4 NOISE

4.1 INTRODUCTION

To create a platform for the terminals a reclaimed area will be formed south of the TCT peninsula and Pennys Bay. In this subsection the noise impact on sensitive receivers from both the construction and operating phases of the terminal established on this reclamation are identified. In addition the cumulative operation noise impact of four terminal phases is assessed. A single scenario for both construction and cumulative operation noise is presented, assuming:

- marine sand is used as the reclamation material; and
- the amended arrangement for phases III/IV (CT 12/13).

This subsection sets out the environmental context, identifies the relevant legislation and discusses the construction and operation phase impacts and mitigation. Sensitive Receivers are indicated in Figure 4.1 and the general arrangement of the terminals is presented in Figure 4.2.

4.2 BACKGROUND MONITORING

There is no existing data for noise at the proposed site. For the LAPH environmental study, background noise monitoring was undertaken at 13 locations. The closest monitoring point to the site was at Penny's Bay. There were also monitoring locations at Discovery Bay and Peng Chau.

The noise levels registered at the five monitoring stations presented in LAPH environmental study are summarised in Table 4.1.

Table 4.1 Summary of Noise Levels

Monitoring Station	$L_{90\ (1\ hour)}$, dB(A)		
	Day (0700 - 1900)	Evening (1900 - 2300)	Night (2300 - 0700)
Penny's Bay	40.2 - 48.4	48.8 - 51.5	35.2 - 51.8
Discovery Bay North	45.0 - 49.8	45.5 - 46.7	39.8 - 44.8
Discovery Bay South	50.4 - 58.0	47.5 - 51.1	35.2 - 48.0
Peng Chau North	50.1 - 54.9	48.2 - 52.8	42.8 - 49.0
Peng Chau South	52.3 - 56.7	46.3 - 52.3	43.1 - 50.8

4.3 ENVIRONMENTAL LEGISLATION, GUIDELINES AND METHODOLOGY

The Noise Control Ordinance (NCO) provides the statutory framework for noise control. This defines statutory limits applicable to equipment used in Terminal operations and Terminal construction. The NCO invokes three technical memoranda (TM) which define the technical means for noise assessment. Together, the NCO and the TM provide a mechanism for assessing noise levels and the statutory power to control noise.

- TM on Noise from places other than Domestic Premises or Construction Sites;
- TM on Noise from Construction Work other than Percussive Piling; and
- TM on Noise from Percussive Piling.

The Guidelines for Developments in Rural Areas in Chapter 4 of the Environmental Guidelines for Planning in Hong Kong states that in planning any new development in rural areas, any noise emitters introducing a fairly constant excess of 10 dB(A) above the prevailing background should be avoided.

4.3.1 OPERATION NOISE

The TM for the Assessment of Noise from Places Other Than Domestic Premises or Construction Sites provides the statutory control and mechanism for assessing noise from the Port activities. It provides a method for determining the Area Sensitivity Rating (ASR) of a Noise Sensitive Receiver (NSR), and the Acceptable Noise Level (ANL). Table 4.2 shows the criteria for determining the ASR and Table 4.3 shows the ANLs with respect to the time of the day. During the LAPH Studies and this study the Hong Kong Planning Standards and Guidelines (HKPSG) for an Area Sensitivity Rating (ASR) "A" has been used for planning purposes to protect the existing noise climate. EPD has advised that after the terminals are operational, the Noise Control Ordinance would then take into account all of the landuse charecteristics existing at the time, including the terminals. Enforcement during operation would therefore be assessed against ASR "B".

Table 4.2 Area Sensitivity Rating (ASR)

Type of Area		Degree to which NSR is affected by Influencing Factors		
		Not Affected	Indirectly Affected	Directly Affected
1)	Rural area, including country parks or village type developments	A	B	B
2)	Low density residential area consisting of low-rise or isolated high-rise developments	A	B	C
3)	Urban area	B	C	C
4)	Area other than those above	B	B	C

Table 4.3 Acceptable Noise Levels (ANL)

Time Period		ANL dB(A)		
		A	B	C
Day	(0700 to 1900)	60	65	70
Evening	(1900 to 2300)			
Night	(2300 to 0700)	50	55	60

For planning purposes the HKPSG state that fixed noise sources should be 5dB(A) below the appropriate *Technical Memorandum* ANL, or no higher than 10 dB(A) above the prevailing background noise level, whichever is lower. The criteria against which the terminal will be assessed is presented in Table 4.4.

Table 4.4 Operation Noise Criteria

Location	Assessment Criteria for Port Noise dB(A)	
	Daytime	Night-time
Planning Criteria	55	45
Enforcement Criteria	65	55

4.3.2 CONSTRUCTION NOISE

The NCO divides construction noise into activities involving powered mechanical equipment excluding percussive piling, and percussive piling activity. The criteria for the assessment of noise from construction are therefore similarly divided.

Activity other than Percussive Piling

Under the Technical Memorandum on 'Noise from Construction Work other than Percussive Piling' noise from activity excluding piling is not restricted during the period 0700-1900 hours (except Public Holidays). However, the government white paper 'Pollution in Hong Kong - A Time to Act' has signalled a desire to improve the noise environment in Hong Kong whenever reasonably practical. To this end, EPD has suggested a daytime general construction noise limit of 75 dB(A) in the Urban Area. In the LAPH Studies this was taken further by defining an acceptable daytime construction noise level as 10 dB(A) above background. The assessment criteria was therefore taken to be 60 dB(A). Exceedence of this non statutory limit will be identified in this construction noise assessment.

Between 1900 and 0700 hours and all day on Sundays and public holidays, activity is prohibited unless a permit is obtained. A permit will be granted provided that the Acceptable Noise Level (ANL) for the noise sensitive receiver can be complied with.

ANLs are assigned depending upon the Area Sensitivity Rating (ASR). And as noted earlier in the text the receivers in the vicinity of the Port are to be assigned an ASR of A. The corresponding basic noise levels (BNLs) for evening and night time periods, together with a daytime standard, are given in the following Table.

Table 4.5 Construction Noise Criteria for Activity Other Than Percussive Piling

Basic Noise Level for ASR "A"		
$L_{Aeq\ (30\ min)}$ *	$L_{Aeq\ (5\ min)}$	
Daytime	Evening +	Night
60	60	45

* Recommended but not statutory
\+ includes all day Sundays and public holidays

Percussive Piling

Under a separate TM on Noise from Percussive Piling, piling is prohibited between 1900 and 0700 hours and on Sundays and public holidays, unless permission is granted by the Governor in Council. Between 0700 and 1900 hours, piling is allowed under permit, subject to noise level limits (termed Acceptable Noise Levels - ANLs). If the noise level is expected to exceed these limits, restricted hours of operation are included in the permit. Table 4.6 summaries the ANLs to be complied with.

Table 4.6 Acceptable Noise Levels (ANLs) for Percussive Piling

NSR Window Type or Means of Ventilation	ANL, 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

* 10 dB(A) shall be deducted from the above when the NSRs are hospitals, schools or law courts.

4.3.3 ASSESSMENT METHODOLOGY

In this report the cumulative noise effects of the terminal construction and operation will be assessed to identify potential constraints on the construction programme and terminal operation. Detailed scheduling, plant inventories and utilisation data are not yet available and the assessment is therefore semi-quantitative and intended only as a preliminary review of the issues. The object is to identify the potentially significant areas where impact, requiring mitigation or restrictions, could be anticipated. The assessment is based on the procedures and data presented in the appropriate Technical Memoranda to the NCO. However in view of the large distance between noise generator and sensitive receiver the effects of atmospheric absorbtion and, where appropriate, topographic

shielding have been included.

Calculation Procedure

The assessment will generally follow the procedures given in the TM on Noise from Construction Work other than Percussive Piling, and the TM on Noise from places other than Domestic Premises, Public Places or Construction Sites. Attenuation for distances over 300m is not provided in the TM. For the purpose of assessment of noise arising from powered mechanical equipment, the distance attenuation was calculated using the standard formula:

Distance Attenuation in dB(A) = 20 log D + 8

where D is the distance in metres.

In view of the large distance between the terminals and the NSRs, atmospheric absorption will be included when predicting the noise impacts on NSRs.

The approximate excess attenuation at a temperature of 20°C has been calculated from the expression :

$$A_{ex} = 7.4 \left(\frac{F^2 r}{\phi}\right) 10^{-8}$$

where:

A_{ex} = excess attenuation (dB)
F = geometric mean frequency of the band (Hz) - assumed to be 250 Hz
r = distance between source and receiver (m)
ϕ = relative humidity (%) - assumed to be 77%

The positions of fixed Powered Mechanical Equipment (PME) or fixed noise sources are assumed to be located at notional source position (NSP) of each respective work area, selected in accordance with the procedures in the TM on Noise from Construction Work other than Percussive Piling.

Sound Power Levels (SWLs) of the equipment were taken from Table 3 of the Technical Memorandum on Noise from Construction Work other than Percussive Piling (TM). Where no SWL was supplied in the TM, then reference has been made to BS 5228 or previous similar studies or from measurements taken at other sites in Hong Kong.

4.4 CONSTRUCTION PHASE

4.4.1 GENERAL

The works included in this cumulative construction noise assessment are :

- o terminal construction;
- o terminal construction working areas;
- o construction of backup areas;

- o construction of the breakwater; and
- o committed works areas within Pennys Bay.

Identification of the phasing for activities and positioning of the main activity areas, except the terminals, has been obtained from the Ancillary Works consultant. The latest available information is presented here.

4.4.2 CONSTRUCTION PLANT ACTIVITY

In this section the construction plant which it is predicted will operate in the working areas is defined. The sound power levels indicated have been taken from the relevant Technical Memorandum, BS 5228 Part I; or agreed noise levels from other projects carried out in Hong Kong.

Terminals

It has been assumed that the terminals will be constructed in a similar manner. Three distinct activities have been identified. :

- o reclamation works;
- o berth construction; and
- o works areas.

An assumed plant utilisation schedule has been prepared by the engineering design team which identifies plant and equipment requirements on a monthly basis. Due to the dynamic nature of construction activity this utilisation schedule has been used in the assessment to generate a monthly cumulative construction noise impact chart and identify worst case impact. The monthly output for three NSR at Discovery Bay (DB1) and Peng Chau (R4 & R4a) are presented in Figure 4.3.

Table 4.7 Assumed Equipment Requirements for Quay and Deck Construction

Activity and Equipment	Equipment	
	Sound Power Level (dB(A))	Maximum Number in Use
Quay and Deck Construction: Trench Fill and Rockfill		
Grab dredger	112	1
Hopper barge and tugboat	104/110	2
Quay and Deck Construction: Quay Rock-mound		
Derrick lighter	104	1
Tugboat	110	1
Quay and Deck Construction: Blockwork and Tetrapods		
Derrick lighters	104	2
Tugboat	110	2

Table 4.8 Assumed Equipment Requirements for CT10 Reclamation

Activity and Equipment	Equipment	
	Sound Power Level (dB(A))	Maximum Number in Use
Geotextile		
Barge	110	2
Wick drains		
Barge	110	7
Dredging, Sandfill and Surcharge		
Cutter suction dredger	104	2
Trailer suction dredger	109	3
Booster pump	109	2
Removal of surcharge		
Dumptruck (25 cu.m.)	121	37
Bulldozer	115	6
Loader	112	12

Table 4.9 Assumed Equipment Requirements for CT11 Reclamation

Activity and Equipment	Equipment	
	Sound Power Level (dB(A))	Maximum Number in Use
Geotextile		
Barge	110	2
Wick drains		
Barge	110	7
Dredging, Sandfill and Surcharge		
Cutter suction dredger	104	2
Trailer suction dredger	109	2
Booster pump	109	2
Removal of surcharge		
Dumptruck (25 cu.m.)	121	21
Bulldozer	115	4
Loader	112	7

Table 4.10 Assumed Equipment Requirements for Advance Works

Activity and Equipment	Equipment	
	Sound Power Level (dB(A))	Maximum Number in Use
Trailing suction hopper dredger	109	2
Cutter suction hopper dredger	104	1
Derrick lighter	104	6
Hopper barge	104	8
Grab pontoon	112	8
Backhoe	112	5
Dumptruck (50 tonnes)	121	8
Loader	112	2

4.4.3 CONSTRUCTION IMPACT ASSESSMENT

General Construction

In this subsection the results of the cumulative assessment are reported. The reporting concentrates on NSR identified as being the most susceptible to impact from terminal construction. Phases I and II will be ongoing at the same time, and the assessment has identified the critical points in the construction programme where peak activity and noise levels occur. The reporting records *worst case* conditions during concurrent construction at Berths 1 (Phase 1) and 5 (Phase 2).

Table 4.11 Noise Levels due to Terminal Construction

Receiver Identification	Peak Facade Noise Level due to Construction [dB(A)]
	Berths 1 (Phase I) and 5 (Phase II)
DB-1 (Cherish Court, DB)	65.7
DB-3 (Twilight Court, DB)	64.4
DB-5 (Discovery Bay Plaza, DB)	63.4
DB-9 (Woodbury Court, DB)	62.4
DB-13 (Greenery Court, DB)	62.8
R4 (Central Peng Chau)	55.4
R4(a) (HA Estate on Peng Chau)	55.6
R4(b) (Headland Peng Chau)	67.1
Fa Peng (with shielding)	67.0

Notes

(i) Construction includes reclamation, terminal construction and works in the backup area.
(ii) Peng Chau [R4(b)] is an indicator point on the headland centred on the transmitter station to represent all properties on the headland.
(iii) Fa Peng was identified as an NSR in the LAPH studies. It represents the closest NSR to the terminals. Site visits during this study revealed that the village had been abandoned and the dwellings were derelict.

Impacts on Discovery Bay NSR

Table 4.11 identifies the peak impact on the NSR at Discovery Bay at the most exposed receivers during Phase I/II construction. Activities during concurrent activities at Berths 1 (Phase 1) and 5 (Phase 2) exceed the daytime assessment criterion of 60 dB(A). During the evening, construction noise is expected to exceed the NCO criterion of 60 dB(A). It is proposed that construction activity will continue for a 16 hour day (0700hrs to 2300hrs), i.e., daytime and evening. In order to achieve the NCO evening requirement some form of mitigation will have to be incorporated into the construction activities.

Impacts on Peng Chau NSR

The analysis indicates that concurrent construction of Berths 1 and 5 will adversely impact any NSR without the benefit of shielding topography It is noted that the majority of the sensitive receivers on Peng Chau are located in the central area, which is shielded by the northern headland. Isolated receivers on the northern headland of Peng Chau will be similarly protected by shielding topography. The properties on the north headland are single storey and in the event of adverse impact being detected there would be potential to provide some form of acoustic barrier at the NSR to mitigate impact.

Impacts on Fa Peng

Fa Peng is the closest indicator point to the terminals. The village is now deserted and buildings are derelict and in a poor state of repair. Shielding topography immediately to the south will provide protection to the majority of receivers. For any property found to be adversely affected by the terminal construction barriers at the receiver could be considered.

4.4.4 MITIGATION OF CONSTRUCTION NOISE

The adoption of the non statutory 60 dB(A) daytime criteria, in the LAPH Studies, together with the requirements of the NCO TM for evening work (17.00hrs - 23.00hrs), sets a 60 dB(A) acceptable noise impact level between 07.00hrs and 23.00hrs. The engineering team have advised that to maintain the construction programme a 16 hour working day (07.00 - 23.00) will be required. Construction activities between 19.00 - 23.00 hrs require issue of a Construction Noise Permit from EPD. In the event that 24 hour working is required, the period 23.00 to 0700hrs would require a CNP and would need to meet the strict 45 dB(A) night time criteria.

Mitigation of construction impact can generally be achieved through adoption of combinations of four techniques :

- **Source mitigation** - using quieter plant and machinery;
- **Path mitigation** - using physical barriers, either permanent bunds or movable acoustic screens;
- **Programming** - phasing of activities to reduce the impact; and
- **Receiver mitigation** - protection for the NSR at the NSR, methods include provision of high quality glazing in well gasketted windows and air conditioning.

Source mitigation is an efficient and attractive method of mitigation. This assessment has used normally adopted plant without special noise attenuating characteristics. There is a growing awareness of the impact of construction noise which has resulted in tighter noise standards for construction equipment and spawning a new generation of quiet plant. This type of mitigation can be implemented at a site by the presentation of performance specifications for equipment in Contract Documentation. On this project surcharge removal necessitates a large fleet of heavy (25 cu.m) dump trucks.

Path Mitigation involves the use of physical screens between source and receiver to reduce impact. For this project path mitigation divides into two streams:

- temporary acoustic barriers, provided by the contractor to shield noisy activities; and
- barriers which will be incorporated into the permanent works for the terminal to mitigate operation noise.

Temporary acoustic barriers, in the form of hoardings, can offer efficient mitigation. The NSRs most affected by construction activity will be the elevated NSRs in Discovery Bay. Acoustic screens close to the noise generator will effectively screen high level NSR. The LAPH Studies identified the need for a permanent acoustic barrier at the western end of terminal Phases I/II to shield operation noise, primarily the noise from vehicles moving around the stacking area. This study has identified a potential need for an additional barrier between individual terminals to mitigate operation noise due to additional vehicle movements. It has been proposed that for both phases I and II of the terminals that noise walls be constructed as initial works. This approach would incorporate effective permanent noise barriers for the majority of the works and is strongly supported on environmental grounds. The integration of permanent noise bunds is advised, along with temporary screens to regularly used haul routes and the careful siting of fixed equipment behind screening bunds.

Evaluation of Effectiveness of these Measures: Evaluation of the exact effectiveness of these measures at a given receiver requires a knowledge of the planned construction schedule, which is not available at this stage. Estimates of the noise reductions capable are provided below:

- Stationary and Earth-moving Plant: These pieces of equipment include excavators, bulldozers, loaders, and dumptrucks. Noise reduction can be achieved through proper maintenance of the exhaust system, and through exhaust silencers. Additionally, engine noise is amenable to reduction through isolation of vibrating engine components, installation of partial or full acoustic enclosures of noise-generating components, and damping of vibrating panels. U.S. tests have shown that partial or full enclosures can achieve noise reductions of 10 and 25 dB(A) respectively.

- Barrier: A purpose-built mobile noise barrier, located close to the noise source, can be fabricated to protect sensitive receivers. Effective barriers are typically lined on the noise-generating side with a noise-absorbing material, and have a surface mass of at least 7 kg/m^2. Assuming that the barrier has no gaps, and that it blocks the line of sight between noise generator and noise receiver, reductions of 5 to 10 dB(A) can be achieved.

- Sample Calculation: To assess the practicality of mitigation the plant requirements have been critically reviewed. The main source of impact is from the fleet of dump trucks transporting surcharge material. This study has adopted a SWL of 121 dB(A). Reference to BS 5228 gives SWL in the range 103 dB(A) to 120 dB(A) for 50 tonne dump trucks. Assuming a 10 dB(A) reduction in the SWL of earth-moving equipment, the construction noise at the most exposed NSR in Discovery Bay (DB1) could be reduced to below 60 dB(A). This assumed 10 dB(A) reduction is consistent with US-reported SWL reductions resulting from the use of partial engine enclosures, and with sample SWLs of dumptrucks shown in BS 5228.

Programming of activities offers a method of spreading the impact thereby reducing individual impact levels. The approach is similar to that adopted for percussive piling where the activity may be severely time constrained in an attempt to minimise effects on NSR. The intensity of activity and the requirement for large dump trucks are unlikely to provide an opportunity to significantly reduce construction phase impact by programming. Programming will be applicable if contractors wish to work at night (23.00hrs - 07.00hrs). The assessment has shown that with the shielding identified the activity levels proposed will exceed the night time criteria. There may be opportunity for a contractor to carry out limited night-time activities if quiet, or reduced activity levels, can be incorporated into the programme.

Receiver mitigation is a final alternative when all reasonable avenues of mitigation have been exhausted. Locally, it has been used at Ma Wan for NSRs adversely affected by the construction of the Lantau Fixed Crossing. It is most appropriate when the impact is only affecting a small number of NSR and source and path mitigation are not cost effective. For the receivers at Discovery Bay and Peng Chau this is unlikely to be a preferred option due to the capital and ongoing running costs of such a scheme. In addition it only protects individual NSRs, there is no overall noise reduction in the area since noise impacts are not contained, and there will be a consequent increase in background levels of noise and degradation of the local environment. To retain the character of the area it is believed that other mitigation alternatives, particularly source path and programmking are more appropriate.

Measures other than Noise Reduction (Liaison and Good Community Relations): Though not effective in reducing noise levels, the establishment of good community relations can be of great assistance to both the contractors and receivers. Residents of Discovery Bay, Peng Chau, and other nearby settlements should be notified in advance of planned operations, and informed of progress. If necessary, a liaison body can be established to bring together representatives of the affected communities, the government, and the contractors. In addition, residents may be provided with a telephone number for the Resident Engineer's office, where they may register complaints concerning excessive noise. If justified, the Resident Engineer may order noisy operations to cease or to be conducted at more appropriate hours. These issues are addressed in the Environmental Monitoring and Audit (EM&A) Manual produced for this project.

4.5 OPERATION PHASE

4.5.1 INTRODUCTION

In order to carry out meaningful assessment and ensure that early phases of the terminals do not dominate the noise environment forcing later phases to include onerous noise mitigation measures an assessment of cumulative impact has been carried out.

The cumulative assessment has been carried out for four phases of the terminals operating, with CT10 & 11 representing Phases I and II and later development identified as Phases III and IV. The configuration of the terminals have been modified from those assumed in the LAPH Studies as discussed in Section 3. The operating characteristics also vary from those used in the earlier LAPH Studies as discussed in Section 3. The general arrangement of the terminals, including key elements, is indicated in Figure 4.2.

4.5.2 EQUIPMENT UTILISATION ADOPTED IN THIS STUDY

The reasons for selecting the types and levels of equipment have evolved from the findings of the LAPH Studies and a re-evaluation from observations taken for other Hong Kong terminal studies through discussion with existing terminal operators in Hong Kong. The equipment numbers refer to a total for each berth with the opportunity for some sharing of equipment within a terminal. The evolution of the equipment utilisation and selection of SWL's has been documented in Section 3 of this report. The utilisation levels and appropriate SWLs are identified in Table 4.12

Table 4.12 Terminal Equipment Utilization

Equipment	Utilization		Number per berth		Assumed SWL dB(A)
	Day	Night	Day	Night	Adopted
Container Terminal					
Container Cranes	100%	100%	3/4	3/4	109.0
RTGs	100%	75%	17	17	107.0
Barges	100%	-	1	0	112.0
Internal Tractors (running)	55%	55%	17	17	$106.5_{(1)}$
Internal Tractors (idle)	45%	45%	17	17	99.0
External Tractors (running)	17%	32%	105	59	110.0
External Tractors (idle)	34%	68%	105	59	99.0
External Tractors (parked)	49%	-	105	0	Nil
Forklift for Empties	100%	-	1/2	0	110.4

Notes: A. Sound Power Levels of Terminal Equipment obtained from the following sources:

- o Container Cranes: Fax of 8 October 1993 from Hong Kong International Terminals (HIT) to Maunsell Consultants, stating "practically achievable" noise level for this piece of equipment. Matches monitored noise level obtained at HIT Terminal 7 in November 1992.
- o Yard Cranes (RTGs): Fax of 8 October 1993 from HIT to Maunsell Consultants, stating "practically achievable" noise level for this piece of equipment.
- o (1) Container Tractor: Derived from manufacturer's reported noise level (January 1993) of a Douglas Tugmaster NS8-220 tractor (for terminal and distribution operations) at full throttle.
- o Barges/Lighters: "Technical Memorandum on Noise from Construction Work other than Percussive Piling", Table 3 (value for barge-mounted crane).
- o Forklift : Derived from supplier's reported noise measurement for Boss BECH Empty Container Handler (April 1993).

CONTAINER BACKUP AREA/CONTAINER FREIGHT STATION

Equipment needs have been established in accordance with maximum capacity requirements, a dwell time of 7 days, and 330 working days per year. The equipment list per berth is as shown in the following table:

Table 4.13 Port Backup Area Equipment Utilization

Equipment	Number per berth	Assumed SWL dB(A)
Electric Forklift	4	95.0
Tractors	2	106.5
Miscellaneous Vehicles	1	112.0
Crawler Cranes	2	112.0
Lorries	2	106.5

Notes:

(i) Information from Mott Macdonald (25 August 1994).
(ii) Assumes 24-hour operation in the backup area.
(iii) 50 percent utilization at night assumed.

The backup areas for CT10 and CT11 are located within Penny's Bay and behind the berths. Backup areas for CT12 and CT13 are not known at the present time. Notional equipment locations have been assumed.

4.5.3 OPERATION IMPACT ASSESSMENT

The results of the modelling exercise are presented for NSR in Discovery Bay, Peng Chau and isolated receivers. Discovery Bay is subdivided into existing receivers and future receivers in Yi Pak Bay. No information on the Yi Pak development is available, though it is understood that the proposal is for a population of 15,000. This assessment assumes high rise property on the hillside and low rise property on new reclamation in Yi Pak Bay. This style of development would be in keeping with adopted practise within the existing residential area.

Three sets of tables are presented for the facade noise levels at each sensitive receiver and representing:

- the impact of terminal noise only, assuming the utilisation factors and mitigation identified in Section 3 of this report;
- the impact of port backup noise, based on detailed assessment carried out by the ancillary works consultant for CT10 & 11 and notional locations for CT12 & 13; and
- the cumulative impact of terminals and port backup areas combined.

Night-time impact levels are critical and any noise impacts which is predicted to exceed the night-time planning criteria of 45 dB(A) is indicated in **bold** typeface and in excess of the night-time NCO enforcement criteria of 55 dB(A) in **bold and underlined.**

Table 4.14/1 Noise Levels at Discovery Bay (Terminal Only - Existing NSR)

NSR ID and Elevation	Facade Noise Levels dB(A) during:			
	Phase 1	Phase 2	Phase 3	Phase 4
Receiver DB-1	(Daytime/Night-time)			
81 mPD	40.9/39.4	48.3/**47.3**	48.9/**47.9**	50.4/**49.5**
72 mPD	40.7/39.1	47.7/**46.5**	48.4/**47.1**	50.0/**49.0**
63 mPD	40.5/38.9	47.0/**45.7**	47.8/**46.4**	49.6/**48.5**
54 mPD	40.0/38.7	46.5/45.0	47.3/**45.8**	49.3/**48.2**
Receiver DB-3	(Daytime/Night-time)			
91 mPD	40.0/38.6	47.2/**46.2**	47.7/**46.7**	49.1/**48.2**
82 mPD	39.8/38.2	46.5/**45.3**	47.1/**45.9**	48.7/**47.6**
73 mPD	39.6/38.0	45.9/44.7	46.6/**45.3**	48.3/**47.2**
64 mPD	39.4/37.8	45.4/44.0	46.1/44.7	48.0/**46.9**
Receiver DB-9	(Daytime/Night-time)			
103 mPD	37.7/36.2	43.7/42.5	44.4/43.1	46.0/44.9
94 mPD	37.6/36.0	43.4/42.1	44.1/42.8	45.8/44.7
85 mPD	37.4/35.8	43.0/41.6	43.8/42.3	45.6/44.4
76 mPD	37.3/35.6	42.6/41.2	43.4/42.0	45.4/44.2
Receiver DB-13	(Daytime/Night-time)			
117 mPD	38.4/37.0	45.0/44.0	45.5/44.4	46.7/**45.7**
108 mPD	38.2/36.7	44.4/43.3	45.0/43.8	46.3/**45.2**
99 mPD	37.9/36.4	43.8/42.6	44.4/43.2	45.9/44.8
90 mPD	37.8/36.2	43.4/42.2	44.1/42.8	45.6/44.5
Receiver DB-5	(Daytime/Night-time)			
28 mPD	39.2/37.7	43.6/42.1	44.4/42.9	45.2/43.7

Planning criteria is exceeded at Peninsular Village from completion of Phase II (CT10 & 11 in operation) and at the high rise blocks in the northern area on completion of Phase IV (CT 10, 11, 12 & 13 operating). There may be opportunity to reduce impact by incorporating noise attenuation barriers into Phase IV. There are no instances of the enforcement criteria being exceeded.

Table 4.14/2 Noise Levels at Discovery Bay (Terminal Only - Future NSR)

NSR ID and Elevation	Facade Noise Levels dB(A) during:			
	Phase 1	Phase 2	Phase 3	Phase 4
Receiver YP-1	(Daytime/Night-time)			
16mPD	37.6/35.9	47.7/46.9	48.0/**47.1**	48.4/**47.5**
Receiver YP-2	(Daytime/Night-time)			
126mPD	41.7/40.8	48.9/**48.2**	49.1/**48.4**	49.8/**49.0**
117mPD	41.5/40.6	48.7/**48.0**	49.0/**48.2**	49.6/**48.9**
108mPD	39.8/38.6	48.3/**47.5**	48.6/**47.8**	49.3/**48.5**
99mPD	39.5/38.3	48.2/**47.4**	48.5/**47.6**	49.2/**48.4**

Planning criteria is exceeded at high rise development on the hillside from completion of Phase II (CT10 & 11 in operation) Planning criteria exceeded at low rise receiver in Yi Pak Bay on completion of Phase III (CT 10, 11 & 12 operating). There are no instances of the enforcement criteria being exceeded.

Table 4.14/3 Noise Levels at Peng Chau (Terminal Only)

NSR ID and Elevation	Facade Noise Levels dB(A) during:			
	Phase 1	Phase 2	Phase 3	Phase 4
R4 Central Peng Chau	(Daytime/Night-time)			
Ground	42.9/41.2	44.6/42.9	47.0/**45.3**	48.0/**46.3**
R4 (a) Housing Authority Estate on Peng Chau(Daytime/Night-time)				
28 mPD	45.5/44.4	47.2/**46.2**	48.7/**47.6**	49.4/**48.2**

Planning criteria is exceeded at the new Hong Kong Housing Authority development from completion of Phase II (CT10 & 11 in operation) Planning criteria exceeded within the main body of Peng Chau on completion of Phase III (CT 10, 11 & 12 operating). There are no instances of the enforcement criteria being exceeded.

Table 4.14/4 Noise Levels at Isolated Receivers (Terminal Only)

NSR ID and Elevation	Facade Noise Levels dB(A) during:			
	Phase 1	Phase 2	Phase 3	Phase 4
R4 (b) Northern Peng Chau headland	(Daytime/Night-time)			
Ground	55.7/55.2	57.0/56.5	57.4/56.8	58.4/57.8
Fa Peng	(Daytime/Night-time)			
Ground	56.8/56.4	57.0/56.5	57.1/56.6	57.2/56.7
Tso Wan	(Daytime/Night-time)			
Ground	53.6/53.1	53.8/53.3	53.9/53.4	54.1/53.6
Hei Ling Chau 1	(Daytime/Night-time)			
Ground	39.7/39.0	44.0/43.3	47.0/46.3	49.2/48.6
Hei Ling Chau 2	(Daytime/Night-time)			
Ground	39.7/39.0	43.7/43.0	47.4/46.7	50.5/49.9

The enforcement criteria is exceeded for the indicator receivers at Fa Peng and north headland of Peng Chau from Phase I. It should be remembered that these are only indicators for the area. The receivers at Peng Chau are shielded from terminal activity by screening topography immediately to the north. Dwellings are generally single storey and would be amenable to mitigation by barrier erected close to the receiver, should impact be detected. Site visits have confirmed that the village of Fa Peng is deserted and dwellings are derelict. In addition there is shielding topography for the majority of terminal activity. Planning criteria is exceeded at the Tso Wan from Phase I, though the enforcement criteria are not exceeded. The planning criteria is exceeded a Hei Ling Chau on completion of Phase III (CT 10, 11 & 12 operating), but the enforcement criteria is not exceeded.

The next four tables set out the impact from the Port Backup Area (PBA). The Phase I and II backup areas have been subjected to rigorous analysis and proposals for detailed mitigation measures by the ancillary works consultant and their findings are recorded here. More rigorous analysis of the Phase III & IV proposals will be required in preliminary and detailed design.

Table 4.15/1 Noise Levels at Discovery Bay (Port Backup Areas Only - Existing NSR)[3]

NSR ID and Elevation	Facade Noise Levels dB(A) during:			
	Phase 1	Phase 2	Phase 3	Phase 4
Receiver DB-1	(Daytime/Night-time)			
81 mPD	35.2/32.2	40.5/37.5	42.5/39.5	43.4/40.4
72 mPD	34.9/31.9	40.2/37.2	42.4/39.4	43.3/40.3
63 mPD	34.7/31.7	39.8/36.8	42.1/39.1	43.1/40.1
54 mPD	34.5/31.5	39.3/36.3	41.8/38.8	42.8/39.8
Receiver DB-3	(Daytime/Night-time)			
91 mPD	34.9/31.9	38.1/35.1	40.6/37.6	41.6/38.6
82 mPD	34.5/31.5	37.8/34.8	40.4/37.4	41.5/38.5
73 mPD	34.2/31.2	37.5/34.5	40.3/37.3	41.3/38.3
64 mPD	33.9/30.9	37.1/34.1	40.1/37.1	41.2/38.2
Receiver DB-9	(Daytime/Night-time)			
103 mPD	31.3/28.3	34.7/31.7	37.9/34.9	39.0/3 6.0
94 mPD	31.3/28.3	34.6/31.6	37.8/34.8	39.0/36.0
85 mPD	31.2/28.2	34.4/31.4	37.7/34.7	38.9/35.9
76 mPD	31.2/28.2	34.2/31.2	37.6/34.6	38.8/35.8
Receiver DB-13	(Daytime/Night-time)			
117 mPD	29.9/26.9	34.3/31.3	38.1/35.1	39.1/36.1
108 mPD	29.3/26.3	33.8/30.8	37.9/34.9	38.9/35.9
99 mPD	28.6/25.6	33.4/30.8	37.7/34.7	38.8/35.8
90 mPD	27.9/24.9	33.1/30.4	37.6/34.6	38.7/35.7
Receiver DB-5	(Daytime/Night-time)			
28 mPD	32.9/29.9	34.2/31.2	38.4/35.4	39.7/36.7

Note: i) Noise levels for Phases 1 and 2 are provided by Mott Macdonald.
ii) Noise levels for Phases 3 and 4 are estimated using assumed locations and equipment requirements.

3 Information derived by the Ancillary Works Consultant

Table 4.15/2 Noise Levels at Discovery Bay (PBA Only - Future NSR)

NSR ID and Elevation	Facade Noise Levels dB(A) during:			
	Phase 1	Phase 2	Phase 3	Phase 4
Receiver YP-1	(Daytime/Night-time)			
16mPD	23.7/20.7	31.7/28.7	38.0/35.0	39.2/36.2
Receiver YP-2	(Daytime/Night-time)			
126mPD	30.5/27.5	37.1/34.1	39.8/36.8	40.5/37.5
117mPD	29.7/26.7	36.3/3 3.3	39.4/36.4	40.2/37.2
108mPD	28.9/25.9	35.8/32.8	39.1/36.1	40.0/37.0
99mPD	28.2/25.2	34.9/31.9	38.7/35.7	39.7/36.7

Table 4.15/3 Noise Levels at Peng Chau (PBA Only)

NSR ID and Elevation	Facade Noise Levels dB(A) during:			
	Phase 1	Phase 2	Phase 3	Phase 4
Receiver R4 Central	(Daytime/Night-time)			
10mPD	30.1/27.1	34.4/31.4	40.7/37.7	43.6/40.6
Receiver R4 (a) HKHA Housing	(Daytime/Night-time)			
28mPD	34.9/31.9	39.9/36.9	42.9/39.9	44.6/41.6

Table 4.15/4 Noise Levels at Isolated NSR (PBA Only)

NSR ID and Elevation	Facade Noise Levels dB(A) during:			
	Phase 1	Phase 2	Phase 3	Phase 4
Receiver R4 (b) Northern Headland	(Daytime/Night-time)			
24mPD2	37.7/34.7	43.2/40.2	45.7/42.7	47.1/44.1
Fa Peng	(Daytime/Night-time)			
16mPD	30.1/27.1	28.5/25.5	51.5/**48.5**	51.6/**48.6**
Tso Wan	(Daytime/Night-time)			
16mPD	26.4/23.4	25.9/22.9	48.0/45.0	48.1/**45.1**
Receiver HLC-1	(Daytime/Night-time)			
31mPD	25.8/22.8	32.0/29.0	35.7/32.7	38.9/35.9
Receiver HLC-2	(Daytime/Night-time)			
103mPD	26.2/23.2	30.7/27.7	35.5/32.5	40.1/37.1

The previous information for terminal noise (Tables 4.14/1-4) and Port Backup Area (Tables 4.15/1-4) is combined to obtain cumulative facade noise levels which are recorded in the next four tables.

Table 4.16/1 Cumulative Noise Levels at Discovery Bay (Existing NSR)

NSR ID and Elevation	Facade Noise Levels dB(A) during:			
	Phase 1	Phase 2	Phase 3	Phase 4
Receiver DB-1	(Daytime/Night-time)			
81 mPD	41.9/40.2	49.0/**47.7**	49.8/**48.5**	51.2/**50.0**
72 mPD	41.7/39.9	48.4/**47.0**	49.4/**47.8**	50.8/**49.5**
63 mPD	41.5/39.7	47.8/**46.2**	48.8/**47.1**	50.5/**49.0**
54 mPD	41.1/39.5	47.3/**45.5**	48.4/**46.6**	50.2/**48.8**
Receiver DB-3	(Daytime/Night-time)			
91 mPD	41.2/39.4	47.7/**46.5**	48.5/**47.2**	49.8/**48.7**
82 mPD	39.7/40.4	47.0/**45.7**	47.9/**46.5**	49.4/**48.1**
73 mPD	40.7/38.8	46.5/45.1	47.5/**45.9**	49.1/**47.7**
64 mPD	40.5/38.6	46.0/44.4	47.1/**45.4**	48.8/**47.4**
Receiver DB-9	(Daytime/Night-time)			
103 mPD	38.6/36.9	44.2/42.8	45.3/43.7	46.8/**45.4**
94 mPD	38.5/36.7	43.9/42.5	45.0/43.4	46.6/**45.3**
85 mPD	38.3/36.5	43.6/42.0	44.8/43.0	46.4/45.0
76 mPD	38.3/36.3	43.2/41.6	44.4/42.7	46.3/44.8
Receiver DB-13	(Daytime/Night-time)			
117 mPD	39.0/37.4	45.4/44.2	46.2/44.9	47.4/**46.2**
108 mPD	38.7/37.1	44.8/43.5	45.8/44.3	47.0/**45.7**
99 mPD	38.4/36.7	44.2/42.9	45.2/43.8	46.7/**45.3**
90 mPD	38.2/36.5	43.8/42.5	45.0/43.4	46.4/**45.1**
Receiver DB-5	(Daytime/Night-time)			
28 m	40.1/38.4	44.1/42.4	45.4/43.6	46.3/44.5

Table 4.16/2 Cumulative Noise Levels at Discovery Bay (Future NSR)

NSR ID and Elevation	Facade Noise Levels dB(A) during:			
	Phase 1	Phase 2	Phase 3	Phase 4
Receiver YP-1	(Daytime/Night-time)			
16mPD	37.8/37.1	47.8/**47.0**	48.4/**47.4**	48.9/**47.8**
Receiver YP-2	(Daytime/Night-time)			
126mPD	42.0/41.0	49.2/**48.3**	49.6/**48.7**	50.3/**49.3**
117mPD	41.8/40.8	48.9/**48.1**	49.4/**48.5**	50.1/**49.2**
108mPD	40.1/38.8	48.5/**47.6**	49.1/**48.1**	49.8/**48.8**
99mPD	39.8/38.5	48.4/**47.5**	48.4/**47.9**	49.7/**48.7**

Table 4.16/3 Cumulative Noise Levels at Peng Chau

NSR ID and Elevation	Facade Noise Levels dB(A) during:			
	Phase 1	Phase 2	Phase 3	Phase 4
Receiver R4 Central	(Daytime/Night-time)			
10mPD	43.1/41.4	45.0/43.2	47.9/**46.0**	49.4/**47.3**
Receiver R4 (a) HKHA Housing	(Daytime/Night-time)			
28mPD	45.9/44.6	47.9/**46.7**	49.7/**48.3**	50.6/**48.9**

Table 4.16/4 Cumulative Noise Levels at Isolated Receivers

NSR ID and Elevation	Facade Noise Levels dB(A) during:			
	Phase 1	Phase 2	Phase 3	Phase 4
Receiver R4 (b) Northern Headland	(Daytime/Night-time)			
24mPD2	55.8/**55.2**	57.0/**57.2**	57.7/**57.0**	58.7/**58.0**
Fa Peng	(Daytime/Night-time)			
16mPD	56.8/**56.4**	57.0/**57.0**	58.2/**57.2**	58.3/**57.3**
Tso Wan	(Daytime/Night-time)			
16mPD	53.6/**53.1**	53.8/**53.8**	54.9/**54.0**	55.1/**54.2**
Receiver HLC-1	(Daytime/Night-time)			
31mPD	39.9/39.1	44.3/43.5	47.3/**46.5**	49.6/**48.8**
Receiver HLC-2	(Daytime/Night-time)			
103mPD	39.9/39.3	43.9/43.1	47.7/**46.9**	50.9/**50.1**

During the night-time, exceedances of the planning criteria are identified at limited numbers of receivers in Discovery Bay and Peng Chau, at Phase II, and more extensively as the later phases are commissioned. However, exceedances of the enforcement criteria

are identified only at the indicator points in Fa Peng and the northern headland of Peng Chau. The shielding effects of topography and mitigation, at the receiver in the form of barriers is recommended at these scattered NSRs. To confirm the actual levels of impact and detailed mitigation requirements a more focused study will be required. Including an identification of the land status for individual dwellings.

Impacts on Discovery Bay NSR

The planning criteria is exceeded at Peninsular Village from completion of Phase II (CT10 & 11 in operation) and at the high rise blocks in the northern area on completion of Phase IV (CT 10, 11, 12 & 13 operating). There may be opportunity to reduce impact by incorporating noise attenuation barriers into Phase IV. There are no instances of the enforcement criteria being exceeded.

For the future Yi Pak development the planning criteria is exceeded at the notional high rise development on the hillside from completion of Phase II (CT10 & 11 in operation). Planning criterias exceeded at the notional low rise receiver on the reclamation in Yi Pak Bay from completion of Phase III (CT 10, 11 & 12 operating). There are no instances of the enforcement criteria being exceeded.

Impacts on Peng Chau NSR

Planning criteria exceeded at the new Hong Kong Housing Authority development from completion of Phase II (CT10 & 11 in operation) Planning criteria exceeded within the main body of Peng Chau on completion of Phase III (CT 10, 11 & 12 operating). There are no instances of the enforcement criteria being exceeded.

Impacts on the isolated NSR

The enforcement criteria is exceeded for the indicator points at Fa Peng and north headland of Peng Chau from Phase I. The main body of receivers at headland Peng Chau are shielded from terminal activity by screening topography immediately to the north. Dwellings are generally single storey and would be amenable to mitigation by barrier erected close to the receiver, should impact be detected. Site visits have confirmed that the village of Fa Peng is deserted and dwellings are derelict. In addition there is shielding topography for the majority of terminal activity. Planning criteria is exceeded at the Tso Wan from Phase I, though the enforcement criteria are not exceeded. The planning criteria is exceeded a Hei Ling Chau on completion of Phase III (CT 10, 11 & 12 operating), but the enforcement criteria is not exceeded.

4.5.4 SUMMARY AND CONCLUSION

Construction Phase

It has been assumed that construction activity will continue for a 16 hour day (0700hrs to 2300hrs). At Discovery Bay unmitigated construction activities during concurrent activities of Berths 1 (Phase 1) and 5 (Phase 2) exceed the daytime assessment criterion of 60 dB(A) and evening NCO criterion of 60 dB(A). At Peng Chau assessment indicate that impact on the main residential area will be within identified criteria for the proposed daytime and evening work. The indicator points at north headland Peng Chau and Fa Peng indicated impacts in excess of the identified criteria. However, the actual NSR at Peng Chau are protected by topography and at Fa Peng the deserted and derelict village will be protected from terminal construction by topography.

To protect the adversely affected NSR mitigation will be required which could include the use of quietened plant, acoustic barriers, and careful scheduling of activities. A quantitative assessment of mitigated construction noise awaits more detailed equipment lists and scheduling, which can allow better estimates of possible equipment reductions to be made. In this assessment construction plant noise was reviewed which indicated that a reduction of 10 dB(A) in the SWL of the earthmoving fleet, the main source of construction noise, would reduce impact levels to within the identified criteria. This assumption is consistent with US reported noise reductions achieved through partial engine enclosure and a review of plant suggests that quieter plant is available.

Operation Phase

During the daytime, no exceedances of the enforcement criteria are anticipated. However, planning criteria (based on an assumed ASR of "A") may be exceeded at the indicator points in Fa Peng and the northern headland of Peng Chau,though topography will shield NSR at these locations.

During the night-time, exceedances of the planning criteria is anticipated at exposed receivers in all assessed receiver locations. However, exceedances of the enforcement limits are expected only at the indicator points at Fa Peng and the northern headland of Peng Chau. Topography will shield the actual NSR at these locations, and further assessment is required to confirm actual levels of impact. Should adverse impact be detected mitigation, in the form of acoustic screening close to the NSR, offers the most effective solution.

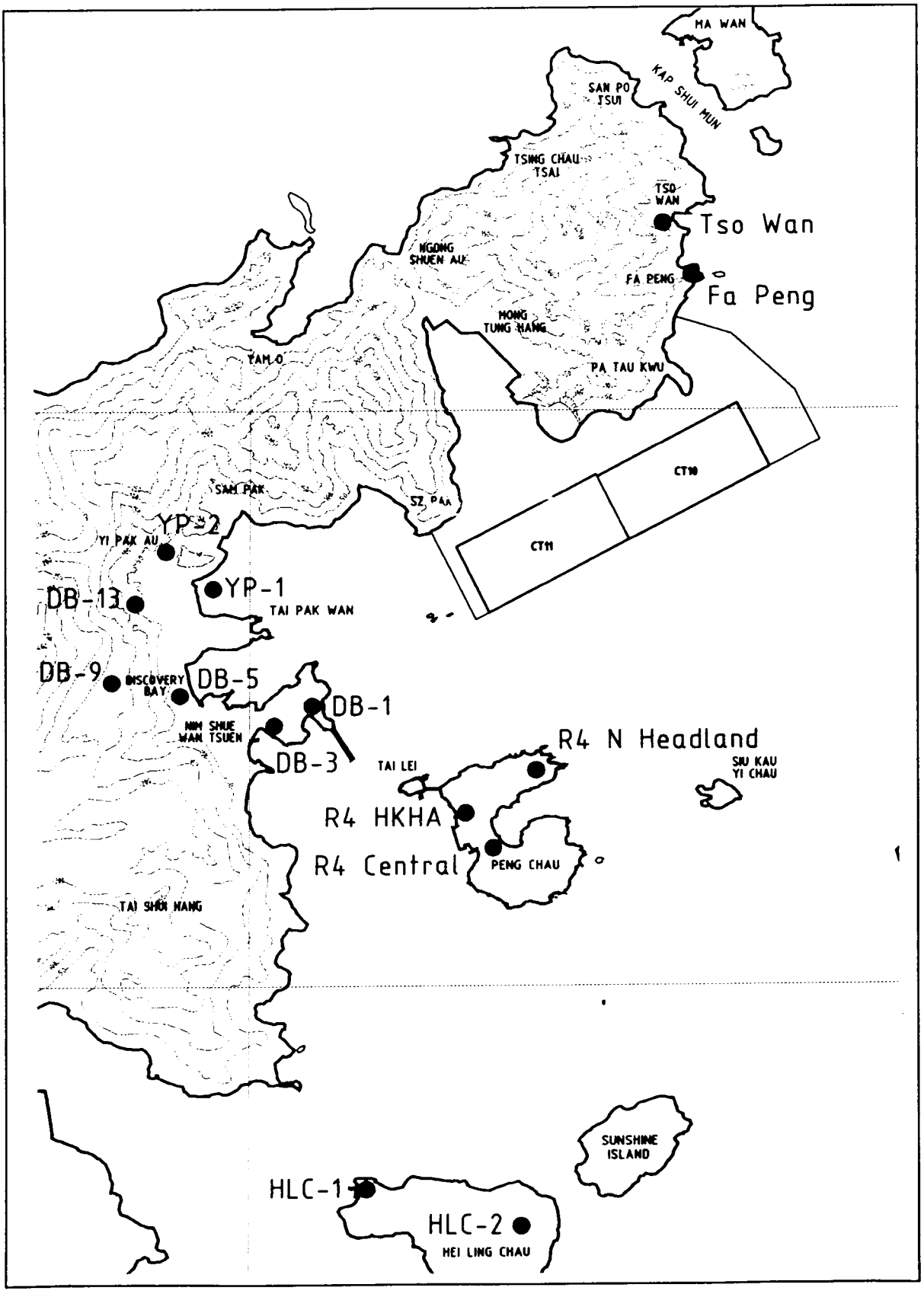

Figure 4.1 Noise Sensitive Receivers

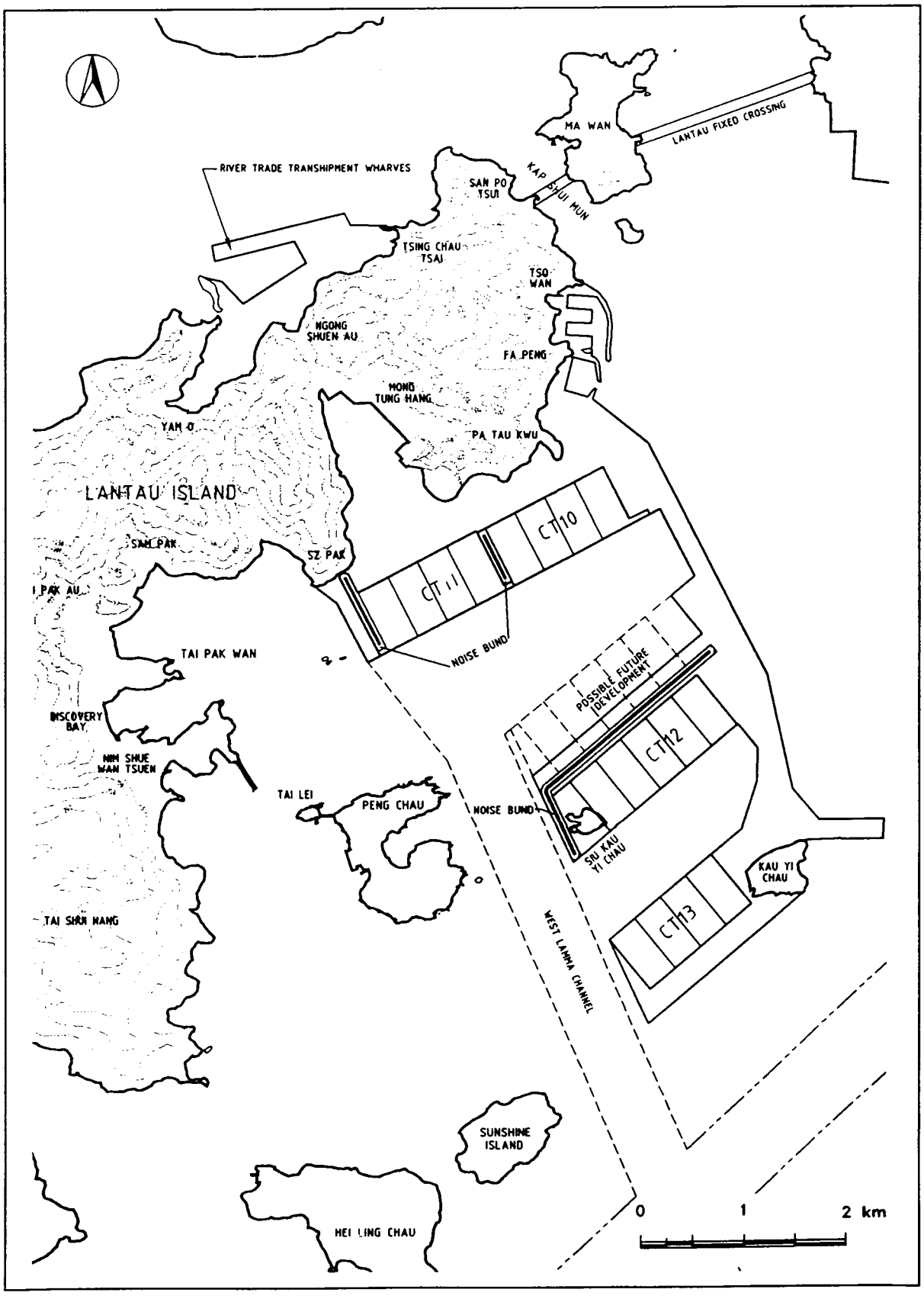

Figure 4.2 General Arrangement of Terminal

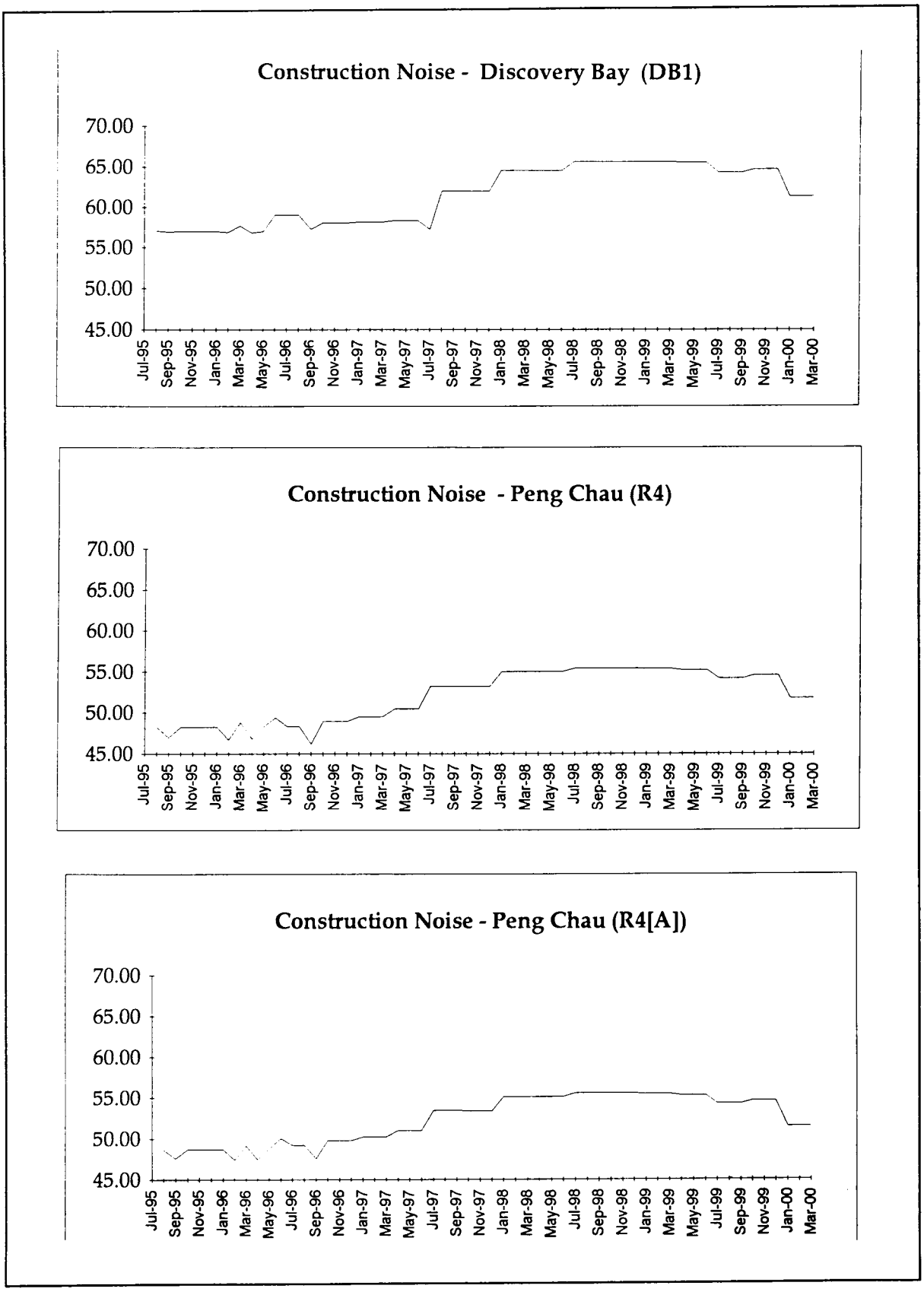

Figure 4.3 Monthly Construction Noise Impacts