

5 NOISE

5.1 Introduction

This section is an initial assessment of the impact of implementing the fully dredged option. The last studies investigated the impact of construction in a drained option. Quantitative modelling and assessment indicated that for the criteria identified, 60 dB(A) in the daytime [non-statutory], and 60 dB(A) in the evening [Noise Control Ordinance], that mitigation could reduce the impact to acceptable levels. Daytime is defined as 0700hrs to 1900hrs and evening as 1900hrs to 2300hrs. The main difference in the fully dredged option is the identified programming requirement of 24 hour working for dredging and filling. It is assumed that only the water-borne fleet will work 24 hours per day. The land based fleet of dozers and trucks will work a 16 hour day from 7.00hrs to 23.00hrs

5.2 Review of Previous Studies

5.2.1 LPD Stage 1 Container Terminals 10 & 11 Preliminary Design Study

The final report for the EIA studies was issued in January 1995. The study was focused on the preliminary design of Terminals CT10 & CT11 but looked at the cumulative impact of operation noise when all Phases of the terminal were commissioned (CT10, 11, 12 & 13) to meet the required criteria the positions of CT12 and CT13 were modified to mitigate impact. The construction programme assumed that a drained reclamation was adopted and construction would be for a 16 hour day (0700hrs to 2300hrs) which would invoke the requirement for a Construction Noise Permit. The study adopted the assumptions made in the LAPH studies, namely that :

- the ASR for the area was "A"; and
- daytime construction noise impact at NSR should be limited to 60 dB(A).

The implications were that both the acceptable daytime and evening construction noise impact levels were set at 60 dB(A). At peak construction it was predicted that the unmitigated impact of construction would exceed the assessment criteria at Discovery Bay by up to 6 dB(A). Mitigation was identified which was capable of reducing construction impacts to within the identified criteria. The main source of impact was the large fleet of dumptrucks moving surcharge material on the reclamation.

5.2.2 LPD Stage I Container Terminals 10 & 11 Ancillary Works (Design)

The final report for the EIA studies was issued in December 1994. This study focused on the design for the areas behind the terminals, the so called port back-up areas but also included cumulative noise modelling of concurrent CT10 & 11 construction activity and also noise generated on Haul Routes. The assumption corresponded to the CT10 & 11 preliminary design, principally : adoption of ASR "A"; 60 dB(A) daytime criteria; and a 16 hour working day. Work associated with the ancillary works were shown to be within the adopted criteria at all identified NSR except headland Peng Chau (not considered as a NSR in the present study following site visits). When the construction activities associated with the Terminals were included noise impact levels at worst affected receiver

(Cherish Court in Discovery Bay) was predicted to be 65.5 dB(A). However the study concluded that mitigation could be applied to mitigate impact to an acceptable level.

5.3 Statutory and Guideline Criteria

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 Public Places 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 and this approach was adopted in the LAPH and LPD Stage I studies where daytime background levels were taken to be 50 dB(A) and an acceptable daytime impact level at receiver was taken to be 60 dB(A).

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) for dwellings 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 involving the use of powered mechanical equipment for the purpose of carrying out construction work 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 No 5.1 : 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

Notes * Recommended but not statutory
 + includes all day Sundays and Public Holidays

5.4 Assessment Methodology

5.4.1 General

In this report the effects of the terminal construction will be assessed to identify potential constraints on the construction programme. Scheduling, plant inventories and utilisation data have been derived by the engineering team and are presented in Chapter 3 of this report. The object of the assessment is to identify occurrence of adverse impact and identify mitigation or restrictions which may need to be applied. 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 absorption has been included.

5.4.2 Modelling 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 300 m 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%

5.4.3 Equipment Characteristics

Plant utilisation schedules for the reclamation of the terminals and entrustment area have been prepared by the engineering design team to identify equipment requirements on a quarterly basis. Maximum plant requirements (not necessarily concurrent) are summarised in the following table. Associated sound power levels have been taken from the *Technical Memorandum on Noise from Construction Work other than Percussive Piling*, BS 5228 Part I, or from similar projects carried out in Hong Kong.

Table No 5.2 : Construction Equipment Characteristics

Activity and Equipment	Equipment		
	Sound Power Level (dB(A))	Maximum number in use per terminal	
		Dredged	Drained
Geotextile			
Barge	110	1	2
Wick drains			
Barge	110	3	10
Dredging, Sandfill and Surcharge ¹			
Cutter suction dredger ²	104	2	2
Trailer suction dredger ²	109	3	3
Removal of surcharge			
Dumptruck (25 cu.m.)	121	10	32
Bulldozer	115	3	8
Loader	112	4	11

NOTES: 1 A booster pump used in previous assessments for distribution of sandfill is no longer considered to be necessary, and has been omitted from this assessment.
2 Only one dredger of each type is expected to be operating at each terminal at a given time.

5.5 Impact on Receivers

General Construction

Reclamation of CT10 and CT11 will commence in the first quarter of 1996. Reclamation in the entrustment area will start at about the same time.

Dredged Option

Under this option, the construction methodology involves initial dredging of the terminal areas and navigation channel. Concurrently with dredging, the terminals will be filled to -7 mPD, then to +5.6 mPD. A surcharge will then be placed at the terminal sites. After removal of the surcharge, the terminal reclamation will

be completed. Anticipated completion dates for the reclamations start in the second quarter 1997 at CT10 and first quarter 1998 at CT11, and follow at about 6-month intervals in each terminal.

Formation of the CT10 noise bund will be started in the fourth quarter of 1996, and will be completed in about one year. It will thus not be complete at the time of surcharge placement and removal on Berths 1, 2 and 3. Formation of the CT11 noise bund will be started in the first quarter of 1997. It will also require about 1 year to complete, and thus will not yet be finished at the time of surcharge placement and removal on Berth 1.

The entrustment reclamation will not be dredged. Works will entail laying geotextile, followed by laying a sand blanket and installing wick drains. The area will be sandfilled, followed by placement and removal of a surcharge. These works are expected to start in the first quarter of 1996 and finish in the last quarter of 2000.

Drained Option

Under this option, the construction methodology involves some initial dredging of the terminal areas, entrustment and navigation channel. Concurrently with dredging, a sand blanket will be laid at the terminal and entrustment sites, followed by installation of wick drains. The area will be sandfilled, and a surcharge will then be placed. After removal of the surcharge, the terminal reclamation will be complete. Anticipated completion dates for the reclamations start in the first quarter 1998 at CT10 and second quarter 1998 at CT11, and follow at about 6-month intervals in each terminal.

Formation of the CT10 noise bund will be started in the fourth quarter of 1997, and will be completed in about half a year. It will thus not be complete at the time of surcharge placement and removal on Berths 1 and 2. Formation of the CT11 noise bund will be started in the third quarter of 1998. It will also require about half a year to complete, and thus will not yet be finished at the time of surcharge placement and removal on Berths 1, 2 and 3.

The following table indicates *worst case* noise levels during concurrent reclamation at CT10, CT11, and the entrustment, along with dredging of the navigation channel. Only NSR DB-1 is considered in the assessment, since previous assessments have shown this to be the critical receiver. Daytime and evening activities are assumed to be identical. Night-time activities are assumed to be restricted to dredging and filling operations only, and to exclude activities associated with geotextile placement, wick drain installation, and surcharge removal.

Table No 5.3 : Predicted Construction Noise during Reclamation Activity

Assessment Period	Criteria	Maximum Facade Noise Level at NSR DB-1 due to Construction [dB(A)]	
		Dredged	Drained
Daytime and Evening	60	61.3	64.6
Night-time (dredging and filling only)	45	41.0	41.9 (see note No4)

NOTE: 1) Based on reclamation activity at CT10, CT11, and the entrustment, and dredging in the navigation channel.
 2) Dredging will involve 3 trailer suction dredgers operating at each site, though only a single dredger will be at the reclamation site at any one time.
 3) Reclamation involves 2 cutter suction dredgers at each site rehandling material and 1 trailer dredger at the site discharging its load (see note 2).
 4) Night-time activity not anticipated - result included for reference only

During reclamation works, noise levels due to dredging and filling are expected to remain below the night-time limit (as well as below daytime and evening limits). However, the large fleet of dumptrucks required to remove the surcharge is expected to cause an exceedance of the daytime and evening noise criterion.

Dredged Option - Exceedance of the 60 dB(A) daytime and evening criterion is slight, and is predicted to occur only over two quarters (fourth quarter 1997 and first quarter 1998) during concurrent surcharge removal at Berths 2 and 3 (CT10) and Berth 1 (CT11).

Drained Option - The anticipated daytime and evening noise levels significantly exceed the 60 dB(A) criterion, due to the equipment required to remove the expected 12-m surcharge. This exceedance is expected to last for 7 quarters (fourth quarter 1997 to second quarter 1999), being most severe at the beginning of this period when surcharge is being removed from both Berth 1 (CT10) and Berth 1 (CT11). This exceedance was not anticipated in earlier assessments, where removal of a 9-m surcharge (requiring fewer dumptrucks) was assumed.

The adoption of the non-statutory 60 dB(A) daytime criteria from the LAPH studies, together with the requirements of the NCO Technical Memorandum for evening work (17.00 - 23.00 hrs), 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 24-hour working schedule for dredging and filling equipment, and a 16-hour working day (07.00 to 23.00) for other plant, will be required. The need for mitigation during the daytime and evening is therefore anticipated.

5.6 Mitigation

Construction activities between 19.00 - 23.00 hrs require issue of a Construction Noise Permit from EPD. For the drained option it is assumed that a 16 hour working day will be required. The fully dredged option assumes that reclamation and filling activity will take place around the clock (24 hours of each day). The

calculations in this section indicate that during the night-time period (23.00 to 07.00hrs) the dredging and filling operation **could** meet the strict 45 dB(A) night time criteria.

For daytime working impact assessment identifies adverse impact which will require mitigation. 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 gasketed windows and air conditioning , though this is not a preferred option.

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 effective mitigation if they are placed along the haul routes. Once construction of the terminals has proceeded sufficiently far, the noise bunds at the western ends of CT10 and CT11 will act as effective barriers to construction noise.

Evaluation of Effectiveness of these Measures: 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/m². 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, each of which has been assumed to generate a SWL of 121 dB(A). Assuming a 10 dB(A) reduction in the SWL of the dumptrucks, the construction noise at DB1 could be reduced to below 60 dB(A). This assumed 10 dB(A) SWL reduction is consistent with monitored noise levels of 50-tonne dumptrucks provided in BS 5228 Part 1 (1984), which gives SWL values in the range of 103 dB(A) to 120 dB(A) for 50 tonne dump trucks. It is also consistent with US-reported SWL reductions resulting from the use of partial engine enclosures.

Programming of activities offers a method of spreading the impact thereby reducing individual impact levels.

Under the dredged reclamation option, programming may permit noise levels to be reduced sufficiently to meet daytime and evening noise criteria. For example, if the number of operating dumptrucks at Berth 1 (CT11) was reduced from 9 to 7, it is expected that the 60 dB(A) criterion could be met. Under the drained reclamation option, the more severe exceedance of the noise limits makes equipment reduction less viable. The number of dumptrucks would have to be reduced by over half to bring daytime and evening noise levels to 60 dB(A); this measure is not considered feasible without disrupting the construction schedule.

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. It is unlikely to be a preferred option for the area surrounding CT10 and CT11, 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 programming 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 authorise 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.

5.7 Conclusion

In this assessment quantitative modelling has been carried out to predict the impact of the drained and fully dredged reclamation options. For the drained option it is assumed that work will only proceed for a 16 hour day, while for the dredged option 24 hour working is assumed for the dredging / filling activities. The assessment indicates that the night-time work can be conducted within the identified criteria. The daytime assessment carried out for the drained option differs from the LPD Stage I Preliminary Design assessment in that surcharge height is increased to 12 metres, from the assumed 9 metres. This increases the level of construction activity and associated noise impact. For the fully dredged option only 4 metres of surcharge are needed. Unmitigated peak construction noise impact of 61.3 dB(A) and 64.6 dB(A) for the dredged and drained options respectively are predicted. The duration of the exceedence is about six months for the dredged option and about twenty one months for the drained option. The assessment has identified mitigation that is capable of reducing the construction noise impact to below the 60 dB(A) daytime and evening criteria. It is believed that with sympathetic programming the impacts could be reduced to within the assessment criteria for the dredged option, for the drained option the number of operating dumptrucks would have to be halved which would disrupt the construction programme.

In view of the fact that unmitigated construction activity for the drained option will exceed the assessment criteria for 15 months longer than for the fully-dredged option, and is less amenable to mitigation, it is concluded that in overall terms the dredged option offers the least impact to the environment.