9.6). This programme will serve to detect any deterioration in marine water quality and to assess the effectiveness of the Sewage Disinfection and Dechlorination Facility in treating additional flows from Discovery Bay North. It will also serve to monitor the effect of the container port works on Discovery Bay.

Impacts following Connection to SHWSTW

Earlier Scheduling of Discovery Bay to SHWSTW Sewer Connection

9.5.7 The marine water quality in the Discovery Bay area would improve significantly following redirection of sewage flows to the SHWSTW in late 1998. This improvement will become more evident upon redirection of Peng Chau flows to the SHWSTW.

9.5.8 The connection of Discovery Bay sewage flows to SHWSTW is in accordance with the OISMP. WAHMO modelling has previously been conducted to assess the impact of the sewage discharge from SHWSTW and this predicted no significant environmental impact provided that primary treatment was provided by 2006. As the modelling was based on connection of Discovery Bay flows in 2004, early connection should have no significant effect on the overall environmental implications. Any detailed consideration of the water quality effects of the SHWSTW is outside the scope of this study.

Additional Flows

9.5.9 Total sewage loads from Discovery Bay will increase as a result of Master Plan 6.0(A). Upon completion of the present Master Plan 5.7, the population will be approximately 18,000. Master Plan 6.0(A) would increase this population to approximately 25,000 by the year 2004, an increase of 7,000 persons, resulting in an estimated average daily sewage flow of 9,371 m^3/day excluding Peng Chau. This is 2,855 m^3/day more than the sewage flows allowed for in the OISMP SWNT Interim Recommended Strategy (IRS), 1521 m^3/day more than that allowed for in the original planning for SHWSTW, but 5,197 m^3/day less than that allowed for in the OISMP Maximum Growth Hybrid Option (MG). The planning scenario adopted is the IRS.

9.5.10 As Discovery Bay flows of 7,850 m^3/day were originally planned for SHWSTW in 2004, the environmental impact of the relatively small additional flow of 1,521 m^3/day due to Discovery Bay North is not anticipated to be significant, particularly bearing in mind the overall throughput of SHWSTW, and its capability of accommodating the additional flows. Stage II sewage treatment (Primary Sedimentation), originally scheduled for 2006, is likely to require earlier scheduling owing to these additional flows in conjunction with the redirection of all of Lantau Island sewage arisings to SHWSTW.

9.5.11 The additional flows from the Discovery Bay North should also be considered in relation to the total flows at SHWSTW in 2040 which will increase to more than 160,000 m^3/day (only 1.8% of total flow).

9.5.12 An additional 1,725 m^3/day sewage is estimated to result from Peng Chau, which is only a fraction more than that accounted for in the earlier planning studies.

Sewage Overflow

9.5.13 Sewage overflow could occur during periods of total power failure within Discovery Bay. However, a power outage has only occurred once in Discovery Bay over the past 10 years and this occurred due to typhoon damage to a transmitter. The duration of this power outage was 6 hours. Apart from storm damage, the only other potential cause of a power outage would be a control panel fire and this has never occurred within the Discovery Bay substation.

9.5.14 Power supply to Discovery Bay is suspended once every five years during routine inspections of the substation by CLP. The power supply is resumed within 6 hours.

9.5.15 Thus, over the past ten years, the power supply to Discovery Bay has only been suspended three times and then for a period of 6 hours at a time. The potential frequency of a sewage overflow can then be taken as once every ten years due to storm events, and twice every ten years due to routine maintenance of the substation. Discussions will be held with CLP to minimise the period of power supply suspension during routine maintenance inspections.

9.5.16 Any sewage overflow would be screened to remove any litter in the effluent stream. Hand rigged screens with a 6mm mesh size would be used and would be suitable for manual operation. Notices would be placed at any nearby bathing areas to warn people of the potential sewage hazard following an overflow incident. The impact on the receiving water should be minimal due to the short period of any discharge and the infrequency of such events.

9.5.17 The possibility of sewage overflow at the sewage pumping stations will be minimised by the following measures:

- Dual power supply (from separate sub-stations) will be provided if possible after consultation with CLP. Standby generators would not be appropriate due to the potential noise nuisance.
- Stand-by pumps will be provided in accordance with DSD requirements.
- The pump sump storage capacity will be 0.5 hours at average flow rates.

9.5.18 Consequently, the likelihood of sewage overflow occurring at the pumping stations would be only under exceptional circumstances. With the implementation of the recommended control measures, the risk is not considered to be significant.

Odour

9.5.19 Odour has the potential to occur at pumping stations, manhole chambers and the vortex drop shaft. However, except for the pumping stations at Discovery Bay, there are no sensitive receivers close to these facilities. The three pumping stations in the Discovery Bay North development have been sited as far away from residential buildings as possible. The design of the sewage pumping system aims to minimise the residence time of sewage in all parts of the system during normal operations. Odour levels will be monitored during pumping station operation. The pumping stations should be designed so that activated carbon filters can be retrofitted at a later stage if necessary.

Safety

9.5.20 Methane can be emitted by sewage and be released from the closed pipe system at the same locations as those identified for odour. This is a potential hazard owing to its flammable nature. The only potential location of concern is in enclosed spaces such as the tunnel. Manhole chambers will be located outside the tunnel which will be ventilated by a jet fan system preventing any build up of methane. There is not considered to be any significant safety risk arising from methane in the sewer.

9.5.21 Hydrogen sulphide can also be generated by sewage if it becomes septic. The residence time of sewage in all parts of the system has been minimised through pumping system design to prevent septicity problems.

Construction Effects

9.5.22 The construction works for the sewerage connection would be undertaken as an integral part of the construction programme. No additional works areas would be required apart from the connection to the SHWSTW and no special construction requirements have been identified. Construction effects are not considered to be significant.

9.6 Additional Monitoring

9.6.1 A monitoring programme was previously agreed with EPD for the Sewage Disinfection and Dechlorination Facility effluent discharge and the Discovery Bay marine waters. It is proposed, in addition to increasing the dosage of treatment chemicals, to increase the monitoring frequency from early 1998, as it is proposed that the Disinfection Facility will be receiving sewage flows from the first occupation phase of Discovery Bay North and the treatment plant will be operating under modified conditions.

9.7 Conclusions

9.7.1 The following conclusions are drawn from the assessment and following consultation with the project's Study Management Group:

- Both interim and long-term sewage disposal strategies have been identified and the environmental impact of the strategies assessed. A Sewage Disinfection and Dechlorination Facility was commissioned in October 1995 and will improve the bacteriological/microbiological marine water quality in Discovery Bay.
- The growing population due to Discovery Bay North in 1998 will increase the sewage discharge volumes. However, the sewage will be disinfected and *E. coli* levels are expected to improve compared to present levels. The Sewage Disinfection Facility will be capable of treating the additional flows from Discovery Bay North.
- From the end of 1998, it is planned to redirect the sewage from Discovery Bay and Peng Chau to the SHWSTW in accordance with the OISMP. Upon redirection of the sewage to the SHWSTW, the marine water quality in Discovery Bay will improve. This will help mitigate the potential water quality impacts caused by the embayment of Discovery Bay by the proposed Lantau Port Development. Connection to SHWSTW is technically feasible and the treatment works is capable of accommodating additional flows under normal operating conditions.
- Early connection to SHWSTW and the additional flows due to Discovery Bay North population are not anticipated to have any significant environmental impact upon North Lantau marine waters.

9.7.2 There are no significant impacts due to the planned sewage treatment strategy and the project will promote acceleration of the relevant part of the OISMP. Discovery Bay and Peng Chau sewage disposal at the SHWSTW will have the important benefit of improving water quality in Discovery Bay which is particularly important in view of the effects of the proposed Lantau Port development on water circulation patterns in the area.

9.7.3 The proposals for treatment of sewage from Discovery Bay will be reviewed at the end of 1996 when firmer details of the Road and Tunnel Link construction programme will be available. The review will consider the need for sewage treatment alternatives should the Road and Tunnel Link programme be substantially delayed.

9.7.4 Phases subsequent to Phase 1a of Master Plan 6.0(A) will not be occupied before completion of the sewage link to Siu Ho Wan unless a sewage treatment and disposal option has been secured and commissioned which is acceptable to EPD.

10.

WASTE

10. Waste

10.1 Introduction

10.1.1 This section addresses spoil and construction waste arisings from Discovery Bay North and the collection arrangements for operational waste including:

- construction waste minimisation and recovery;
- requirements for temporary storage and treatment of spoil;
- marine mud disposal; and
- detailed design of the refuse collection point (RCP) and arrangements for refuse collection during the operation of Discovery Bay North.

10.2 Legislation

10.2.1 The following legislation and regulations govern the handling, treatment and disposal of wastes in Hong Kong and are relevant to this waste assessment:

- Waste Disposal Ordinance (Cap. 354);
- Hong Kong Planning Standards and Guidelines;
- Waste Disposal (Chemical Waste [General]) Regulations; and
- Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes.

10.2.2 In accordance with the Polluter Pays Principle, the Government intends to implement a charging policy for the disposal of waste, including construction waste, to landfill next year.

10.3 Construction Waste Minimisation and Recovery

-Sources and Types of Construction Waste

10.3.1 Construction wastes can be divided into two broad categories - building debris and site clearance materials. The major sources of waste during construction of Discovery Bay North will include:

- site clearance activities including the removal of existing platforms, haul roads and vegetation;
- site excavation and blasting works, particularly blasting of Yi Pak Hill;
- dredging works for the proposed reclamation;
- Yi Pak tunnel portal formation;
- general works for residential buildings, community facilities and infrastructure;

- civil works including construction of the sea wall and ferry pier; and
- road construction.

10.3.2 The types of wastes generated by these works will include:

- rocky spoil from excavation and blasting works and Yi Pak tunnel portal formation;
- marine sediments from dredging;
- sandy/rocky material from clearance of existing spoil stockpiles;
- soil and sand from site clearance ('site clearance muckaway');
- concrete from site clearance and building works;
- asphalt from removal of existing haul roads and road works;
- bamboo poles used in scaffolding;
- wood used as shuttering and form work during concrete pouring;
- vegetation including trees, shrubs and grasses from site clearance;
- ferrous and non-ferrous metals, glass, plastic, bricks and tiles from general construction works and building fitting out;
- worker derived wastes such as food and beverage containers;
- wastes from servicing and maintenance of construction equipment (including tyres, used engine oils, air and oil filters); and
- packaging materials such as bags, straps, pallets etc.

10.3.3 Most of the waste arising during construction of Discovery Bay North will consist of rocky spoil, marine mud, soil, sand and vegetation material. The largest volume of waste will be solid spoil from site excavation and formation of the Yi Pak tunnel portal. Approximately 1,010,000 m^3 of solid spoil will be generated. Marine dredging will generate approximately 150,000 m^3 of sediment. Soil, sand and vegetation from site clearance and preparation activities will also contribute significantly to the quantity of construction waste produced. The quantities of wastes such as concrete, wood used for concrete shuttering and form work and building materials will be minimal due to the economic implications of such material wastage for the contractor.

10.3.4 Construction wastes will be the property of the contractor. Conditions will be incorporated into the contract to require the proper disposal of all waste. The contractor will be encouraged by the Developer to reuse all materials. The contractor should prepare a comprehensive on-site waste management plan which incorporates the recommendations of the following sections.

General Waste Minimisation and Recovery Strategy

10.3.5 The general strategy to minimise and recover wastes generated by construction of Discovery Bay North will include:

- control of waste generation at source through waste minimisation and engineering design;
- construction phasing to ensure the efficient use of resources;
- provision of site staff responsible for waste minimisation and to sort construction wastes; and
- sorting of wastes on site.

10.3.6 The most effective measure to reduce construction waste will be the control of the quantities of waste generated at source. This can be achieved through the minimisation of material wastage during construction and the use of engineering solutions to limit the waste arising from the construction works. The engineering design of the reclamation minimises the extent of marine mud dredging works required which both reduces the volume of marine mud for disposal and reduces the volume of fill material needed for the reclamation.

10.3.7 Careful planning of construction phasing will ensure that resources are used efficiently and that fill material generated on site is available when required for the reclamation and platform and road embankment works. In addition, careful construction phasing can minimise resources used during construction through the re-use of materials such as bamboo scaffolding and wood for shuttering and form work.

10.3.8 Sufficient site staff will be provided to oversee and carry out sorting of construction wastes. These staff will supervise the works to prevent the generation of unnecessary volumes of construction waste and to ensure that resource efficient construction practices are followed. The importance of construction waste minimisation, recycling and site cleanliness will be stressed to all contractors. Consideration will be given to the inclusion of financial penalty clauses for excessive and unnecessary waste generation and site littering in contractors' contracts. However, the minimisation of resource wastage will be a priority of the contractor to enhance project profitability.

10.3.9 All wastes will be sorted on site and classified according to one of the three following categories:

- wastes which can be re-used without treatment;
- wastes which are recoverable with treatment; or
- wastes which are only suitable for landfill or public dumps and which must be transported off site.

10.3.10 Once the wastes are categorised, the appropriate re-use, recycling or disposal option outlined in the following section will be followed.

Practical Construction Waste Minimisation and Recovery Measures

10.3.11 A range of the inert, clean and non-biodegradable construction wastes generated by works for Discovery Bay North will be suitable for use as fill material for the proposed land reclamation and platform and road embankment formation works. Such wastes include rocky and sandy spoil, concrete/mortar and asphalt. Rock fill will be used for construction of the sea wall if suitable. Surplus fill material will be used in the reclamation and in the formation of the lower development platforms and road embankments.

10.3.12 Approximately 235,000 m^3 of general fill will be required for the reclamation and 275,000 m^3 of rock fill for the sea walls. 310,000 m^3 of this general fill requirement will be derived from the land based cut works; the remaining 200,000 m^3 of general fill will be imported. Thus, all the suitable spoil generated by construction works will be re-used within the site as general and rocky fill.

10.3.13 Hard, inert construction wastes such as concrete rubble and asphalt may also be crushed and graded on site in mobile crushing/grading plant and re-used as a low-grade aggregate substitute. Such aggregates may be used as a granular sub-base material for roads. Crushed bricks are also suitable as a sub-base material for roads.

10.3.14 Marine sediments will be left *in situ* at the site of the proposed reclamation wherever possible in order to minimise the quantity of mud requiring disposal and to reduce the volume of fill material required for the reclamation. Marine muds will be excavated from the sites of the sea wall foundation, the reclamation access road, the retail and commercial facilities and building platforms. Approximately 150,000 m^3 of marine muds will be removed. A site investigation study determined that the marine sediments at the site of the reclamation are uncontaminated (see Appendix 3). Uncontaminated marine muds will be used in the creation of the mangrove mudflat and in landscaping works after dewatering and salt removal.

10.3.15 Top soil and other soil material removed from the site during site clearance works should be stockpiled and subsequently used in landscaping and revegetation works. The viability of soil organisms which are important for soil structure and fertility, such as earthworms and bacteria, must be maintained throughout the soil storage period. The size of the soil stockpiles should be controlled to maintain sufficient oxygen supply for the soil fauna.

10.3.16 Bamboo poles can be reused as scaffolding material for as long as they remain structurally sound. When the poles become unsafe, the bamboo can be used as a resource in the manufacture of chipboard.

10.3.17 Wood used as shuttering and form work for concrete works should be re-used as much as is practicable. However, wood has limited re-use potential as shuttering and form work needs to be a precise shape and requires wood

with a smooth finish. If the wood is not suitable for re-use as shuttering or formwork, it should be used elsewhere on site in works wherever possible. Metal shuttering should be considered as an alternative as it is more durable, and hence reusable, than wood but has the disadvantage of being more expensive.

10.3.18 Wood processing facilities are available in Hong Kong and will accept waste such as wooden packaging crates. Wood waste materials can be reprocessed to form secondary wood products such as chipboard.

10.3.19 The contribution of the existing site vegetation to the waste stream may be reduced in several ways. Mature trees and shrubs removed from working areas should be replanted in landscaping schemes elsewhere on the site. This has the added benefit of enhancing the value of the landscaping schemes through the use of plant species occurring naturally on the site. Cleared vegetation which is not suitable for replanting, leaf litter and other suitably non-bulky material should be composted for subsequent use as a fertilising mulch in landscaping works.

10.3.20 Ferrous metals can be recycled at processing facilities available in Hong Kong. Recycling facilities for small quantities of non-ferrous metals, such as aluminium and copper, are also available locally.

10.3.21 Certain plastics are recyclable. However, the quantity of recyclable plastic material generated on construction sites is generally small and the facilities for post-consumer plastic recycling are limited in Hong Kong.

10.3.22 Construction worker derived wastes such as food and beverage containers will be minimised through the provision of an on-site canteen to reduce the need for workers to provide their own food and drinks. General site litter will be controlled though the provision of convenient litter disposal points, litter patrols and worker briefings to stress the importance of site cleanliness.

Wastes from Plant and Equipment

10.3.23 The main items of construction plant and equipment will require maintenance and servicing. This will generate limited quantities of dirty lubricants, spent air and oil filters and other sundry materials. While relatively inert materials, such as the air filters, are suitable for landfill disposal and can be disposed of via the normal Discovery Bay refuse disposal system, it is important to prevent machine oil, spent oil filters, grease, gearbox fluids etc. from contaminating the ground water or land. If possible, the waste oil can be recycled and this will be arranged at the appropriate time. Disposal will require collection of the waste oil and transport off-side by a licensed chemical waste collector in accordance with the Waste Disposal (Chemical Waste [General]) Regulations. All maintenance activities will be restricted to a dedicated plant area with suitable drainage and interceptor facilities.

10.4 Spoil Arisings and Disposal

10.4.1 Spoil will arise primarily from excavation and formation works for the main platform areas, excavation for foundation works as well as dredging works for the reclamation. Spoil from the Yi Pak tunnel portal will be treated as general spoil from the site formation works and is therefore incorporated into this assessment.

Spoil Volumes

10.4.2 1,010,000 m^3 of spoil is estimated to be generated from site excavation works. The majority of this spoil is likely to be rock which is anticipated to be clean and suitable for use in reclamation or platform formation. Consequently, it is intended that all such material will be reused on site to form building platforms and the seawall. The potential impacts of spoil handling, transport and placement relate to dust and noise. Movements and storage of the material prior to reuse will be contained within the development site. The spoil will be loaded by mechanical shovel onto trucks for transport to either temporary storage areas within the site or to areas of reuse.

10.4.3 A handling and pretreatment (crushing and screening) area for rocky spoil will be required prior to its use as a fill material. The stone crushing and screening plant will be a potential source of noise and dust and should be operated according to best practical means (Section 5). A licence will be required under the Air Pollution Control Ordinance for the operation of the plant as a specified process if its capacity exceeds 5000 tonnes per annum.

Temporary Spoil Storage

10.4.4 The majority of spoil will be reused on site as it is excavated. It is anticipated that the stockpiling of spoil will therefore be limited to relatively small quantities of rock material for operational reasons. The sea wall will generally be constructed in advance of the reclamation. However, some gaps will be left in the wall to allow barge access to the reclamation during construction. Once the reclamation is complete, the remaining rock material will be used to complete the seawall.

10.4.5 Potential impacts from spoil stockpiles generally relate to fugitive dust emissions and noise from plant used in material handling at the stockpile. The specific details of the expected size and location of stockpiles and the nature and physical condition of the spoil are needed to enable the accurate prediction of specific impacts. The stockpiled material will consist of rock and the stockpiles will be relatively small. Therefore, provided that temporary storage areas are selected with due consideration to the location of sensitive receivers, potential impacts will be minimal.

10.4.6 A review of the site and spoil storage requirements has been completed and the most appropriate areas for storage identified. After consideration of site topography, the location of sensitive receivers and planned reuses, the most suitable location for the spoil storage is the site of the proposed central landscape and water feature. The area to the north of the site is limited by the steep slopes of Yi Pak Hill. To the west and south are existing residential blocks and immediately to the east, the reclamation and sea wall.

Maintenance of Temporary Spoil Storage Areas

10.4.7 Maintenance of the temporary spoil stockpiles will reduce any potential impacts. Stockpiles should be covered in adverse weather conditions and associated noise impacts reduced through the selection of quiet plant and working methods and limiting operational hours if necessary.

10.5 Dredged Marine Sediments

Site Investigation

10.5.1 Approximately 150,000 m^3 of marine muds will arise from the dredging operation at the site of sea wall bordering the reclamation. The marine mud under the reclamation area will remain *in situ* where possible; this will minimise both volume of marine mud for disposal and the volume of reclamation fill required. A marine mud contamination site investigation study was undertaken in March 1995. The results showed that the marine sediments in the reclamation area are not contaminated with heavy metals and can be classified as Class A sediments in accordance with the EPD Technical Circular No. 1-1-92 *Classification of Dredged Sediments for Marine Disposal.* The sediment study report is included as Appendix 3.

10.5.2 No special dredging, transport or disposal methods will be required beyond those which would normally be applied for the purpose of ensuring compliance with EPD's Water Quality Objectives, or for protection of sensitive receptors near the dredging or disposal areas (see Section 8.9). The dredged sediments may be used in landscaping works following treatment or in the formation of the mangrove mudflat as the material is uncontaminated. Dredged sediment will be transported from the dredging platform to the shore/mangrove transplantation area by barge. Sediment for use in landscaping works will be transported on site in sealed trucks to minimise any loss of material.

Use of Dredged Sediment in Landscaping Works

10.5.3 Suitable uncontaminated dredged sediment may be processed to form topsoil or subsoil for use in landscaping works (Dr. B. Thomas, pers. comm., Chartered Engineer with Acer Consultants (Far East) Ltd., Hong Kong; Fleming *et al.*, 1987). This reuse of the dredged material would reduce the volume of spoil requiring disposal and also the quantity of soil which would need to be imported for landscaping works.

10.5.4 The sediment will be stockpiled and then processed in batches in a designated area of the site. The soil product would be stockpiled and used as required in landscaping works. The sediment treatment programme will aim to minimise the land area required for processing and soil storage. The Environmental Monitoring Team will oversee the sediment processing and will liaise with the Site Manager to avoid potential interfacing problems with construction activities.

10.5.5 Almost all desired soil properties can be obtained by the controlled processing of dredged material. The processing method consists of an initial quality appraisal, dewatering, mixing and desalination.

10.5.6 The aim of the quality appraisal is to determine the chemical status, salinity and the degree of contamination by trace metals, organic pollutants, oils and tars of the dredged material. The analysis would focus on contaminants which are hazardous to human health or which are phytotoxic. The analytical results would be compared with established guidelines for soil contamination such as the Interdepartmental Committee on the Redevelopment of Contaminated Land (ICRCL) Guidance Note 59/83, Second Edition (Department of the Environment, U.K.). This Guidance Note established 'threshold' and 'action' trigger concentrations for potentially contaminated soils in relation to the proposed end use, in this case 'parks, playing fields and open space'.

10.5.7 The quality appraisal would also determine the engineering properties and classification of the dredged material in terms of moisture content, bulk density, shear strength, particle size, Index limits and mineralogy.

10.5.8 The slurry-like dredged material would be dewatered soon after deposition on land. Dewatering can be achieved through natural evaporation and drainage of thin layers (less than 1m thick) of the dredged material. The dewatering process can take 2 to 3 months or longer depending on factors such as climate, material type and layer thickness. The dewatered material is suitable for mixing and handling by earth-moving machinery prior to desalination.

10.5.9 All water arising during handling of the dredged material and during the dewatering process should be directed through settling ponds to remove suspended solids and prevent potential mud contamination of water draining from the site.

10.5.10 Following dewatering, the dredged material can be mixed with a variety of soil additives to enhance the soil skeleton and to increase soil permeability. The optimum mix ratio is dependent on the particle size of the source material and the required specifications of the soil product. A rotavator would be used to mix the dredgings with the soil additives.

10.5.11 The mixed soil must then be desalinated to provide a successful growth medium. Desalination is achieved through irrigation (by natural precipitation or through the use of sprinklers) combined with rotavation. Adequate drainage must be provided to remove the leached liquid. This can be achieved by providing a positive drainage gradient and ensuring that ponds of

irrigation water do not form on the surface of the soil. The leached liquid should be directed to settling ponds to remove suspended solids.

10.5.12 The resultant soil may require the addition of fertilisers to provide the nutrients essential for plant growth. Biological components such as bacteria and earthworms are essential for soil health and can be obtained from innoculums from topsoil removed during site clearance works and stockpiled for use in landscaping works.

10.5.13 The soil will be suitable for use either as topsoil or subsoil depending on the quality of the soil produced and the required end-use. A higher quality product will be required for areas to be planted extensively with shrubs and trees. A lower quality soil will be suitable for use as a subsoil or in areas which will be planted mainly with grass species. Plant growth in the areas in which the processed soil is used should be monitored to detect any nutrient or soil structure deficiencies.

10.6 Operational Waste Collection and Disposal

Introduction

10.6.1 The current Discovery Bay development generates 12.5 tonnes of waste per day for the population of nearly 12,000. 93% of this waste is domestic, 6% is commercial and 1% consists of vegetation from maintenance works. Approximately 650 kg of paper materials (cartons, newspapers etc.) and 4 kg of aluminum cans are collected daily by Discovery Bay Services Management Ltd. for recycling.

10.6.2 Upon completion of Master Plan 6.0(A), the total volume of domestic, commercial and vegetative waste which will be produced daily for the population of 25,000 is estimated to be approximately 26 tonnes.

10.6.3 Currently, domestic waste from low-rise blocks is bagged by the cleaners and placed in small containers provided at each block. Waste from high-rise blocks is placed in ventilated refuse rooms on the ground floor of individual blocks. Small trucks collect the bagged domestic waste and deliver it to one of 4 RCPs. Commercial waste is collected and delivered to the RCP adjacent to the central commercial plaza. The RCPs are totally enclosed concrete structures with mechanical ventilation.

10.6.4 Wastes are then transferred to the larger RCP near the vehicular ferry pier in Area 10b near Nim Shue Wan for transfer to a barge supplied by the Regional Services Department (RSD) and subsequent landfill disposal. All wastes are transferred to the barge within 24 hours of collection from the residential and commercial premises.

Proposed Waste Collection and Disposal Strategy

10.6.5 EPD is constructing a new Refuse Transfer Station on North Lantau which will accept waste arising from Discovery Bay in addition to waste from other developments on North Lantau. The North Lantau Refuse Transfer Station (NLRTS) will accept domestic, commercial, bulky and vegetative wastes from Discovery Bay, but not construction wastes. In addition, the NLRTS may accept recyclable materials such as paper and aluminum cans depending on the demand for such items. Waste will be compacted and containerised at the NLRTS and transferred by barge for landfill disposal.

10.6.6 It is therefore proposed that all municipal waste from Discovery Bay be transported to the NLRTS via the road and tunnel link included in Master Plan 6.0(A). Negotiations are currently underway between Hong Kong Resort Company Limited and RSD regarding the provision of a road based refuse collection service for Discovery Bay by RSD refuse collection vehicles (RCVs). The existing private recycling arrangement at Discovery Bay could be continued if the NLRTS contractor does not include a waste recycling process in the station.

10.6.7 Master Plan 6.0(A) will provide a new Refuse Collection Point adjacent to the roundabout on the Yi Pak tunnel portal approach road. A buffer distance has been provided between the new RCP and residential premises. The new RCP will supplement the existing RCPs. It is envisaged that the RSD's RCVs will collect the municipal waste generated within Discovery Bay from a series of small RCPs, rather than from one large facility. The design of the existing RCPs will be reviewed with regard to RSD's requirements for access, vehicle maneuvering and waste handling areas, cleaning facilities and environmental controls, as well as the HKPSG requirements for RCPs.

Potential Impacts at the Refuse Collection Points

10.6.8 The potential environmental impacts arising at the RCPs under the proposed waste collection scheme include:

- **air quality** impacts from RCV exhaust emissions, dust from waste handling and odour from the collected waste;
- **noise** impacts from collection vehicles, waste handling or ventilation systems;
- **visual** impacts of the RCP structures and litter;
- **water quality** impacts from washwater used to clean the RCPs and discharged to the foul sewer (may contain oils, organic material, silt, litter or spilled chemicals);
- **pests** such as rodents, birds and insects (flies, cockroaches and mosquitoes); and
- **traffic safety** implications of RCV movements.

10.6.9 These potential impacts will be minor due to the small size of the RCPs. Mitigation measures included in the design of the new RCP and the redesign of the existing RCPs will minimise any potential impacts to acceptable levels.

10.6.10 The strategy of waste collection from a series of RCPs is environmentally preferred to the possible plan of waste collection from one large RCP serving the whole of Discovery Bay. Collection from only one RCP would involve the storage and handling of a large volume of waste in a small area and would probably result in a greater environmental nuisance than collection from a series of smaller RCPs.

Mitigation Measures

10.6.11 The new RCP and the existing RCPs will include features to minimise any potential environmental impacts. These features and other mitigation measures include:

- total enclosure of the facilities to reduce odour, dust and noise emissions;
- vehicle exhaust ventilation systems to remove exhaust air produced by vehicles inside RCPs;
- odour absorption systems using activated charcoal to reduce odour emissions from the RCPs;
- rapid waste turnaround times to minimise odour generation;
- direction of ventilation system outlets away from surrounding sensitive uses;
- timetabling of waste delivery and collection times so as to minimise disruption to neighbours in terms of noise impacts and vehicle movements;
- maximisation of the setback of RCPs from surrounding sensitive buildings to reduce noise impacts;
- sensitive design of RCP structure and appearance so that they blend in with surrounding buildings;
- provision of landscaped areas to shield the RCP structures from view;
- the regular use of high pressure hoses to clean the RCPs and waste containers to maintain site hygiene and reduce odour;
- inclusion and regular maintenance of oil interceptors, silt traps and coarse screens in the channels draining RCPs to remove oils, dust and litter and to ensure that the washwater meets the standards for effluents discharged to foul sewers in the 1991 EPD Technical Memorandum 'Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters';
- spill plans to deal with any accidental spills within RCPs to prevent the potentially contaminating material entering the foul sewer;
- control of bird nuisance through careful building design to reduce perching sites, covering of RCP entrances, and the sealing of ventilation outlets with wire mesh;

- control of rodent nuisance through the sealing of all pipes with wire mesh and the use of baits and traps within the RCP structures;
- control of insects through regular spraying for cockroaches and careful design to avoid areas in which water can stagnate and provide a breeding ground for mosquitoes;
- regular facility inspection for bird and insect nests, rodent burrows and signs of gnawing;
- maintenance of a high standard of site cleanliness to reduce litter and dust and to prevent pest infestations; and
- the provision of safe and convenient vehicular access to maintain traffic safety and minimise traffic disruption.

Waste from Sewage Pumping Stations

10.6.12 The existing Discovery Bay Pumping Station No. 2 operates a sewage screening facility. The screenings are macerated, dehydrated and bagged for disposal. No odour nuisance results from this operation. The screenings from the proposed pumping facilities in Master Plan 6.0(A) will be treated in a similarly controlled manner and should not cause odour or other nuisance.

10.7 Conclusions

10.7.1 The following conclusions are drawn from the assessment:

- Approximately 1,010,000 m^3 of spoil will be generated as part of the Discovery Bay North development. The majority of the spoil will be clean material suitable for use in reclamation and platform creation.
- 150,000 m^3 of marine muds will be dredged for the construction of the sea wall and reclamation. The marine muds are not contaminated and will be used on site or disposed of at a suitable approved site.
- The main environmental impacts of the spoil activities relate to dust, noise and water quality impacts. These have been addressed in the relevant sections of this report and suitable controls identified. Any potential impacts can be reduced to acceptable levels.
- The contractor should prepare a comprehensive on-site waste management plan. The EM&A Team will monitor the storage, transport, collection and disposal of construction wastes to ensure good practice.
- The management of domestic waste from the whole of Discovery Bay would be improved and simplified as a result of the project. Export via the tunnel to the North Lantau RTS is consistent with the waste disposal strategy for Lantau.
- With the inclusion of appropriate controls and mitigation measures, the operation of the RCP and sewage screening facilities is not anticipated to results in adverse environmental impacts.

11.

ENVIRONMENTAL MONITORING AND AUDIT

11. Environmental Monitoring and Audit

11.1 Introduction

11.1.1 Environmental monitoring and audit (EM&A) procedures are essential in order to:

- ensure that any environmental impacts resulting from the construction and operation of Discovery Bay North are minimised or kept to acceptable levels;
- establish procedures for checking that mitigation measures have been applied and are effective, and that the appropriate corrective actions are undertaken, if and when required; and
- provide a means of checking compliance with environmental objectives, recording anomalies and documenting corrective action.

11.1.2 This section outlines the EM&A requirements in relation to noise, air quality, landscape/visual, ecology, water quality and waste impact mitigation management.

11.1.3 EM&A schedules for construction and operation of Discovery Bay North are provided for the necessary environmental parameters. EM&A schedules and requirements would be incorporated into the construction contract(s) in the form of environmental clauses.

11.2 Technical/Personnel Requirements

Responsibilities

11.2.1 Hong Kong Resort Company Limited will be responsible for ensuring that the EM&A requirements are met during construction and operation of Discovery Bay North.

Staffing

11.2.2 The EM&A work will be carried out by an independent environmental team consisting of suitably qualified and experienced personnel. The qualifications and experience of the EM&A personnel will be sent to EPD for information/comment. The Environmental Team Leader will report directly to the Site Manager. In addition to regular reporting on the EM&A findings, the team leader should take a pro-active approach and advise the Site Manager on potential problems and possible solutions on an *ad hoc* basis.

EM&A Manual

11.2.3 Hong Kong Resort Company Limited will be responsible for preparing an EM&A manual, the contents of which would be agreed with EPD. The contents would include the following:

- the programme for construction of Discovery Bay North and information on the operational phase of the development, together with the required construction and operation EM&A programmes;
- an overview of the potential environmental impacts and the rationale for the EM&A programmes;
- the location, frequency and type of EM&A requirements to assess the environmental impacts of the construction and operation of the project;
- the form/content of event/action plans (including any emergency plans where appropriate) for noise, air quality, landscape/visual, ecology and water quality impacts;
- review of pollution sources and working practices/procedures required in the event of environmental pollution levels being exceeded;
- compliance audit procedures and follow-up;
- the content/presentation of monitoring data and audit results and the actions taken with respect to non-compliance with established environmental pollution standards;
- appropriate report formats/frequency of submission/special event reports etc.;
- complaints/consultation procedures;
- monitoring equipment type, service records and calibration requirements; and
- the locations of sensitive receivers.

Reporting

11.2.4 A periodic EM&A report will be prepared by the independent environmental monitoring team and submitted to Hong Kong Resort Company Limited and simultaneously sent to EPD. The frequency of reporting would be agreed with EPD.

11.2.5 The report would be a relatively brief and concise account of the environmental monitoring during the previous period and would include a summary of:

- **Project Data** - a synopsis of the project organisation, project programme and management liaison structure;
- **Monitoring/Audit Requirements** - summary of monitoring parameters, Trigger/Action/Target Levels, Action Plans, environmental protection requirements in contract documents and engineering conditions;

- **Monitoring Methodology** - monitoring equipment used, locations and duration/frequency;
- **Monitoring Results** - parameter, date, time, environmental conditions, location etc.;
- **Audit Results** - review of pollution sources, working procedures in the event of non-compliance with environmental monitoring levels, action taken in the event of non-compliance and follow-up procedures related to earlier non-compliance actions;
- **Comments, recommendations and conclusions of monitoring** - general and specific comments and recommendations for the EM&A programme based on the results of monitoring;
- **Complaints** - liaison and consultation undertaken, subsequent action, database of telephone/written complaints, location of complaints, action plan and follow-up procedures etc.; and
- **Appendices** - to include drawings/tables of monitoring locations, sensitive receiver locations and EM&A requirements.

11.2.6 The EM&A reports would be supported by summary reports and would probably be submitted quarterly during the construction phase and annually during the operational phase.

11.3 Environmental Monitoring

General

11.3.1 Environmental monitoring falls broadly into two categories. The first is baseline monitoring which establishes the existing environmental conditions in the study area and provides the information to establish environmental impact thresholds and limits for the construction and operational phases of a project. The second monitoring category is compliance monitoring which is carried out during both the construction and operational phases to achieve the following general objectives:

- assessment of the performance of construction/operation activities in environmental terms;
- provision of an early warning of potential problem areas to permit timely remedial action and to identify any environmental impacts;
- compliance with appropriate standards and environmental objectives; and
- provision of reassurance to local communities.

11.3.2 As part of the EM&A programme, three categories of environmental parameter levels have been devised to monitor compliance with environmental objectives and to provide early warning of potential problem areas, thus ensuring the implementation of remedial action measures before the regulatory standards are reached. The three levels are:

- the **Trigger Level** which is a reference value to be used as an 'early warning' of a deterioration in environmental quality. Achievement of this level may lead to increased monitoring and preliminary investigation to identify any causes and possible remedial action;
- the **Action Level** which indicates that deterioration is significant and that urgent corrective action is required; and
- the **Target Level** which is the maximum permissible level which will achieve compliance with the appropriate regulatory standards, or other standards such as construction noise criteria outside restricted hours.

11.3.3 Construction monitoring for the proposed Discovery Bay North development will be required to measure noise levels, Total Suspended Particulate (TSP) levels for air quality, water quality and ecological parameters. In addition, monitoring will involve checking general working practices and compliance with the various control and mitigation measures identified in the IAR (HKR, 1994a) and in this report.

11.3.4 Operational monitoring will cover the effectiveness of landscape/visual and ecological mitigation measures for 3 years post-construction.

Environmental Monitoring Plan

11.3.5 A check list would be prepared by the monitoring team relating to each of the environmental issues. Together with environmental clauses in the contract documents, this check list will form the basis of a proforma for the environmental monitoring programme.

11.4 General Environmental Auditing

General

11.4.1 The purpose of environmental auditing is to review the effectiveness of the overall environmental protection programme (both construction and operation) in terms of monitoring, mitigation and corrective action. The audit process should not be divorced from general management activities and should promote a pro-active approach to environmental protection.

Construction Phase Auditing

11.4.2 Records of environmental monitoring would be maintained by the Site Manager and the environmental audit would seek to check:

- records of environmental monitoring procedures and results;
- that mitigation measures are being applied;
- records of exceedence of any regulatory requirements/target levels;
- details of control and mitigation action taken in response to unacceptable environmental impacts; and
- records of any complaints from residents/sensitive receivers in the study area and the actions taken once the complaints have been received.

11.4.3 Assessment of monitoring records will ensure that any unanticipated impacts are being addressed and that any improvements required for future monitoring programmes are identified.

Operational Auditing

11.4.4 The audit would be designed to assess the performance of the landscape/visual and ecological mitigation measures for the first 3 years of operation of Discovery Bay North. Auditing should verify the findings of the EIA and provide a mechanism for:

- reviewing the effectiveness of, and requirement for on-going monitoring programmes;
- reviewing environmental management practices in terms of achieving environmental objectives;
- ensuring that mitigation measures are being applied; and
- recommending improvements in environmental controls in the event that environmental objectives are not achieved and environmental impacts are unacceptable.

11.5 Noise Monitoring

Introduction

11.5.1 Noise monitoring at noise sensitive receivers (NSRs) will be performed during construction of Discovery Bay North. The purpose of construction noise monitoring is to ensure compliance with the guidelines for construction noise to minimise nuisance to neighbouring NSRs.

Monitoring Locations

11.5.2 The likely affected NSRs have been identified as the existing residential blocks including Greenvale Village, Parkridge Village, Parkland Drive, Seabee Lane and Headland Drive. At least two monitoring locations at the worst affected facades, which have direct line of sight of the work sites shall be selected for the construction noise monitoring (Figure 11.1). The measurement times shall be at least three times per week and chosen to fairly represent normal construction activities.

Monitoring Equipment

11.5.3 Sound level meters to be used shall comply with the International Electrotechnical Commission Publications 651:1979 (Type 1) and 804:1985 (Type 1). The sound level meter including the sound level calibrator shall be certified by the manufacturers every two years to show that the meters and calibrators have been undergone absolute calibration within the past two years prior to the noise measurement.

Monitoring Methodology

11.5.4 Prior to the construction works, baseline monitoring shall be carried to determine and agree ambient noise level. The baseline monitoring shall be carried out on normal working days with the approved instrument for a period of two weeks.

11.5.5 The construction noise measurement shall be made at 1m from the worst affected external facade of the NSRs. Immediately before and after each noise measurement, the sound level meter shall be checked with the approved calibrator. A drift exceeding the allowable limits of ±1 dB shall render the measurements invalid. The measurement shall be carried out on dry days with wind speed of not exceeding 5 m/s and 10 m/s in any direction for steady and gusty wind, respectively.

11.5.6 For construction noise, the $L_{Aeq(30min)}$ shall be measured during the unrestricted daytime on normal weekdays and the average of three consecutive L_{Aeq}(5min) shall be recorded during the restricted hours, at each of the agreed locations following the calibration and measurement procedures as described before.

Trigger, Action and Target Levels

11.5.7 The construction noise Trigger, Action and Target Levels are defined in Table 11.1.

Table 11.1 Construction Noise Trigger, Action and Target Levels

	Trigger Level	Action Level	Target Level
07.00 - 19.00 hrs on normal weekdays	When a complaint is received.	When more than one complaint is received within 2 weeks for the same event/location.	75 dB(A)
07.00 - 23.00 hrs on holidays; and 19.00 - 23.00 hrs on all other days	When a complaint is received.	When more than one complaint is received within 2 weeks for the same event/location.	60 dB(A)
23.00 - 07.00 hrs of next day	When a complaint is received.	When more than one complaint is received within 2 weeks for the same event/location.	45 dB(A)

Monitoring Schedule

11.5.12 The noise monitoring schedule is presented in Table 11.2.

Action Plans

11.5.13 On breaching of the Trigger, Action or Target Levels, appropriate action should be taken as described in the Noise Action Plan presented in Table 11.3.

Table 11.2 Construction Noise Monitoring Schedule

Parameter	Objective	Location	Frequency/Timing
$L_{Aeq\ (30\ min)}$	Compliance monitoring (non-restricted daytime hours)	NSRs	Minimum of 3 times per week between 07.00 and 19.00 hrs during general construction work; as appropriate during noisy activities.
$L_{Aeq\ (5\ min)}$	Compliance monitoring (restricted hours)	NSRs	Minimum of 3 times per week during work in restricted hours.
$L_{Aeq\ (30\ min)}$	Response to complaints (non-restricted daytime hours)	Complainant	As appropriate.
$L_{Aeq\ (5\ min)}$	Response to complaints (restricted hours)	Complainant	As appropriate.

Note : NSRs Noise Sensitive Receivers
N/A Not Applicable

Table 11.3 Construction Noise Action Plan

EVENT	ACTION	
	Monitoring Personnel	*Site Manager*
Breach of **Trigger Level** - when a complaint is received.	Notify Site Manager. Conduct measurement. Investigate noisy operations.	-
Breach of **Action Level** - when more than one complaint is received within 2 weeks or at the same location.	Notify Site Manager. Analyse investigation. Require Site Manager to propose measures for the analysed noise problem. Increase monitoring frequency to check mitigation effectiveness.	Submit noise mitigation proposals to Monitoring Team Leader. Implement noise mitigation proposals.
Breach of **Target Level** - 75 dB(A) exceeded between 07.00 - 19.00 hrs on normal weekdays 60 dB(A) exceeded between 07.00 - 23.00 on holidays, and 19.00 - 23.00 hrs on all other days. 45 dB(A) exceeded between 23.00 - 07.00 hrs of next day.	Notify Site Manager. Notify EPD. Require Site Manager to implement mitigation measures. Increase monitoring frequency to check mitigation effectiveness.	Implement mitigation measures. Prove to Monitoring Team Leader the effectiveness of measures applied.

11.6 Air Quality Monitoring

Introduction

11.6.1 The air quality monitoring programme will monitor TSP levels during construction of Discovery Bay North to ensure the effectiveness of dust control measures and to highlight any associated deterioration of air quality. The TSP monitoring and audit programme will be in accordance with the 1993 EPD Environmental Monitoring and Audit Guidelines for Dust Monitoring. Potential odour from the proposed sewage treatment/pumping stations will be monitored upon commissioning.

TSP Monitoring Locations

11.6.2 TSP monitoring will be performed near two representative air quality sensitive receivers. Monitoring Station 1 would be Greenbelt Court to the west of the Discovery Bay North site. Two additional high rise blocks are proposed for Area 7C under Master Plan 5.7. These blocks may be built and occupied before construction for Master Plan 6.0(A) begins. In this situation, Monitoring Station 1 would be Block 1 which is the more northerly of the two blocks.

11.6.3 Monitoring Station 2 would be near the existing low-rise housing on Parkland Drive to the south-west of the Yi Pak site. Both proposed monitoring locations are shown in Figure 11.1.

TSP Monitoring Equipment

11.6.4 High volume samplers would be used to determine 24 hour average TSP levels at the two monitoring locations. The high volume samplers would comply with the specifications included as Annex A of the 1993 EPD Environmental Monitoring and Audit Guidelines for Dust Monitoring.

11.6.5 As the operation of the high volume samplers is noisy and could be a source of nuisance to residents near the two monitoring locations, the samplers will probably be positioned on the roofs of Greenbelt Court (or Block 1 in Area 7C) and near a house on the northern end of Parkland Drive provided a source of power is available and access requirements are met. The samplers will be secure and stable in these locations, thus reducing the risk of interruption to the monitoring programme.

11.6.6 Hand held direct reading dust monitors would be used to measure 1 hour average TSP levels at the two monitoring locations. The hand held monitors would also be used to investigate complaints of high dust levels and to perform spot checks around the site.

11.6.7 The High Volume Samplers would be calibrated on a bimonthly basis using the traceable standard orifice place method in accordance with the 1993 EPD guidelines for dust monitoring. The hand held dust meters would be calibrated against the High Volume Samplers during the baseline monitoring and bimonthly thereafter.

Trigger, Action and Target TSP Levels

11.6.8 The 24 hour Trigger Level will be set at a value 30% above the 24 hour background TSP level established through baseline monitoring. The Action Level will be calculated as the average of the Trigger and Target TSP Levels. The Target Level will be the standard set in the Hong Kong AQO of a 24 hour average TSP concentration of 260 $\mu g/m^3$ and an annual average concentration of 80 $\mu g/m^3$.

11.6.9 The 1 hour Trigger Level will be set at a value 30% above the 1 hour background TSP level established through baseline monitoring. The 1 hour Action Level will be the average of the Trigger and Target TSP Levels. The 1 hour TSP Target Level will be set as 500 $\mu g/m^3$.

TSP Monitoring Schedule

11.6.10 The TSP monitoring schedule is presented in Table 11.4.

TSP Action Plans

11.6.11 On breaching of the Trigger, Action or Target TSP levels, appropriate remedial action should be taken as described in the TSP Quality Action Plan outlined in Table 11.5.

11.6.12 The TSP monitoring programme would include regular checks throughout the construction period to ensure that the mitigation measures for dust control are implemented. These mitigation measures include:

- the use of water sprays and bowsers at regular intervals in the active working areas of construction plant such as front end loaders, dozers and haul trucks;
- regular application of proprietary dust suppressants on all haul routes;
- vehicle speed limits - 25 km/hr on unpaved roads and in open areas, 40 km/hr on paved roads within the site;
- good site housekeeping;
- enclosure of material storage areas;
- erection of wind breaks around storage areas; and
- good construction practice, in particular for spoil and fill handling and transportation.

11.6.13 The monitoring team would inform the Site Manager if any of the mitigation measures were not being adequately implemented and would advise on the appropriate action to be taken.

Table 11.4 TSP Monitoring Schedule

Parameter	Objective	Location	Monitoring Equipment	Frequency/Timing
TSP	Baseline Monitoring	At Monitoring Stations 1 and 2 as illustrated in Figure 11.1.	High volume sampler Hand held direct reading dust monitor	Continuous 24 hr sampling for 2 weeks prior to construction. Three 1 hour samples every 3 days for 2 weeks. Samples would be taken at the times of the predicted peak periods of construction activity.
TSP	Compliance monitoring during construction.	At Monitoring Stations 1 and 2. Any relocation of the Monitoring Stations would first be agreed with EPD.	High volume sampler Hand held direct reading dust monitor	24 hour samples every 6 days. * Three 1 hour samples every 6 days. Samples would be taken at peak periods of construction activity.
TSP	Investigation of complaints during construction.	Site of complaint.	Hand held direct reading dust monitor	1 hour sample
TSP	Spot checks during construction (on a random basis).	Within site boundary.	Hand held direct reading dust monitor	1 hour sample

Note : * US EPA Ambient Air Quality Surveillance requirements as set out in Title 40 of the Code of the Federal Regulations, Chapter 1 (Part 50), Appendix B.

Table 11.5 TSP Action Plan

EVENT	FREQUENCY	ACTION	
		Monitoring Personnel	Site Manager
Breach of **Trigger Level**	One sample	Repeat measurement. Inform Site Manager.	Check construction methods/practices to identify source.
	More than one consecutive sample	Repeat measurement. Inform Site Manager and EPD.	Identify source and impose necessary mitigation measures.
Breach of **Action Value**	One sample	Repeat measurement. Inform Site Manager and EPD.	Identify source and impose necessary mitigation measures.
	More than one consecutive sample	Perform daily monitoring. Inform Site Manager and EPD. Request Site Manager to make additional proposals for dust suppression.	Identify source and review plant and equipment and working practices. Submit proposals for reducing dust to Monitoring Team Leader. Implement remedial action to reduce dust emissions immediately. Notify Monitoring Team Leader of action taken.
Breach of **Target Level**	One sample	Perform daily monitoring. Inform Site Manager and EPD. Request Site Manager to make additional proposals for dust suppression. Record events in monitoring report for submission to EPD.	Identify source and review plant and equipment and working practices. Submit proposals for reducing dust to Monitoring Team Leader. Implement remedial action to reduce dust emissions immediately. Notify Monitoring Team Leader of action taken. Provide investigation report.
	More than one consecutive sample.	Perform daily monitoring. Inform Site Manager and EPD. Request Site Manager to make additional proposals for dust suppression. Record events in monitoring report for submission to EPD.	Identify source and review plant and equipment and working practices. Submit proposals for reducing dust to Monitoring Team Leader. Implement remedial action to reduce dust emissions immediately. Notify Monitoring Team Leader of action taken. Provide investigation report. Stop the relevant portion of work as necessary as determined by the Monitoring Team Leader.

TSP Monitoring Contingency Plans

11.6.14 Sufficient technical and supervisory staff, monitoring equipment and laboratory facilities for the air monitoring programme will be available throughout the construction period for Discovery Bay North. Backup resources will be available to minimise the risk of illness, equipment failure or theft interrupting the monitoring programme.

11.6.15 The two fixed monitoring stations will be located on or close to buildings managed by a subsidiary of Hong Kong Resort Company Limited. As a result, the monitoring stations will be accessible to the monitoring team and security will be provided by Hong Kong Resort's site security personnel.

11.6.16 Adverse weather conditions are unlikely to affect the monitoring programme. The programme may be interrupted when typhoon signal 3 or above is raised. Under these conditions, however, construction activity would be reduced or stopped and precipitation would reduce TSP levels.

Sewage Odour Monitoring

11.6.17 Following commissioning, the sewage pumping stations will be inspected monthly for 6 months by the Environmental Monitoring Team to determine if sewage odour is at a level likely to cause offense outside the pumping station boundary. Odour inspections will also be carried out in response to complaints and will be performed at the pumping station boundary and at the site of the complaint. The degree of odour nuisance will be determine subjectively by the monitoring team and recommendations for remedial action made if necessary.

11.7 Landscape/Visual Monitoring

Introduction

11.7.1 The landscape/visual monitoring programme will monitor the success of the measures taken to mitigate the visual and landscape impacts of the proposed Discovery Bay North development. Landscape impacts refer to effects upon the physical characteristics and components which make up a landscape, while visual impacts refer to changes to a landscape which alter individual receptor group views of the landscape.

11.7.2 The landscape impact of the proposed development will be considerable in that most key landscape features of the site will be obliterated (the existing mangrove) or substantially altered (the streams). Moreover, the character of the site as a whole will be changed from essentially open and undeveloped to suburban residential. This replacement of an open green area with a residential development will also entail considerable visual impacts upon visual receptors in the area.

11.7.3 Landscape and visual mitigation measures include recreation of the main Yi Pak stream along an altered course and compensation for loss of the mangroves through creation of a new mangrove mudflat either to the south or to the north of the site. Another major component of the visual and landscape impact mitigation measures is strategic landscape planting. Trees and shrubs, as they mature, will reduce the obtrusiveness of the man-made elements in the development by partially screening them and by allowing the development to blend to some extent into the surrounding countryside.

11.7.4 Monitoring of the landscape/visual impact mitigation measures will therefore have a number of objectives:

- to assess the success of the recreation of landscape elements such as the stream and mangroves in mitigating impacts of loss of the original elements;
- to assess the success of the landscape plantings in landscape/visual impact mitigation; and
- to identify necessary modifications to ongoing mitigation measures or the need to adopt new mitigation measures.

Identification of Visual Sensitive Receptors

11.7.5 Visual impact can be categorised in terms of the following factors:

- quality of the existing view;
- degree of change that will occur to the existing view;
- availability of alternative views;
- period of exposure to view;
- proximity of receptor groups;
- size of receptor groups; and
- sensitivity of receptor groups.

11.7.6 The proposed development is sited in a bowl-shaped depression, surrounded on three sides by hills and on the fourth by the coast. Two groups of high-rise residential blocks (Greenvale Village and Parkridge Village) are situated upslope immediately behind the development. A group of low-rise residences extends along the coast immediately to the south of the site (Headland Drive, Parkland Drive and part of Seabee Lane). These residential areas lie closest to the site and comprise the largest single receptor group. Residents in these areas overlooking the site currently enjoy unobstructed green views and are considered to be high sensitivity receptors who will be subject to the most severe visual impacts from the development.

11.7.7 Visual receptors who will be affected to a lesser extent will include recreational users of the hillside areas above and around the development, and marine vessels in Discovery Bay.

11.7.8 Recreational users of the surrounding hills are primarily hikers and walkers, especially at weekends. While the hills do not lie within a Country Park boundary, they are in close proximity to a large number of residences and consequently form a recreational amenity of great value to the Discovery Bay community. The area is particularly valuable for the open views available from the ridgeline, both south and east toward Discovery Bay and Hong Kong Island and north and west toward the mainland. Thus these users, in view of their numbers and degree of sensitivity to the quality of the views, should be considered sensitive visual receptors. However, due to their shorter period of exposure, as compared to residents of nearby blocks, they are considered to be medium rather than high sensitivity receptors.

11.7.9 Ferry passengers, fishing vessel operators and recreational water users within the Tai Pak Wan visual envelope will constitute the third group of visual receptors. Due to their shorter period of exposure, farther distance from the site, and lower sensitivity to the view, they are classed as low sensitivity receivers.

11.7.10 Once the development is complete and the new residences, playgrounds and parks and other facilities are in use, the issue of visual receptors within the development site will arise. It is anticipated that the most important visual issues for these receptors will relate to outward views toward older phases of the Discovery Bay development, for example the high-rise blocks that constitute the Greenvale Village group.

Methodology

11.7.11 The success of landscape impact mitigation measures will be monitored through periodic visual and photographic inspection of new and modified landscape elements, comparison with baseline visual and landscape data and assessment of whether these fulfil the landscape functions of elements that have been modified or lost.

11.7.12 Monitoring of the success of visual impact mitigation measures will require definition of the visual envelope for the site and selection of a number of key viewpoints within this envelope (see Figure 6.1). First-hand visual assessment will be made from these viewpoints, supported by colour photographs taken from these sites.

11.7.13 Key viewpoints will be selected as close as possible to identified sensitive receptors. Table 11.6 identifies probable viewpoint sites, to be finalised during the initial round of monitoring.

Table 11.6 Monitoring Viewpoint Sites

Receptor Group	Viewpoint Site
Residents in Greenvale and Parkridge Villages	On top of blocks and immediately in front of blocks.
Residents on Headland and Parkland Drives	In vicinity of residences and affected open recreational areas.
Recreational users of hills surrounding site	On ridgelines and intermediate points on slopes overlooking site.
Vessel traffic in bay	Vessel in Tai Pak Wan within visual envelope of site.
Residents and recreational users within development site	Open recreational areas and vicinity of residence blocks on site.

11.7.14 Monitoring will take place on a semi-annual basis. A six month interval is considered adequate to allow perceptible growth of vegetation between rounds of monitoring. It also allows for assessment of the effects of seasonal phenomena such as tree and shrub flowering.

11.7.15 The monitoring programme will continue for three years in order to track the growth of vegetation and progressive integration of the new development into the surrounding area, and to provide a basis for the proposal of further mitigation measures as required.

11.7.16 For both landscape and visual impact monitoring, baseline data will be collected prior to commencement of construction in order to provide a basis for comparison.

11.7.17 A summary of the operation landscape and visual monitoring requirements is presented in Table 11.7.

Table 11.7 Operational Landscape/Visual Monitoring

Objective	Location	Frequency/Timing
To monitor success of recreation of landscape elements e.g. diverted Yi Pak stream, mangrove restoration area, in mitigating landscape/visual impacts.	Key viewpoints identified in Table 11.6.	Every 6 months for 3 years.
To monitor success of strategic landscaping plantings in mitigating landscape/visual impacts.	Key viewpoints identified in Table 11.6.	Every 6 months for 3 years.

11.8 Ecological Monitoring and Audit

11.8.1 The ecological EM&A plan will monitor the effectiveness of the mitigation proposals presented in Section 7. These proposals include:

- mitigation of impacts to mangrove/estuarine resources through the creation of a mangrove estuary;
- mitigation of impacts to fisheries resources through the construction of rock/boulder shore at the seawall and the creation of mangrove estuary;
- mitigation of impacts to terrestrial/avian ecological resources through revegetation of disturbed areas and adjacent upslope woodlands/ shrublands, revegetation for enhancement of areas of the Sam Pak catchment and relocation of the Black-eared Kite nest; and
- mitigation for loss of Yi Stream through restoration of the stream channel.

Mangrove/Estuarine Ecological Resources

Monitoring of Construction of Mangrove Mudflat

11.8.2 Construction of the replacement mangrove area will involve the following steps (described in detail in Section 7):

- creation of a seawall;
- installation of tide and freshwater control structures; and
- filling behind the seawall with suitable dredged spoil.

11.8.3 The engineering design of the seawall and tide control structure is beyond the scope of this report and will be addressed during the detailed design phase of the development. However, as the functions of these two elements are critical to the long-term success of the mangrove mitigation project, they must be carefully monitored to ensure proper control of freshwater runoff and tidal input to the mudflat. Equally important, the design must ensure that sediments placed behind the seawall remain in place and are not washed away by normal tidal erosion or exceptionally erosive conditions such as typhoons and other storms.

11.8.4 Due the propensity of the Yi Pak and Sam Pak beaches to accumulate solid waste, the tide control structure will require the added capability of excluding litter from the created estuary. The design and installation of this litter control feature should also be monitored.

11.8.5 During the course of the detailed design and construction of the seawall and tide and litter control features for the mudflat, an experienced mangrove restoration ecologist should provide input to engineers and designers. As recommended in Section 4, levels of the existing mangroves at Yi Pak Wan should be surveyed to provide the appropriate range for levels of sediment to be placed behind the created seawall. As this step will be critical to sediment placement and because sediment levels in the existing mangrove at Yi Pak

Wan can only be determined accurately prior to disturbance, this process must be monitored carefully before the onset of intensive surface disturbance.

11.8.6 The sediments most suitable for use as a mangrove planting substrate would be those currently located in the Yi Pak Wan mangrove stand. Whether these or other dredged sediments are used, it is critically important that sourcing, dredging and placement processes be monitored by an experienced mangrove restoration ecologist. During this process, the ecologist should be on site full time.

11.8.7 Routing of the stream supplying freshwater to the created mangrove area will also be important to the success of the mitigation project. Ideally, the stream would follow a sinuous path rather than a straight path through the mudflat. The creation of the stream channel during the sediment placement process should be monitored carefully.

Monitoring of Propagule Planting, Survival and Growth

11.8.8 Following construction of the mangrove substrate, the process of mangrove restoration will begin. Supervision and monitoring must be conducted during the following stages of habitat restoration:

- sourcing mangrove propagules;
- planting; and
- replacement of propagules if necessary.

11.8.9 Mangrove propagules may be sourced from a variety of locations and should be carried out by an experienced mangrove restoration ecologist. Purchase from outside sources may also be required for species for which propagules are impossible to source locally. Consideration must be given to seasonality of propagule availability.

11.8.10 Planting should be monitored to ensure replication of the existing Yi Pak Wan species abundance ratios as far as possible. The total mangrove area and species relative abundance at Yi Pak Wan will guide the design of a planting scheme for the created mangrove area. Again, planting should be carried out and monitored by experienced mangrove restoration ecologists.

11.8.11 Survival and growth of planted propagules should be monitored quarterly for the first three years following planting and then at 6 month intervals for an additional two years (Lewis, 1990a). This regime is adequate to achieve the required level of detail in survival and growth data recording.

11.8.12 Replacement of propagules which do not survive should be conducted annually during spring and summer seasons when propagules are available. Replanting should be done as early as possible in spring to ensure the greatest possible length of growing season for propagule establishment.

Invertebrate Colonisation of Mudflat Substrate

11.8.13 Sampling should start as soon as the mudflat substrate deposition is complete and the area is ready for mangrove planting. The sampling should continue quarterly for 2 years.

11.8.14 Sampling stations should lie along a transect running from the high to low shore. Samples may be taken by driving a square, sheet-aluminium frame of 0.25 m^2 into the substratum to a depth of 20cm, and should be taken during low spring tide. Once epifauna has been collected and crabs removed from their burrows, the quadrat can be excavated and the samples picked over by hand or seived using a 1mm mesh (Sasekumar, 1984).

Boulder Shore Monitoring

11.8.15 Quantitative data on the colonisation of the restored boulder shore can be obtained through the use of belt transect surveys. General information can be gained through broader qualitative surveys. Surveys should be carried out during spring tides on a quarterly basis for 2 years.

11.8.16 Two permanent transect lines will be set up running from the upper shore to spring low tide. Flexible quadrats of 0.1 m^2 will be used at suitable intervals from high to low eulittoral levels to record the colonisation of the rock surfaces by intertidal organisms. In the case of smaller animals such as barnacles, the quadrat area will be sub-sampled with a 0.01 m^2 perspex square subdivided into 10mm squares. Estimates will be made of crevice-living species. Photographic records will be made of each quadrat frame along the transects from a standardised position. This will support data gained from enumeration and identification of species and will record any algal growth.

Terrestrial Ecological Resources

Revegetation Monitoring

11.8.17 Plans for restoration of vegetation are included in Sections 3 and 4 of this report. Six categories of vegetation are proposed for restoration within and surrounding the project site. The vegetation should be monitored at 6 month intervals to assess survival and growth for 3 years post-transplantation.

11.8.18 Survival and growth monitoring should be based on sampling plots or on individually number tagged plants (trees). On upland sites upslope from the development, fixed plots will be established to document survival of planted trees and shrubs and to monitor colonisation. Plots should measure 5 x 5m. On sites within the development, trees will be selectively number tagged to maintain individual records of growth and survival. Sampling results will be used as a guide for plant replacements and additional horticultural management. Sampling should be conducted by an experienced plant ecologist.

Revegetation for Enhancement of Sam Pak Catchment

11.8.19 A 0.3 ha hillside/riparian site in the Sam Pak catchment has been recommended as a site for intensive revegetation to mitigate the overall impacts due to the loss of estuarine woodlands at Yi Pak Wan.

11.8.20 The revegetation works should be monitored closely to ensure that planting takes place as quickly and effectively as possible and maximises the potential for habitat enhancement through the use of indigenous species. Revegetation at this site should be monitored at 6 month intervals to assess the survival and growth of planted trees.

Fauna

11.8.21 Relocation of the Yi Pak Black-eared Kite nest to the Sam Pak valley should be undertaken prior to the onset of any construction works. Timing of the relocation should be monitored to ensure that the Kite breeding season is avoided. Installation of the new nest structure should be supervised and monitored by a biologist who is on site at the time of the relocation. Following nest relocation, monitoring should be conducted twice monthly from November to May to document occupancy and record the success of any breeding attempts.

11.8.22 The presence of the Brown Fish Owl at Yi Pak Wan should be monitored prior to construction. If continued use of Yi Pak Wan is documented, particularly for breeding, AFD should be consulted regarding the actions to be taken.

11.8.23 Avifaunal use of the created mangrove and former nursery area should be monitored monthly between December and June each year to document winter and breeding season bird use. Monitoring should begin following completion of planting on the created mangrove mudflat as it is assumed that the construction project will largely preclude bird use of the area. Monitoring should continue through the construction period in the Sam Pak valley as this area will receive the relocated Black-eared Kite nest and may also support a breeding pair of Collared Scops Owls. It is also possible (but highly unlikely) that Brown Fish Owls would use the Sam Pak Wan area following the beginning of construction at Yi Pak Wan.

Yi Pak Stream Restoration

11.8.24 The Environmental Monitoring Team should oversee the restoration of the main Yi Pak stream with particular regard to channel geometry, sediment and water regimes and the restored riparian plant community. The success of recolonisation by native aquatic plants and animals should be determined and suitable species should be introduced if self-colonisation does not occur.

Other Monitoring Tasks

11.8.25 The Environmental Monitoring Team should monitor the effectiveness and integrity of fences erected to protect areas of woodland and shrubland not required for project construction. In addition, the team should check with the Site Manager that fire fighting plans have been developed and that manual fire fighting is readily available on site.

11.8.26 A summary of the ecological EM&A requirements is included in Table 11.8.

Table 11.8 Ecological Monitoring

Objective	Location	Frequency/Timing
Supervision of mangrove mudflat construction.	Mangrove restoration site.	During construction of seawall, installation of tide and freshwater control structures, filling behind seawall with dredged sediment, and during propagule planting.
Monitoring success of mangrove planting.	Mangrove restoration site.	Every 3 months for first 3 years following planting, then every 6 months for an additional 2 years.
Monitoring invertebrate colonisation of mangrove substrate.	Mangrove restoration site.	Sampling to start once mudflat construction is complete and area is ready for planting. Sampling to occur every 3 months for 2 years.
Monitoring of colonisation of boulder shore.	Restored boulder shore.	During spring tides every 3 months for 2 years.
Monitoring success of landscape revegetation plantings.	Planting sites.	Monitoring at 6 monthly intervals for 3 years post-planting.
Monitoring avifaunal use of site.	Mangrove restoration area and Sam Pak catchment revegetation site.	Monthly between December and June for two years, starting after mudflat restoration and Sam Pak site replanting is complete.
Monitoring Black-eared kite use of site.	Black-eared kite nest relocation site in Sam Pak valley.	Twice monthly from November to May for the first year post Black-eared kite nest relocation.

11.9 Water Quality Monitoring

Baseline Monitoring

11.9.1 The proposed locations for baseline monitoring are shown in Figure 11.1 and the monitoring schedule is given in Table 11.9. Station W4 will be the control station under mid-flood conditions (tidal flows from south to north). Station W5 will be the control station under mid-ebb conditions (tidal flows from north to south). The stations will be used in combination according to the dredging location. This monitoring should be completed at least one month prior to the commencement of construction.

Construction Phase Monitoring

11.9.2 The construction works which may have a significant impact on marine water quality are considered to be the dredging and reclamation works. The parameters to be tested (turbidity, suspended solids, dissolved oxygen) reflect the potential impacts from these activities.

11.9.3 The transport and disposal of dredged sediment within the site will be overseen by the Environmental Monitoring Team to ensure that any loss to marine water is kept to a minimum through the implementation of proper material handling methods.

11.9.4 The monitoring personnel will also oversee any on-site dredged sediment processing. Discharges from settlement ponds draining the processing area will be regularly inspected and pH and suspended solid levels in the effluent will be monitored monthly during processing activities to ensure compliance with the WPCO objectives.

Methodology

11.9.5 Salinity, turbidity, dissolved oxygen and pH would be measured *in situ* using a Hydrolab. Suspended solids, inorganic N, orthophosphate and *E. coli* will be analysed at a HOKLAS approved laboratory (or equivalent). The aesthetic appearance would be determined qualitatively by the environmental monitoring team who would inspect for the presence of litter, scum, oil, unusual water colour etc.

Action Plan

11.9.6 The Water Quality Action Plan should be followed by the monitoring personnel and contractor/operator to facilitate appropriate and immediate responses by relevant personnel in the event that the Trigger, Action and Target Levels are attained or exceeded. In order to assess the potential impacts associated with dredging, consideration is given to Suspended Solids, Turbidity and Dissolved Oxygen. The Water Quality Action Plan is outlined in Table 11.10. Table 11.11 defines the Trigger, Action and Target levels adopted for the water quality monitoring programme.

Table 11.9 Marine Water Quality Monitoring Schedule

PARAMETER	OBJECTIVE	LOCATION	FREQUENCY/TIMING
Aesthetic Appearance SS, DO Salinity Inorganic N Orthophosphate *E.coli* Turbidity	Baseline assessment	Designated monitoring and control stations * - 1m below surface - mid level - 1m above sea bed	Prior to commencing construction, 4 times/week for 4 weeks, at mid-ebb and mid flood.
Turbidity, SS, DO	Impact monitoring	Designated monitoring and control stations * - 1m below surface - mid level - 1m above sea bed	3 times/week during marine dredging works, construction of the sea wall and deposition of fill material behind the sea wall. Once these works are complete, DO, SS and turbidity will be monitored once per month.
Salinity Inorganic N Orthophosphate *E.coli* Aesthetic appearance	Compliance monitoring	Designated monitoring and control stations * - 1m below surface - mid level - 1m above sea bed	Once per month.
pH and SS	Impact monitoring	Effluent from settlement ponds draining sediment processing area	Monthly during sediment processing works.

Note : * At monitoring station <8m in depth, only surface and bottom samples will be taken.
SS = Suspended Solids.
DO = Dissolved Oxygen measured using a Hydrolab unit to determine both % DO saturation and absolute quantity (mg/l) of DO.

Table 11.10 Water Quality Action Plan

EVENT	FREQUENCY	ACTION	
		Monitoring Personnel	Site Manager
Breach of **Trigger Level**	One sample	Inform Site Manager.	Rectify unacceptable practice.
	Two or more consecutive samples	Repeat measurement to confirm findings. Identify source(s) of impact. Inform Site Manager. Check monitoring data, all plant, equipment and contractor's working methods. Discuss mitigation measures with the Site Manager. Assess effectiveness of mitigation measures.	Rectify unacceptable practice. Check all plant and equipment. Consider change of working methods. Discuss mitigation measures with Environmental Team Leader. Implement mitigation measures.
Breach of **Action Level**	One sample	Repeat measurement to confirm findings. Identify source(s) of impact. Inform Site Manager. Check monitoring data, all plant, equipment and contractor's working methods. Discuss mitigation measures with the Site Manager. Assess effectiveness of mitigation measures. Repeat measurement on the next day of exceedance.	Rectify unacceptable practice. Check all plant and equipment. Consider change of working methods. Discuss mitigation measures with Environmental Team Leader. Implement mitigation measures.
Breach of **Action Level**	Two or more consecutive samples	Repeat measurement to confirm findings. Identify source(s) of impact. Inform Site Manager. Check monitoring data, all plant, equipment and contractor's working methods. Discuss mitigation measures with the Site Manager. Ensure mitigation measures are implemented and assess effectiveness.	Rectify unacceptable practice. Check all plant and equipment. Consider change of working methods. Discuss mitigation measures with Environmental Team Leader within 3 working days. Implement mitigation measures.

Table 11.10 Water Quality Action Plan (continued)

		Prepare to increase monitoring frequency to daily. Repeat measurement on the next day of exceedance.	
Breach of **Target Level**	One sample	Repeat measurement to confirm findings. Identify source(s) of impact. Inform Site Manager, EPD and AFD. Check monitoring data, all plant, equipment and contractor's working methods. Discuss mitigation measures with the Site Manager. Ensure mitigation measures are implemented and assess effectiveness. Increase monitoring frequency to daily until no exceedance of Target Level.	Rectify unacceptable practice. Check all plant and equipment. Review critically the working methods. Discuss and agree the mitigation measures with Environmental Team Leader within 3 working days. Implement mitigation measures.
Breach of **Target Level**	Two or more consecutive samples	Repeat measurement to confirm findings. Identify source(s) of impact. Inform Site Manager, EPD and AFD. Check monitoring data, all plant, equipment and contractor's working methods. Discuss mitigation measures with the Site Manager. Ensure mitigation measures are implemented and assess effectiveness. Increase monitoring frequency to daily until no exceedance of Target Level for 2 consecutive days.	Rectify unacceptable practice. Check all plant and equipment. Review critically the working methods. Discuss and agree the mitigation measures with Environmental Team Leader within 3 working days. Implement mitigation measures. Consider and instruct, if necessary, the contractor to slow down or to stop all or part of the marine work until no exceedance of Target Level.

Table 11.11 Trigger, Action and Target Levels for Water Quality

Parameter	Trigger Level	Action Level	Target Level
Dissolved Oxygen, DO, mg/L (surface, middle and bottom)	Surface & Middle: DO<5%ile of baseline data for surface and middle layer Bottom: DO<5%ile of baseline data for bottom layer	Surface & Middle: DO<1%ile of baseline data for surface and middle layer Bottom: DO<1%ile of baseline data for bottom layer	Surface & Middle: <4 mg/L Bottom: <2 mg/L
Suspended Solids, SS, mg/L (depth averaged)	SS>90%ile of baseline data and SS>110% upstream control station's SS at the same tide of the same day	SS>95%ile of baseline data and SS>120% upstream control station's SS at the same tide of the same day	SS>99%ile of baseline data and SS>130% upstream control station's SS at the same tide of the same day
Turbidity, Tby, NTU (depth averaged)	Tby>90%ile of baseline data and Tby>110% upstream control station's Tby at the same tide of the same day	Tby>95%ile of baseline data and Tby >120% upstream control station's Tby at the same tide of the same day.	Tby>99%ile of baseline data and Tby>130%upstream control station's Tby at the same tide of the same day

Note: Depth averaged is calculated by taking the arithmetic means of readings at all three depths.

For monitoring locations less than 8m in depth, only surface and bottom samples would be taken.

11.10 Construction Waste Monitoring

11.10.1 The contractor should prepare a comprehensive on-site waste management plan which will include the storage, transportation and disposal measures recommended in Section 10. The EM&A team will monitor the arrangements for waste minimisation and management procedures to ensure good practice and will inform the Site Manager should additional measures be required.

819 000 N

818 500 N

818 000 N

819 000 E

819 500 E

820 000 E

N

A1

A2

W1

W2

W3

W4

W5

Greenvale Village

Parkland Drive

Parkridge Village

Headland Drive

Seabee Lane

Key

A1	Air Monitoring Station 1
A2	Air Monitoring Station 2
W1-3	Water Monitoring Stations 1-3
W4-5	Water Control Stations 4 and 5

0 100m

Figure 11.1
Monitoring Locations

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REFERENCES

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APPENDIX 1

Discovery Bay Extension
Environmental Impact Assessment (EIA) Study Brief

1. Introduction

1.1 The purpose of this EIA Study is to provide information on the nature and extent of environmental impacts arising from the construction and operation of the proposed Discovery Bay Extension and all related activities taking place concurrently. It will include provision of a tunnel link from Discovery Bay to the utility road next to the North Lantau Expressway, will involve minor reclamation, and development of a integrated residential community with a range of support services. This information will contribute to decisions on :

i) the overall acceptability of any adverse environmental consequences that are likely to arise as a result of the proposed project;

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

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

1.2 No approval should be given to the proposed development unless it can be demonstrated quantitatively that no unacceptable environmental impacts will result from its implementation.

2. Objectives of the Environmental Impact Assessment Study

2.1 The objectives of the assessment are as follows:

i) to describe the proposed development, identify the location of the development and the requirements for carrying out the development;

ii) to identify and describe the elements of the community and environment likely to be affected by the proposed development, and/or likely to cause adverse impacts upon the proposed development including both the natural and man-made environment;

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

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

v) to propose the provision of practical and cost-effective mitigation measures so as to avoid or minimize pollution, environmental and ecological disturbance and nuisance during construction and operation of the development;

vi) to identify, predict and evaluate the residual (i.e. after practicable mitigation) environmental impacts and cumulative effects expected to arise during the construction phases of the Discovery Bay Extension in relation to the sensitive receivers, potential affected uses, potential north Lantau country park extension and its visitors.

vii) to identify, assess and specify methods, measures and standards, to be included in the detailed design and construction of the project(s) which are necessary to mitigate these impacts and reduce them to acceptable levels;

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

ix) to investigate the extent of side-effects of proposed mitigation measures that may lead to other forms of impacts; and

x) to identify constraints associated with the mitigation measures recommended in the study.

3. Requirements of the Environmental Impact Assessment Study

3.1 The Consultants shall meet all the objectives listed in section 2 above by:

i) carrying out the necessary background studies to identify, collect and analyze existing information relevant to the EIA study;

ii) carrying out any necessary environmental survey, field sampling, laboratory testings and analysis, site investigations and baseline monitoring work to achieve the objectives;

iii) Identifying and evaluating the cumulative impacts of the proposed development and other developments. e.g. the Lantau Port Development and Peng Chau Effluent Export Scheme in the vicinity during construction and operation of the development.

iv) quantifying, by use of models or other predictive methods, the residual and cumulative environmental impacts (specifying whether these are transient, long term and/or irreversible) arising from the construction, operation (and decommissioning) of the project(s);

v) proposing practicable, effective and enforceable methods, measures and standards to effectively mitigate any significant environmental impacts in the short and long term; and

vi) outlining a programme by which the environmental impacts of the project(s) can be assessed, monitored and audited.

3.2 The proponent and consultants shall liaise with relevant Government Departments and agencies, their consultants and all other parties involved in this development and any other projects or developments likely to be affected by these developments.

4. Technical Requirements of the Environmental Assessment Study

4.1 The content of this study should consider, but not be limited to, the following:

i) Noise Impact

Noise impacts are concerned primarily with noise from internal noise, utilities, plant and machinery operation, other background noise and the Lantau Port Development. The consultant shall carry out, where necessary, any further elaboration or assessment in addition to the noise impact assessment reports that have been previously submitted to demonstrate quantitatively that the noise impacts from road traffic and the Lantau Port Development are within the standards laid down in Hong Kong Planning Standards and Guidelines. Detailed assessment should be carried out for the preferred layout. Suitable land use layout, building design and other technical measures should be recommended for inclusion in the development.

ii) Air Quality Impact

Air quality impacts from the proposed development will include construction dust/machine emission during the construction phase. The impacts during the operational phase will include traffic emission impacts from road traffic and tunnel portals/ventilation shafts, odour impacts from the sewerage system and any sewage treatment facilities, and the air quality within the vehicular tunnel.

The study will require assessment on the possible plume impingement problem on the high-rise residential towers of the proposed development due to the chimney emission of the Penny's Bay power station.

The air quality impact assessment shall address the following:

(a) existing and background air quality in the study area for the purpose of evaluating the cumulative air quality impacts of the proposed project;

(b) identification of representative receptors and/or potential affects uses; the locations of the representative sensitive receptors and/or potential affected uses should be agreed with the Director of Environmental Protection;

(c) provision of an emission inventory of the air pollution sources;

(d) analysis of construction activities and related adverse air quality impacts;

(e) analysis of operational activities (after commissioning), its related air quality impacts (including the associated traffic air quality impacts due to noise enclosures and noise barriers) and characterization;

(f) assessment and evaluation of the net an cumulative air quality impacts of the air emissions identified in (c) at the receptors identified in (b) by dispersion modelling. The Consultant should provide detailed methodology statement and key assumptions of the selected model such as emission factors and other input parameters etc. to the Director of Environmental Protection for comment and consent before the commencement of the study. For evaluation of dust impact from construction activities, Fugitive Dust Modelling (FDM) is usually preferred. The report should contain sample calculations and input parameters used in modelling. Air pollution Isopleths should be provided as output of the study;

(g) proposals of effective mitigation measures to reduce the cumulative air pollution impacts to acceptable levels.

In case of odour impact, any odour prediction at a receptor exceeding five odour units based on a prediction averaging time of five seconds shall be considered as an indication of odour nuisance to the receptor. For odour monitoring, two odour units at the site boundary shall be the criteria for odour nuisance.

iii) <u>Water Issues</u>

(a) Water and Sediment Quality
information and analysis of the existing water systems and sediments. Characterization of water and sediment quality. Identification of all sensitive receivers, and evaluation of all existing and future activities that would affect the water systems and sensitive receivers. Evaluation of the cumulative impacts of the proposed development and other projects such as the Lantau Port Development. Proposals of measure to minimize impacts and evaluation of the residual impacts with respect of the water quality objectives, criteria and standards.

(b) Dredging and Reclamation
identification, quantitative prediction and evaluation of all impacts associated with dredging , fill extraction, reclamation and dumping activities on the water system, sediment and sensitive receivers and mitigation proposals.

(c) Stormwater Drainage
review of existing drainage system and evaluation of the adequacy of the proposed drainage plan to cope with the development. Quantification of the pollutant loads of the stormwater, evaluation of the impacts on the water system and sensitive receivers, and mitigation proposals.

(d) Sewage Disposal
The assessment shall estimate the requirements for sewage disposal of the overall development at discovery Bay and develop a cost effective scheme to accommodate this consistent with government's strategy and programme for sewage treatment.

These plans are expected to utilise the proposed tunnel to facilitate export of sewage from discovery bay to the Sui HO Wan sewage treatment plant. This analysis will be required to address programme, operational and safety issues, including the use of the tunnel for sewage connections.

As the ultimate plans for Sui Ho Wan sewage treatment works have already assumed acceptance of the existing sewage load from Discovery Bay, and the additional load will be minor in the context of the total sewage load at the plant, it is not considered necessary to undertake WAHMO modelling of the effect of the additional load effluent load on the receiving waters of North Lantau. However, it is still necessary to evaluate the impacts of the additional flow and load on the Siu Ho Wan plant and outfall and the receiving water.

An interim sewage treatment scheme, which adequately addresses the water quality issues and environmental impacts, will be developed and implemented before the sewage from the proposed development is exported to Siu HO Wan. The assessment should include the following two scenarios:

i) The sewage diversion to Siu Ho Wan STW is implemented in late/end 1997; and

ii) The sewage diversion to Siu Ho Wan STW is implemented after 1997.

(e) Landuse and infrastructural development
identification of all major landuse and infrastructural development proposals that would affect the water systems and evaluation of their impacts. Proposals to minimize these impact to an acceptable level.

iv) Ecological Impacts

The proposed project should take into account the importance of ecological components for natural flora/fauna habitats in Hong Kong. It is essential to observe the importance of protecting, rehabilitating and maintaining the natural environment. In particular, the proposed project(s) should avoid locations in the vicinity of Sites of Special Scientific Interests, Sites of Special Archaeological Interest and other sensitive areas. The assessment shall focus on the following:

a) Review the existing information relevant to the proposed development;

b) identification and quantification as far as possible of any direct/indirect and onsite/offsite impacts that lead to the destruction, displacement or adverse effect on flora, fauna and natural habitats (such as, loss of shelter and food, reduced species diversity, loss of breeding ground(s), loss of wetland, loss of fisheries, species extraction, loss of carrying capacity); and

c) evaluation of the impacts and proposals for any mitigation measures.

v) Visual and landscape Impact

A complete 'Visual and landscape Impact Assessment' shall consist of the following major elements:

a) identification of visual envelope and sensitive receivers or viewpoints;

b) illustrations of the proposed development by photomontage and/or scale model;

c) elaboration on visual impacts of proposed developments to individual receivers & identification of the most affected views.

d) identification of the landscape impacts and illustration of the proposed landscape treatment.

vi) Construction Activities

The extent of construction activities including dredging, reclamation and the tunnel should be identified. The extent of contamination of marine muds should be determined and suitable proposals made for treatment/disposal.

vii) Solid Waste Pollution

Solid waste assessment shall focus on:

a) identification of the sources of solid waste (including municipal waste, construction waste) with details of the waste generation, waste characterization and waste separation;

b) collection of existing solid waste arising data in discovery bay and forecast the growth of the future waste arisings,

c) investigation on any secondary impacts such as, odour, gas emission;

d) evaluation of the proposed waste management strategy, which include waste handling, treatment, disposal methods, temporary and emergency waste transfer arrangement.

e) identification of site(s) for handling refuse based on the recommended waste management strategy;

f) assessment of environmental impacts and identification of mitigation measures for the proposed waste management strategy;

g) incorporation of waste reduction/reuse/recycling by any practical means.p

4.2 The assessment shall be carried out in accordance with the following criteria:

i) Reference shall be made to the Environmental Chapter of the "Hong Kong Planning Standards and Guidelines" and other relevant Ordinances, Regulations, Technical Memoranda and guidelines.

ii) The methodology of the assessment used including dispersion models, input parameters, receptor locations and meterological conditions, etc., should be agreed with the Director of Environmental Protection. Cost-effective mitigation measures, for situations where the predicted cumulative pollution levels exceed the acceptable levels shall be proposed.

5. Environmental Monitoring and Audit (EM&A) Requirements

i) Environmental Monitoring

The Consultants shall identify and recommend environmental monitoring requirements for all construction, post-project and operational phases of the development. These requirements shall include but not be limited to the identification of sensitive receivers, monitoring locations, monitoring parameters and frequencies, monitoring equipment to be used, and any other necessary programmes for baseline monitoring, impact and compliance monitoring, and data management of monitoring results.

ii) Environmental Audit

The Consultants shall identify and recommend environmental audit requirements for all construction, post-project and operational phases of the development. These requirements shall include but not be limited to:

a) organisation and management structure, and procedures for auditing of the implementation of respective environmental mitigation measures recommended for the detailed design, contract document preparation, construction, post-project operation stages of the development;

b) environmental quality performance limits for compliance auditing for each of the recommended monitoring parameters to ensure compliance with relevant environmental quality objectives, statutory or planning standards, or acceptance criteria recommended by the EIA. These limits shall give indication of a deteriorating environmental quality and shall allow proactive responses to be taken. (The commonly used approach is a set of trigger, action and target levels);

c) organisation and management structure, and procedures for reviewing the monitoring results and auditing the compliance of the monitoring data with the environmental quality performance limits (point (b) above), project contractual and regulatory requirements, and environmental policies and standards;

d) Event/Action plans for impact and compliance monitoring;

e) complaints handling, liaison and consultation procedures; and

f) reporting procedures, report formats and reporting frequency including periodical reports and annual reviews to cover all construction and post-project/operational phases of the development.

iii) The Consultants shall prepare an Environmental Schedule (Manual) which covers the requirements and recommendations in (i) and (ii) above. The Manual shall also contain a summary list of recommended environmental mitigation measures. This Manual shall be used as a guideline for environmental monitoring and audit during the construction and post-project operational phases. This Manual shall be a stand-alone document and form part of the EIA report.

6. Liaison and Administration

6.1 The study will be managed by a Study Management Group chaired by a representative of DEP. This shall be the forum for liaison with Government departments and agencies, providing guidelines to the study consultant, and for comment and review on the work and outputs of the study. All secretarial services will be provided by the consultants.

6.2 In accordance with PELB G/C 2/92, the Final EIA Report and Executive Report should normally be made available to the public. The confidential or public security issues shall be prepared in separate appendices which can be removed prior to public release. The consultants may be required to attend meetings for presentation of the study results to Advisory Council on Environment, District Boards, Regional Council etc.

6.3 In accordance with PELB TC 2/92, if there is any disagreement on the findings of the Initial Environmental Impact Assessment or on the necessary environmental protection and pollution control measures, the issue will be referred to the Secretary for Planning, Environment and Lands who shall resolve the differences in consultation with the appropriate Branches and Department.

7. Report Requirements

7.1 The assessment shall consist of at least the following :

i) an **Initial Assessment Report** which

a) provides an initial assessment on the nature and cumulative extent of environmental impacts arising from the proposed development. The *IAR* shall be of sufficient details to conclude whether there are any insurmountable environmental impacts associated with the proposed strategy and to identify all the key issues to be assessed in the next stage of the study.

b) defines measurable environmental parameters and environmental features likely to be affected by the proposed project and identifies the environmental monitoring programmes which are required both to provide a baseline profile of existing environmental conditions and to monitor impacts and compliance during construction of the proposed project;

ii) **Key Issue Reports** covering those issues of key concern identified through the Initial Assessment Report or the review of the Initial Assessment Report by the Director of Environmental Protection. These include noise, air pollution, waste, construction, sewage disposal, water quality, stormwater drainage, visual impact and ecology.

iii) a **Final Assessment Report** which

a) fully satisfies the requirements of this brief in respect to the prediction and assessment of impacts, the identification of environmental impact mitigation measures and the associated residual impacts;

b) describes the agreed schedules and programmes for monitoring and audit requirements;

c) prescribes the specification for detailed design, construction and operation requirements of the proposed project(s) (in any case, the projected decommissioning scenario(s) should be addressed and outline the action(s) to restore and/or rehabilitate the site(s) to an acceptable level prior to handing over to Government or any legal successor(s)); and

d) provides with the impacts summary, the study findings, conclusions, recommendations and a mechanism for implementation;

iii) an **Executive Summary** in both English and Chinese of the study, highlighting the issues of concern to the community, the acceptability of residual environmental impacts and cumulative effects, requirements for implementation of the project(s), and the basis for and implications

of those requirements. It is intended that the information contained therein would assist the Government in undertaking ACE, DB and other public consultation(s);

iv) all working papers comprising Key Issue Report and Final Assessment Report should be prepared and submitted in draft to the Director of Environmental Protection for comment; and

v) any revisions or supplements to the above as might be required by the Director of Environmental Protection.

7.2 The Proponent shall produce the following reports to the Director of Environmental Protection:

i)	a draft Initial Assessment Report	30 copies
ii)	a final Initial Assessment Report	30 copies
iii)	a draft Key Issue Report	30 copies
iv)	a final Key Issue Report	30 copies
v)	a draft Final EIA Report	30 copies
vi)	a Final EIA Report	80 copies
vii)	a draft Executive Summary Report	30 copies
viii)	an Executive Summary Report*	150 copies
xi)	an Environmental Monitoring & Audit Manual	30 copies

* in both Chinese and English versions.

7.3 More copies of the reports may be required by the Director of Environmental Protection if necessary.

7.4 The Proponent shall also supply the government with appropriate copies of such reports, technical notes, working papers, briefs, supporting documents and other relevant inputs as may be required during the EIA Study or any public consultation exercise.

8. <u>Green Measures</u>

The recommended green measures in preparing documents by the consultants should include:

a) All Reports, Technical Notes and Working Papers are to be printed on both sides.

b) Final Reports and the Executive Summary have to be printed, as far as possible, on recycled paper with no less than 50% recycled materials. The logo of recycled paper should be printed in a prominent area of the report.

- END -

APPENDIX 2

APPENDIX 2 DUST EMISSION RATES

Blasting

The quantity of TSP generated by a single blasting operation on the top of Yi Pak Hill was estimated by (AR-42)

E (emission rate) = $344 \cdot A^{0.8}/(D^{1.8} M^{1.9})$ kg/blast

where A (area blasted) = 210 m^2
D (hole depth) = 6m
M (moisture content) = 2%

E = $344210^{0.8} / (6^{1.8} 2^{1.9})$
= 595 kg/blast

Assuming work is carried out over 10 months, 26 days a month and 12 hours a day,

E = 0.0032 $g/m^2/sec$

Transport of Material

The quantity of dust generated by trucks hauling material from the top of Yi Pak Hill to fill sites was estimated by (AP-42).

E (emission rate) = $k\ (1.7)\ (s/12)\ (S/48)\ (W/2.7)^{0.7}\ (w/4)^{0.5}\ (365-p)/365$ kg/VKT

where k (dimensionless particle size factor) = 0.8
s (silt content of road surface) = 9%
S (mean vehicle speed) = 20 km/hr
W (mean vehicle weight) = 26 tonnes
w (mean number of wheels) = 6
p (number of days per year with at least 0.254 mm of precipitation) = 100

E = $0.8\ \ 1.7\ (9/12)\ (26/2.7)^{0.7}\ (6/4)^{0.5}\ (365-100)/365$
= 1.84 kg (VKT)

There is approximately 750,000 m^3 (1,500,000 tonnes) to be moved over 10 months, 26 days a month and 12 hours per day. Thus,

E = 0.14 g/m/s

Loading/Unloading Operations

The emission from dropping fill onto the ground or a truck were estimated by (AP-42, fifth edition).

$E = Q \cdot 0.72^{w} U^{w}$

where $Q = k\,(0.0016)\,(U/2.2)^{1.3} / (M/2)^{1.4}$

w is wind factor

k (particle size multiplier) = 0.74

M (moisture content) = 2%

U is wind speed measured at Cheung Chau at a height of 92m. This needs to be reduced to the average height at Discovery Bay of 25m by (25/92) 0.25 = 0.72 m/s

Q = 0.00027 kg/tonne

Over 10 months, 26 days/month at 12 hours/day and over an area of 24,200 m^2,

E = 0.0000017 $g/s/m^2$

Tunnel Blasting and Tunnel Material Transport

The TSP concentrations for the blasting were calculated in a similar manner as described above with the following parameters:

A (area) = 96 m^2
D (blast depth) = 3m
M (moisture content) = 7.2%

For the transport of material from the tunnel to the reclamation areas, it was assumed that there was approximately 36,650 tonnes of material to be moved.

Reference

"Compilation of Air Pollutant Emission Factors" AP-42 Fourth Edition and Draft of Fifth Edition, *US Environmental Protection Authority.*

APPENDIX 3

Hong Kong Resort Company Limited

Discovery Bay Development

Master Plans 6.0 and 6.0(A)

Discovery Bay North

Sediment Quality Report

Axis Environmental Consultants Limited

June 1995

TABLE OF CONTENTS

1. Introduction

1.1 Background

1.1.1 Hong Kong Resort Company Limited has submitted their proposed Discovery Bay Master Plan 6.0 development for consideration by the planning authorities. The Master Plan 6.0 proposal includes dredging and reclamation works in Yi Pak Wan and Sam Pak Wan to extend the developable area. Approximately 350,000 m^3 of marine muds were to be dredged from the site of the reclamation and seawall under Master Plan 6.0.

1.1.2 Following comments by the project's Study Management Group, the Master Plan 6.0 proposal has been revised and submitted as Master Plan 6.0(A). The Discovery Bay North component of the project now lies within the Hong Kong Resort Company Limited's lease boundary and the area of the reclamation has been reduced. Approximately 150,000 m^3 of marine muds will now be dredged in the Master Plan 6.0(A) proposal.

1.1.3 AXIS Environmental Consultants Limited was commissioned in March 1995 to determine the quality of the surface sediments in the area of the reclamation as required by the Master Plan 6.0 EIA Study Brief issued by EPD. The presence of contaminated marine sediments would have implications for the disposal or appropriate end uses of the dredged material. This study will determine if the surface sediments are contaminated with toxic metals. Further sampling and analysis may be required if the sediments are found to be contaminated.

1.2 Study Objectives

1.2.1 The objectives of the marine sediment study are:

- to determine the quality of the surface marine sediments in the site of the proposed reclamation with respect to toxic metal contamination;
- to classify the marine sediments according to the EPD Technical Circular No. 1-1-92 (see Appendix 1); and
- to identify any constraints on the potential end uses of the dredged sediments as landscaping materials or in the formation of a mangrove mudflat at Yi Pak Wan.

1.3 Report Structure

1.3.1 In addition to this introductory section, this report consists of the following four sections:

- **Section 2** which describes the site's location and potential contamination status;
- **Section 3** which outlines the sampling and analytical methodology;
- **Section 4** which presents and interprets the analytical results; and
- **Section 5** which presents the conclusions of the study.

2. Site Description

2.1 Location

2.1.1 The Discovery Bay North development will extend northwards into Yi Pak and Sam Pak from the northernmost section of the existing Discovery Bay development. The location of the site in the context of North Lantau is shown in Figure 2.1. The site boundaries of the Discovery Bay North development (including the limit of the reclamation) under Master Plan 6.0 and the revised Master Plan 6.0(A) are shown in Figure 2.2.

2.2 Extent of Potential Contamination

2.2.1 A survey of the site and surrounding area indicated that there are no localised land based point sources of toxic metals near the Discovery Bay North development site. Potential sources of metal contaminants include the marine waters entering the Discovery Bay area, which may carry contaminated material from other parts of the Territory, and the unauthorised dumping of wastes from marine vessels.

2.2.2 Given the land use characteristics of the surrounding area, it is anticipated that the marine sediments underlying site of the proposed reclamation will be classified as Class A sediments, i.e. uncontaminated material, according to the EPD Technical Circular No. 1-1-92 (see Appendix 1).

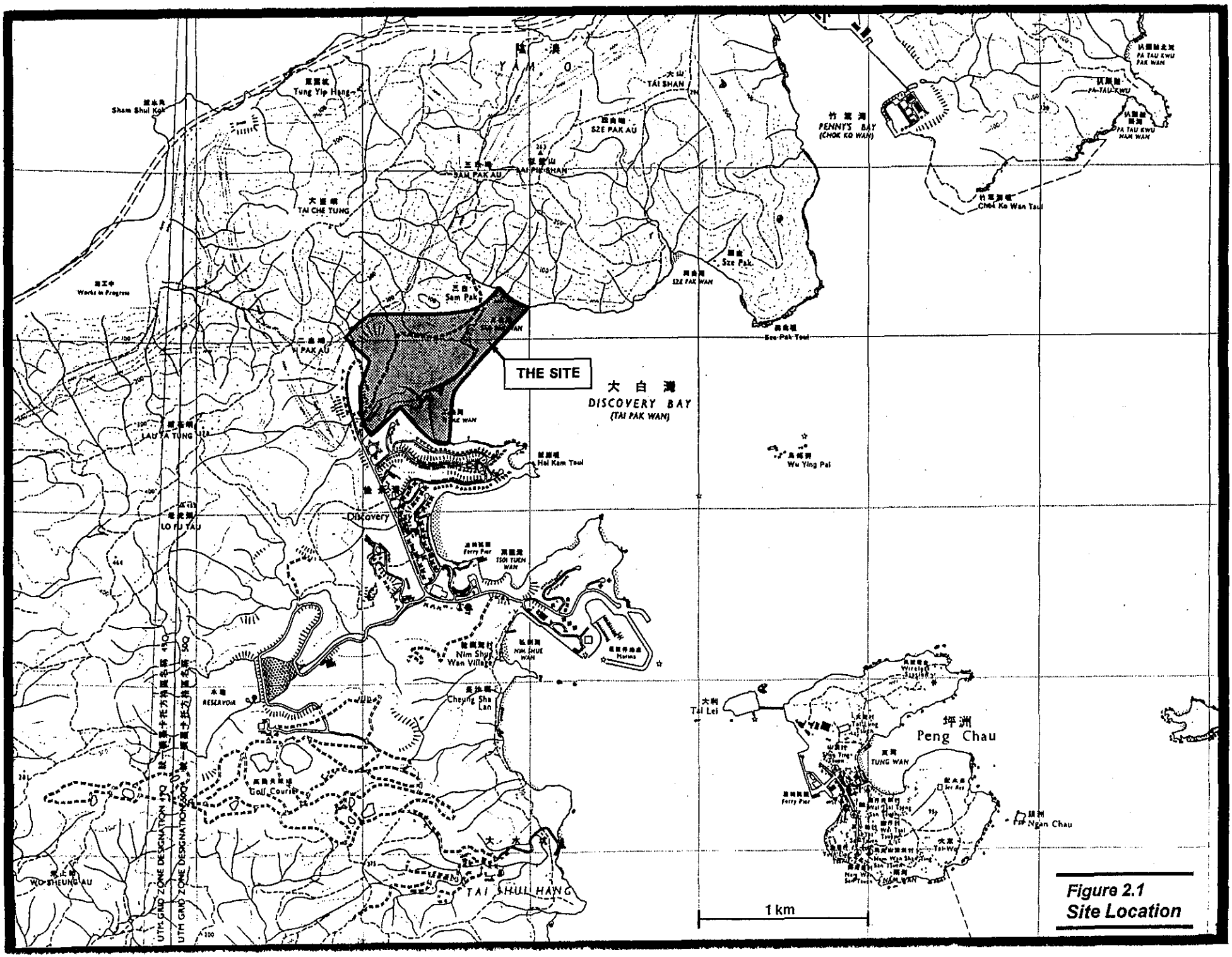

Figure 2.1
Site Location

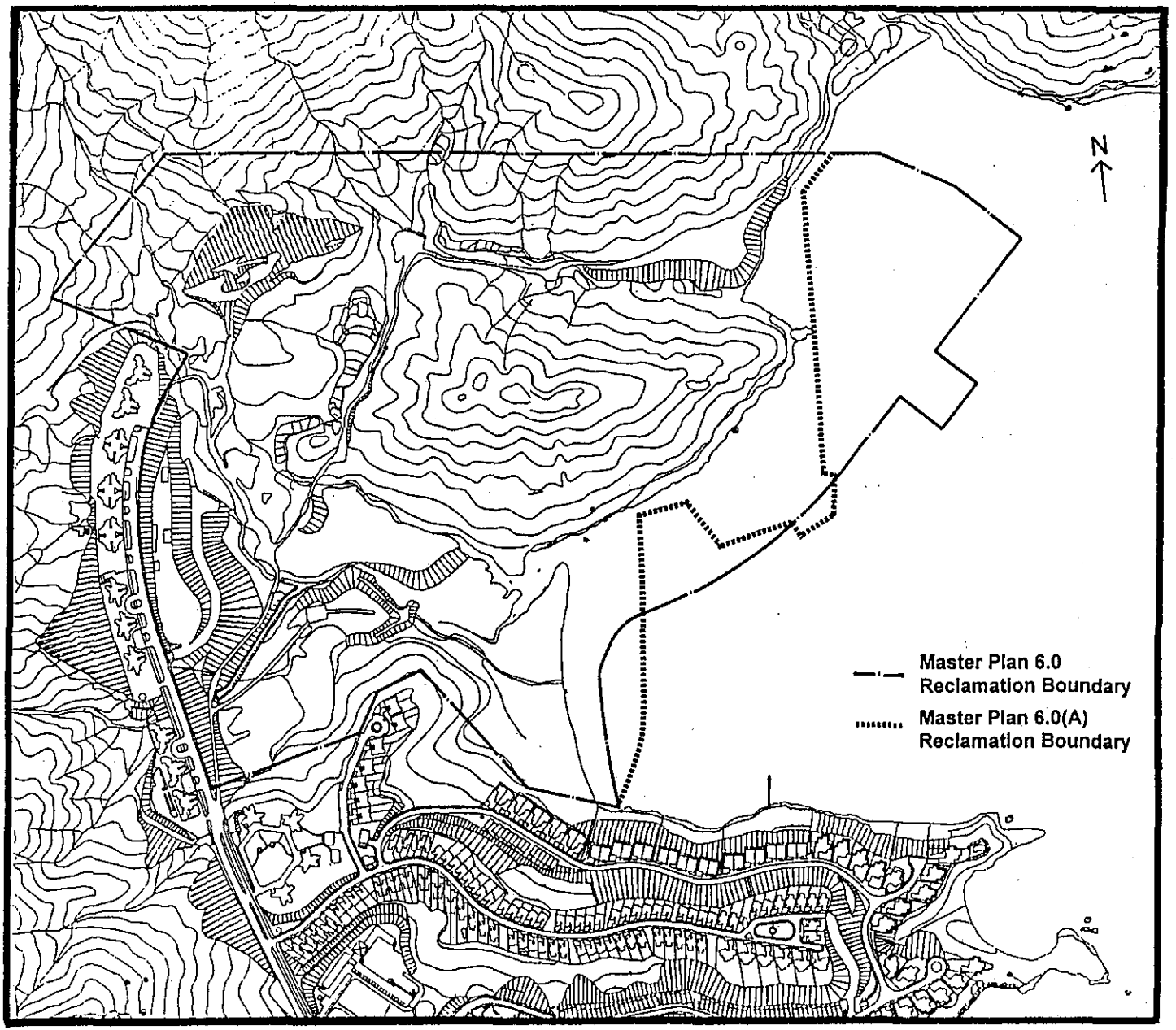

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Figure 2.2
Reclamation Boundary - Master Plans 6.0 and 6.0(A)

3. Methodology

3.1 Introduction

3.1.1 The investigative methodology followed the guidelines in Appendix A of the 1993 Practice Note for Authorised Persons entitled 'Marine Disposal of Dredged Mud' (Buildings Ordinance Office, 1993). The methodology was based on the collection of grab samples of the surface marine sediments.

3.2 Sampling Locations

3.2.1 Twelve surface sediment samples on a 100m grid were collected using a sediment grab sampler on May 5, 1995. The sampling locations are shown in Figure 3.1.

3.2.2 Records were made during sampling of the depth and wet weight of the collected sediments. The sampling was performed at high tide. The sediments were described according to the methods in the Geoguide 3 'Guide to Rock and Soil Descriptions' (Geotechnical Control Office, 1988). The sampling logs are included as Appendix 2.

3.3 Chemical Analysis

3.3.1 The sediment samples were analysed to determine the concentration (mg/kg dry weight) of the following metals:

- cadmium;
- chromium;
- copper;
- mercury;
- nickel;
- lead; and
- zinc.

3.3.2 The analysis was performed by MateriaLab Limited, a HOKLAS accredited Hong Kong laboratory. The analytical method statements are included as Appendix 3.

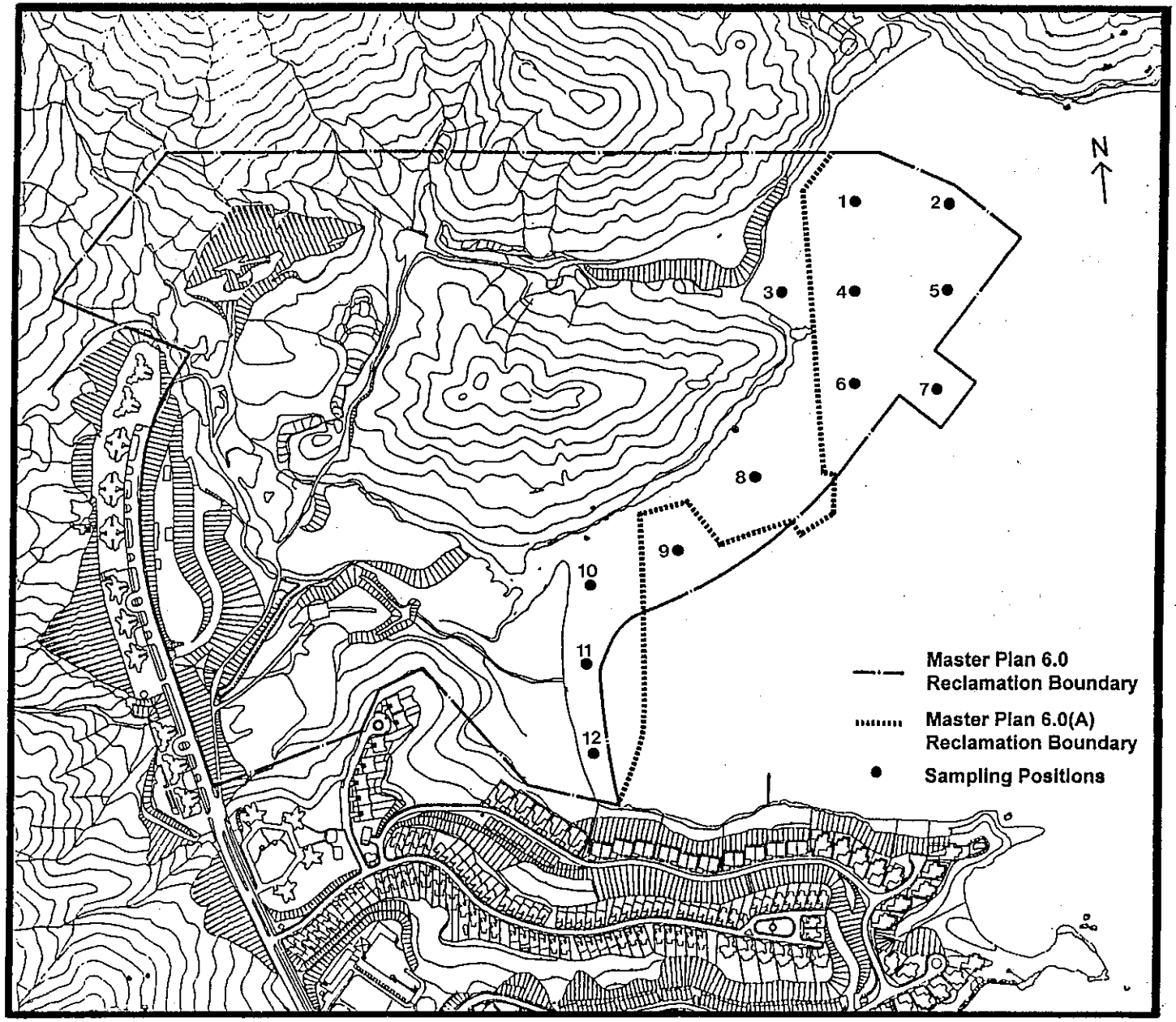

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Figure 3.1
Sampling Locations

4. Results

4.1 Introduction

4.1.1 The full analytical results have been collated and assessed with reference to:

- the appropriate guidelines on contaminated sediments and land;
- the positions of the sampling locations; and
- the proposed disposal/end-uses of the dredged sediments.

4.2 Guidelines and Standards

4.2.1 The sediment samples have been classified by metal content according to the criteria used in the EPD Technical Circular 'Classification of Dredged Sediments for Marine Disposal' (Appendix 1).

4.2.2 The dredged sediments may be used in landscaping works within the Discovery Bay North development and in the creation of a mudflat restoration area at Yi Pak. In order to assess the significance of any contamination with respect to these proposed end-uses, the analytical results have been compared with the standards in the EPD guidelines on 'Contaminated Land Assessment and Remediation' (EPD, 1994) which are based on the Dutch standards on contaminated land.

4.2.3 The results have also been evaluated with reference to the established guidelines on soil contamination prepared by the Interdepartmental Committee on the Redevelopment of Contaminated Land (ICRCL) in the Department of the Environment, U.K. The ICRCL and the Dutch standards are included for reference as Appendix 4.

4.3 Analytical Results

4.3.1 The concentrations of metals (mg/kg dry weight) in the samples are shown in Table 4.1.

Table 4.1 Results of Chemical Analyses

Sample	Dry Weight Ratio (dry weight: wet weight)	Cd mg/kg	Cr mg/kg	Cu mg/kg	Hg mg/kg	Ni mg/kg	Pb mg/kg	Zn mg/kg
1	0.66 : 1	<0.2	5.1	7.2	<0.05	1.9	16	24
2	0.66 : 1	<0.2	13	13	<0.05	6.1	25	37
3	0.77 : 1	<0.2	2.9	5.1	<0.05	<1	12	20
4	0.62 : 1	<0.2	3.2	6.2	<0.05	1.1	12	18
5	0.67 : 1	<0.2	10	9.9	<0.05	4.5	20	38
6	0.67 : 1	<0.2	8.7	10	<0.05	5.1	24	34
7	0.56 : 1	<0.2	19	21	0.15	9.1	37	69
8	0.61 : 1	<0.2	12	14	<0.05	6.5	33	52
9	0.72 : 1	<0.2	3.7	5.3	<0.05	1.2	23	22
10	0.78 : 1	<0.2	3.5	3.0	<0.05	<1	20	19
11	0.76 : 1	<0.2	3.6	5.1	<0.05	1.1	18	18
12	0.70 : 1	<0.2	3.9	5.1	<0.05	<1	17	25

4.4 Interpretation of Results

4.4.1 All of the samples can be classified as Class A sediments with respect to the levels of cadmium, chromium, copper, mercury, nickel, lead and zinc. The concentrations of these metals in the samples are well within the range specified for Class A. Class A sediments consist of uncontaminated material and do not require special dredging, transport or disposal arrangements.

4.4.2 Sediment from sampling location 7 contained the greatest concentrations of all the tested metals when compared with the other samples. Even so, the concentrations were in the middle of the range specified for Class A sediments.

4.4.3 All the samples contained levels of cadmium, chromium, copper, mercury, nickel, lead and zinc which were much lower than the threshold ICRCL trigger levels for these metals. The ICRCL guidelines specify the threshold concentrations of cadmium, chromium, mercury and lead which apply to soils for domestic garden or allotment end-uses and the threshold concentrations of these metals in soils for park, playing field or open space end-uses. The ICRCL threshold concentrations for copper, nickel and zinc apply to soils

which will support plant growth. Levels of copper, nickel and zinc above these threshold concentrations may be phytotoxic.

4.4.3 The concentrations of cadmium, chromium, copper, mercury, nickel, lead and zinc were also lower than the Level A values in the Dutch standards for soil contaminants, indicating that there is no demonstrable contamination in the sampled sediments with respect to these metals.

4.4.4 Thus, the sampled sediments did not contain levels of cadmium, chromium, copper, mercury, nickel, lead or zinc that would require special dredging or material handling techniques. The metal content of the sediments would not preclude their use in landscaping works or in the formation of a mangrove mudflat.

5. Conclusions

5.1 Survey Results

5.1.1 The marine site investigation undertaken by AXIS Environmental Consultants Limited in May 1995 has demonstrated that the surface marine sediments at the site of the proposed reclamation under Master Plans 6.0 and 6.0(A) are Class A sediments, or uncontaminated material, as specified by the EPD technical circular on the 'Classification of Dredged Sediments for Marine Disposal' (Appendix 1). In addition, the surface sediments are uncontaminated by cadmium, chromium, copper, mercury, nickel, lead or zinc when evaluated with reference to established guidelines on contaminated land.

5.1.2 No special dredging or material handling techniques will be required during construction works for the reclamation other than the normal measures to avoid the resuspension of dredged material. The dredged sediments will be suitable for use in landscaping works and as a substrate for the proposed mangrove restoration area at Yi Pak Wan.

5.2 Recommendations

5.2.1 Given the results of this sediment quality study and the land use characteristics of the surrounding area, it is proposed that no further analysis of the sediments within the Discovery Bay Master Plan 6.0 or 6.0(A) site boundary is necessary.

REFERENCES

Buildings Ordinance Office, 1993. *Marine Disposal of Dredged Mud.* Practice Note for Authorized Persons and Registered Structural Engineers 155. Buildings Ordinance Office, Hong Kong.

EPD, 1994. *Contaminated Land Assessment and Remediation.* Practice Note for Professional Persons, PN 3/94. Environmental Protection Department, Hong Kong.

Geotechnical Control Office, 1988. *Guide to Rock and Soil Descriptions.* Geotechnical Engineering Office, Civil Engineering Department, Hong Kong.

Ref : EP 100/C10/16

Environmental Protection Department
28/F., Southorn Centre
130 Hennessy Road
Wanchai, Hong Kong.

9 November 1992

ENVIRONMENTAL PROTECTION DEPARTMENT

TECHNICAL CIRCULAR NO. (TC) NO 1-1-92

Classification of Dredged Sediments for Marine Disposal

1. In fulfilment of my responsibility as the designated officer under paragraph 2(1) in Schedule I of the Dumping at Sea Act 1974 (Overseas Territories) Order 1975, I wish to notify you that dredged sediments will be classified as indicated below for the purpose of issuing licences under the Act. This circular should be read in conjunction with the Works Branch Technical Circular No. 22/92 - Marine Disposal of Dredged Mud which outlines the procedures to be followed in all works, whether public or private, which involve the marine disposal of dredged sediments.

2. Sediments will be classified according to their level of contamination by toxic metals. The classes are defined as follows :

Class A — Uncontaminated material, for which no special dredging, transport or disposal methods are required beyond those which would normally be applied for the purpose of ensuring compliance with EPD's Water Quality Objectives, or for protection of sensitive receptors near the dredging or disposal areas.

Class B — Moderately contaminated material, which requires special care during dredging and transport, and which must be disposal of in a manner which minimizes the loss of pollutants either into solution or by resuspension.

Class C — Seriously contaminated material, which must be dredged and transported with great care, which cannot be dumped in the gazetted marine disposal grounds and which must be effectively isolated from the environment upon final disposal.

3. The classification criteria for contamination levels are laid down in Table A. It should be noted that it is necessary for the concentration of only one metallic element to be exceeded for sediments to be identified as falling within a particular class.

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

	Cd	Cr	Cu	Hg	Ni	Pb	Zn
Class A	0.0-0.9	0-49	0-54	0.0-0.7	0-34	0-64	0-140
Class B	1.0-1.4	50-79	55-64	0.8-0.9	35-39	65-74	150-190
Class C	1.5 or more	80 or more	65 or more	1.0 or more	40 or more	75 or more	200 or more

Note: Test results should be rounded off to two significant figures before comparing with the table, e.g. Cd to the nearest 0.1mg/kg, Cr to the nearest 1 mg/kg, and Zn to the nearest 10 mg/kg, etc.

(Stuart B. Reed)
Director of Environmental Protection

Appendix 2 Sampling Logs

Date	5.5.95
Station Number	1
Station Position	818930N, 819870E
Collection Method	Grab sampler
Sample Type	Surface (10cm)
Water Depth	2m
Sample Weight (wet)	500g
Sample Description	Very soft, brownish grey, slightly sandy fine SILT (marine mud). Some organic material present on surface of sample.

Date	5.5.95
Station Number	2
Station Position	818930N, 819970E
Collection Method	Grab sampler
Sample Type	Surface (10 cm)
Water Depth	2.5m
Sample Weight (wet)	750g
Sample Description	Very soft, dark grey, slightly sandy fine SILT (marine mud).

Date	5.5.95
Station Number	3
Station Position	818830N, 819790E
Collection Method	Grab sampler
Sample Type	Surface (10 cm)
Water Depth	1.3m
Sample Weight (wet)	850g
Sample Description	Loose, light yellowish brown, coarse SAND (marine sand). Contains occasional white shell fragments up to 10mm in length.

Date	5.5.95
Station Number	4
Station Position	818830N, 819870E
Collection Method	Grab sampler
Sample Type	Surface (10 cm)
Water Depth	2.5m
Sample Weight (wet)	400g
Sample Description	Soft, medium brownish grey, slightly sandy fine SILT (marine mud). Contains occasional white shell fragments up to 15mm in length.

Date	5.5.95
Station Number	5
Station Position	818830N, 819970E
Collection Method	Grab sampler
Sample Type	Surface (10 cm)
Water Depth	3m
Sample Weight (wet)	900g
Sample Description	Soft, dark grey, fine SILT (marine mud).

Date	5.5.95
Station Number	6
Station Position	818730N, 819870E
Collection Method	Grab sampler
Sample Type	Surface (10 cm)
Water Depth	2.5m
Sample Weight (wet)	350g
Sample Description	Soft, brownish grey, slightly sandy fine SILT (marine mud). Contains occasional white shell fragments up to 15mm in length.

Date	5.5.95
Station Number	7
Station Position	818725N, 819965E
Collection Method	Grab sampler
Sample Type	Surface (10 cm)
Water Depth	3.3m
Sample Weight (wet)	1000g
Sample Description	Soft, dark grey, fine SILT (marine mud).

Date	5.5.95
Station Number	8
Station Position	818620N, 819770E
Collection Method	Grab sampler
Sample Type	Surface (10 cm)
Water Depth	3m
Sample Weight (wet)	400g
Sample Description	Soft, brownish grey, slightly sandy fine SILT (marine mud). Contains occasional white shell fragments up to 10mm in length and small pitted rocks up to 30mm in length.

Date	5.5.95
Station Number	9
Station Position	818535N, 819670E
Collection Method	Grab sampler
Sample Type	Surface (10 cm)
Water Depth	1.7m
Sample Weight (wet)	350g
Sample Description	Loose, yellowish brown, coarse SAND (marine sand). Some organic matter present on surface of sample. Contains occasional white shell fragments up to 8mm in length.

Date	5.5.95
Station Number	10
Station Position	818500N, 819570E
Collection Method	Grab sampler
Sample Type	Surface (10 cm)
Water Depth	1m
Sample Weight (wet)	750g
Sample Description	Loose, yellowish brown, coarse SAND (marine sand). Contains occasional white shell fragments up to 10mm in length and small pitted rocks up to 10mm in length.

Date	5.5.95
Station Number	11
Station Position	818420N, 819570E
Collection Method	Grab sampler
Sample Type	Surface (10 cm)
Water Depth	1m
Sample Weight (wet)	700g
Sample Description	Loose, yellowish brown, coarse SAND (marine sand). Contains occasional white shell fragments up to 10mm in length.

Date	5.5.95
Station Number	12
Station Position	818320N, 819575E
Collection Method	Grab sampler
Sample Type	Surface (10 cm)
Water Depth	1m
Sample Weight (wet)	700g
Sample Description	Loose, brown, fine SAND (marine sand).

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Sediment Testing

Method Statements

1. Metal Content
(Cadmium, Chromium, Copper, Nickel, Lead & Zinc)

- Ref. ASTM D3974-81 and APHA 17th edition Method 3111

Sediment sample is first sieved and dried, and then digested with nitric acid and hydrochloric acid. The digested sample solution is filtered and analyzed for the metal contents by atomic absorption spectrometry, using the respective hollow cathode lamp for the specific metal.

2. Mercury Content

- Ref. APHA 17th edition Method 3112B

Sediment sample is first sieved and dried. The dried sample is digested with permanganate and persulfate solution in a mixture of sulfuric acid and nitric acid for 2 hours in a water bath at 95°C. The digested solution is decolorized with hydroxylamine hydrochloride solution and then filtered. The filtrate is analyzed by atomic absorption spectrometer using hydride generation technique.

Interdepartmental Committee on the Redevelopment of Contaminated Land 59/83 (Second Edition)

Table 3 Tentative "Trigger Concentrations" For Selected Inorganic Contaminants

CONDITIONS

1. This table is invalid if reproduced without the conditions and footnotes.
2. All values are for concentrations determined on "spot" samples based on an adequate site investigation carried out prior to development. They do not apply to analysis of averaged, bulked or composited samples, nor to sites which have already been developed. All proposed values are tentative.
3. The lower values in Group A are similar to the limits for metal content of sewage sludge applied to agricultural land. The values in Group B are those above which phytotoxicity is possible.
4. If all sample values are below the threshold concentrations then the site may be regarded as uncontaminated as far as the hazards from these contaminants are concerned and development may proceed. Above these concentrations, remedial action may be needed, especially if the contamination is still continuing. Above the action concentration, remedial action will be required or the form of development changed.

Netherlands Standards for Soil Contaminants

The treatment of polluted soil depends on the nature of the concentrations of polluted substances present in it. In connection with this, a test framework is used in the Netherlands, built up of three values which must be distinguished. These values - consisting of different, ascending levels of concentration A, B and C - are differentiated according to the nature of the pollution:

- Level A acts as a reference value. This level may be regarded as an indicative level above which there is demonstrable pollution and below which there is no demonstrable pollution.
- Level B is an assessment value. Pollutants above the B level should be investigated more thoroughly. The question asked is: To what extent are the nature, location and concentration of the pollutant(s) of such a nature that it is possible to speak of a risk of exposure to man or the environment.
- Level C is to be regarded as the assessment value above which the pollutant(s) should generally be treated.

MaterialLab

HOKLAS REGISTRATION NO. 15

Our Ref. No. : 950858e50455

TEST REPORT ON ANALYSIS OF SEDIMENT

Client : Axis Environmental Consultants Ltd.

Project : Discovery Bay Master Plan 6.0 Marine Sediment Analysis

Sample description : Twelve nos. of submitted sediment samples

Sample identification : #1-12

Tested required :
1. Copper content
2. Cadmium content
3. Chromium content
4. Lead content
5. Nickel content
6. Zinc content
7. Mercury content

Date received : 05/05/1995

Date completed : 11/05/1995

Methods used :
1-6. In House Method E-T-026D
7. In House Method E-T-027C

MaterialLab Limited 5 Lok Yi Street, 17 M.S. Castle Peak Road, Tai Lam, Tuen Mun, N.T., Hong Kong. Tel: 2450 8233 Fax: 2450 8138

Interdepartmental Committee on the Redevelopment of Contaminated Land 59/83 (Second Edition)

Table 3 Tentative "Trigger Concentrations" For Selected Inorganic Contaminants

CONDITIONS

1. This table is invalid if reproduced without the conditions and footnotes.
2. All values are for concentrations determined on "spot" samples based on an adequate site investigation carried out prior to development. They do not apply to analysis of averaged, bulked or composited samples, nor to sites which have already been developed. All proposed values are tentative.
3. The lower values in Group A are similar to the limits for metal content of sewage sludge applied to agricultural land. The values in Group B are those above which phytotoxicity is possible.
4. If all sample values are below the threshold concentrations then the site may be regarded as uncontaminated as far as the hazards from these contaminants are concerned and development may proceed. Above these concentrations, remedial action may be needed, especially if the contamination is still continuing. Above the action concentration, remedial action will be required or the form of development changed.

Contaminants	Planned Uses	Trigger Concentrations (mg/kg air dried soil)	
		Threshold	Action
Group A: Contaminants which may pose hazards to health			
Arsenic	Domestic gardens, allotments	10	*
	Parks, playing fields, open space	40	*
Cadmium	Domestic gardens, allotments	3	*
	Parks, playing fields, open space	15	*
Chromium (hexavalent) (1)	Domestic gardens, allotments	25	*
	Parks, playing fields, open space		*
Chromium (total)	Domestic gardens, allotments	600	*
	Parks, playing fields, open space	1,000	*
Lead	Domestic gardens, allotments	500	*
	Parks, playing fields, open space	2,000	*
Mercury	Domestic gardens, allotments	1	*
	Parks, playing fields, open space	20	*
Selenium	Domestic gardens, allotments	3	*
	Parks, playing fields, open space	6	*
Group B: Contaminants which are phytotoxic but not normally hazards to health			
Boron (water-soluble) (3)	Any uses where plants are to be grown (2, 6)	3	*
Copper (4, 5)	Any uses where plants are to be grown (2, 6)	130	*
Nickel (4, 5)	Any uses where plants are to be grown (2, 6)	70	*
Zinc (4, 5)	Any uses where plants are to be grown (2, 6)	300	*

NOTES :

* Action concentrations will be specified in the next addition of ICRCL 59/83.

1. Soluble hexavalent chromium extracted by 0.1M HCl at 37°C; solution adjusted to pH 1.0 if alkaline substances presents.
2. The soil pH value is assumed to be about 6.5 and should be maintained at this value. If the pH falls, the toxic effects and the uptake of these elements will be increased.
3. Determined by standard ADAS method (soluble in hot water).
4. Total concentration (extractable by $HNO_3/HClO_4$).
5. The phytotoxic effects of copper, nickel and zinc may be additive. The trigger values given here are those applicable to the 'worst-case': phytotoxic effects may occur at these concentrations in acid, sandy soils. In neutral or alkaline soils, phytotoxic effects are unlikely at these concentrations.
6. Grass is more resistant to phytotoxic effects then are most other plants and its growth may not be adversely affected at these concentrations.

Netherlands Standards for Soil Contaminants

The treatment of polluted soil depends on the nature of the concentrations of polluted substances present in it. In connection with this, a test framework is used in the Netherlands, built up of three values which must be distinguished. These values - consisting of different, ascending levels of concentration A, B and C - are differentiated according to the nature of the pollution:

- Level A acts as a reference value. This level may be regarded as an indicative level above which there is demonstrable pollution and below which there is no demonstrable pollution.
- Level B is an assessment value. Pollutants above the B level should be investigated more thoroughly. The question asked is: To what extent are the nature, location and concentration of the pollutant(s) of such a nature that it is possible to speak of a risk of exposure to man or the environment.
- Level C is to be regarded as the assessment value above which the pollutant(s) should generally be treated.

Present in: Component/concentration	Soil (mg/kg dry matter)			Groundwater (ug/l)		
	A	B	C	A	B	C
I. Metals						
Cr	100	250	800	20	50	200
Co	20	50	300	20	50	200
Ni	50	100	500	20	50	200
Cu	50	100	500	20	50	200
Zn	200	500	3000	50	200	800
As	20	30	50	10	30	100
Mo	10	40	200	5	20	100
Cd	1	5	20	1	2.5	10
Sn	20	50	300	10	30	150
Ba	200	400	2000	50	100	500
Hg	0.5	2	10	0.2	0.5	2
Pb	50	150	600	20	50	200
II. Inorganic pollutants						
NH_4 (as N)	-	-	-	200	1000	3000
F (total)	200	400	2000	300	1200	4000
CN (total free)	1	10	100	5	30	100
CN (total combined)	5	50	500	10	50	200
S (total)	2	20	200	10	100	300
Br (total)	20	50	300	100	500	2000
PO_4 (as P)	-	-	-	50	200	700
III. Aromatic compounds						
benzene	0.01	0.5	5	0.2	1	5
ethylbenzene	0.05	5	50	0.5	20	60
toluene	0.05	3	30	0.5	15	50
xylenes	0.05	5	50	0.5	20	60
phenols	0.02	1	10	0.5	15	50
aromatics (total)	0.1	7	70	1	30	100
IV. Polycyclic hydrocarbons						
naphthalene	0.1	5	50	0.2	7	30
anthracene	0.1	10	100	0.1	2	10
fenanthrene	0.1	10	100	0.1	2	10
fluoranthene	0.1	10	100	0.02	1	5
pyrene	0.1	10	100	0.02	1	5
1,2-benzopyrene	0.05	1	10	0.01	0.2	1
total polycyclic hydrocarbons	1	20	200	0.2	10	40
V. Chlorinated hydrocarbons						
aliphatic HC (indiv.)	0.1	5	50	1	10	50
aliphatic HC (total)	0.1	7	70	1	15	70
chlorobenzenes (indiv.)	0.05	1	10	0.02	0.5	2
chlorobenzenes (total)	0.05	2	20	0.02	1	5
chlorophenols (indiv.)	0.01	0.5	5	0.01	0.3	1.5
chlorophenols (total)	0.01	1	10	0.01	0.5	2
chlorinated PAHs (total)	0.05	1	10	0.01	0.2	1
PCBs (total)	0.05	1	10	0.01	0.2	1
EOCL (total)	0.1	8	80	1	15	70
VI. Pesticides						
chlorinated organics (indiv.)	0.1	0.5	5	0.05	0.2	1
chlorinated organics (indiv.)	0.1	1	10	0.1	0.5	2
pesticides (total)	0.1	2	20	0.1	1	5
VII. Other pollutants						
tetraphydrofuran	0.1	4	40	0.5	20	60
pyridine	0.1	2	20	0.5	10	30
tetrahydrothiofene	0.1	5	50	0.5	20	60
cyclohexanes	0.1	6	60	0.5	15	50
styrene	0.1	5	50	0.5	20	60
gasoline	20	100	800	10	40	150
mineral oil	100	1000	5000	20	200	600

MaterialLab

HOKLAS REGISTRATION NO. 15

Our Ref. No. : 950858e50455

TEST REPORT ON ANALYSIS OF SEDIMENT

Client : Axis Environmental Consultants Ltd.

Project : Discovery Bay Master Plan 6.0 Marine Sediment Analysis

Sample description : Twelve nos. of submitted sediment samples

Sample identification : #1-12

Tested required :
1. Copper content
2. Cadmium content
3. Chromium content
4. Lead content
5. Nickel content
6. Zinc content
7. Mercury content

Date received : 05/05/1995

Date completed : 11/05/1995

Methods used :
1-6. In House Method E-T-026D
7. In House Method E-T-027C

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HOKLAS REGISTRATION NO. 15

Our Ref. no. : 950858e50455

Results :

Sample identification	Copper Content mg/kg	Cadmium Content mg/kg	Chromium Content mg/kg	Lead Content mg/kg	Nickel Content mg/kg	Zinc Content mg/kg	Mercury Content mg/kg
1	7.2	<0.2	5.1	16	1.9	24	<0.05
2	13	<0.2	13	25	6.1	37	<0.05
3	5.1	<0.2	2.9	12	<1	20	<0.05
4	6.2	<0.2	3.2	12	1.1	18	<0.05
5	9.9	<0.2	10	20	4.5	38	<0.05
6	10	<0.2	8.7	24	5.1	34	<0.05
7	21	<0.2	19	37	9.1	69	0.15
8	14	<0.2	12	33	6.5	52	<0.05
9	5.3	<0.2	3.7	23	1.2	22	<0.05
10	3.0	<0.2	3.5	20	<1	19	<0.05
11	5.1	<0.2	3.6	18	1.1	18	<0.05
12	5.1	<0.2	3.9	17	<1	25	<0.05

Remark : Results are based on mass of sample dried at 103-105°C.

Supervised by : K.F. Wong

Certified by :

Approved Signatory : K.M. Ho

Date : 18/5/95

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